EFFECTS OF POPULATION GROWTH ON BASIC INFRASTRUCTURE FOR BASIC SERVICES PROVISION IN BOJANALA PLATINUM DISTRICT MUNICIPALITY: ECONOMETRIC ANALYSIS OF PANEL DATA

BY

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DECLARATION

I, the undersigned, hereby declare that the thesis "**EFFECTS OF POPULATION GROWTHON BASIC INFRASTRUCTURE FOR BASIC SERVICES PROVISION IN BOJANALA PLATINUM DISTRICT MUNICIPALITY: ECONOMETRIC ANALYSIS OF PANEL DATA"** is my own research work and conclusions herein are my own. This thesis is submitted for the degree of MPhil at the University of Kwazulu-Natal. This thesis has not been submitted for any other degree at any other university, and that all the sources I have used or quoted have been indicated and acknowledged in a complete reference list.

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Joel Marumo Mosenogi

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Abstract

This thesis presents estimation of fixed effect panel data regression analysis on the effects of population growth on infrastructure for basic services provision by the Bojanala Platinum District Municipality. We discuss estimation techniques for both fixed and random effects panel data regression models and ultimately the fixed effect model is applied. The study focused on electricity and water infrastructure with four racial groups being studied separately to determine their individual effects on infrastructure for basic services. the study objectives are to understand the effects of population growth on infrastructure for basic service provision and to explore remedies and responses to population growth and infrastructure challenges in the Bojanala Platinum District Municipality. To effectively study these objectives, a panel data analysis approach is applied. The results showed mixed results amongst racial groups and their relation and effects to infrastructure with African and White population groups growth showing that they negatively affect infrastructure for basic service provision.

It is evident that population growth negatively affects infrastructure for the provision of basic services more especially for the African and White population groups. The study further concludes that economic growth and unemployment do not have any negative impact on infrastructure for electricity provision while an increase in people in poverty would result in an increased demand for basic infrastructure for electricity connection. Furthermore, in the Bojanala Platinum District Municipality, unemployment, economic growth and poverty do not impact basic infrastructure demand for the provision of water service.

Finally, there are various issues that affect infrastructure for basic service and provision thereof in various local municipalities within the Bojanala Platinum District Municipality. Some are negative and

some positive and as indicated above, the focus of this study was primarily on population growth and infrastructure for basic service provision, but not on other factors contributing to the provision or none-provision of infrastructure for basic services.

Table of Contents

List of Acronyms

BPDM	Bojanala Platinum District Municipality
CLTS	Community Led Total Sanitation
DBSA	Development Bank of Southern Africa
DrKKDM	Dr Kenneth Kaunda District Municipality
DrRSMDM	Dr Ruth Segomotsi Mompati District Municipality
FE	Fixed Effects
GDP	Gross Domestic Production
GDP-R	Gross Domestic Production by Region
HDI	Human Development Index
IDP	Integrated Development Plan
IMF	International Monetary Fund
KRLM	Kgetleng Rivier Local Municipality
LED	Local Economic Development
LEDC	Less Economically Development Countries
MEDC	More Economically Developed Countries
MDG	Millennium Development Goals
MIIF	Municipal Infrastructure Investment Framework
MKLM	Moses Kotane Local Municipality
MLM	Moretele Local Municipality

NDP	National Development Plan
NERSA	National Energy Regulator of South Africa
NMMDM	Ngaka Modiri Molema District Municipality
PPPs	Public-Private Partnerships
RDP	Reconstruction and Development Program
RLM	Rustenburg Local Municipality
SACN	South African Cities Network
StatsSA	Statistics South Africa
UN	United Nations
US	United States
VIP	Ventilated Improved Pit
WRC	Water Research Commission

Chapter 0ne

1.1 Introduction

The importance of demographic factors in development planning can never be overemphasized. According to the United Nations (2017), the global population is estimated to reach a total of 6.8 billion in 2019. Further Projections placed the figure at more than 9.2 billion by the year 2050 (another widely cited projection is higher, at 9.5 billion) and most of that population will inhabit the developing world (United Nations, 2017). Of critical importance is understanding the implications of these projections should they be realised. The reason for this is that as part of Africa, South Africa has the estimated population size of 55.6 million in 2016 with 51% being women and 49`% being men and with the majority being young people at 36.2% across all sexes (United Nations, 2017). Therefore, the country needs to pay special attention to the demographic factors.

The North West Province population growth rate has over time been on an increase from 0.8% during the period 1996-2001 to 1.6% during 2006-2011. The total population growth rate from 1996 to 2015 in the North West Province recorded 1.2% and for the period 2015 between 2020 the population it is projected to grow at the rate of 1.2%.

The largest contributor to the North West Province population size and growth rate is the Bojanala Platinum District municipality (BPDM). The Bojanala district population growth rate increased from 1% in 1997 to 2.1% in 2006 and slightly decreased to 2% in 2015 with Dr Kenneth Kaunda District Municipality (DrKKDM) recording the second largest growth rate within the province in 2015 at 1.5% from 0.7% in 1997. Population growth rate shows to be low in the Dr Ruth Segomotsi Mompati District Municipality (DrRSMDM) at 1.1% in 2015 just below the Ngaka Modiri Molema District Municipality (NMMDM) at 1.2% in the same year. In general, the North West Province population grew at 1.6% and the actual population is projected to reach 4 million in 2020 from 3.7 million in 2015.

The Bojanala Platinum District municipality has five local municipalities with Rustenburg and Madibeng being the largest contributors to population growth. These are the most urban local municipalities in the district. As argued by Asoka, Thuo and Bunyasi (2013), there is a growing acknowledgement that the growth of cities is inevitable. Therefore, the solution to urban problems should be reliant on effective urban planning, infrastructure development and management. Rapid and often unplanned population growth is often associated with population demands that outstrip infrastructure and service capacity thus leading to environmental degradation (Asoka, Thuo & Bunyasi, 2013).

Based on data sourced from IHS Markit (2018), the Bojanala Platinum District Municipality is the fastest growing municipality in terms of population and has the highest service delivery backlog in the province. It is worth understanding the relationship between population growth and service delivery. Due to high population growth in the BPDM, basic service delivery such as water, sanitation, refuse removal and electricity remains a challenge for the entire population. It is strategically located along the N4 highway and there are many economic activities taking place which could largely contribute to the population pulling factors. However, such population growth requires public goods and the provision of basic services, more especially for those people relocating to this district municipality in search for jobs and other economic opportunities. Across the North West Province, both social and economic infrastructure are a challenge and the Bojanala Platinum District Municipality is not an exception. This study aims place to the surface the challenges and opportunities faced by this district, possible interventions and further research that may be required to alleviate them.

1.2 Problem Statement

The success or otherwise of economic development process depends largely on the available resources and an enabling environment. Resources such as capital, manpower and technology are

necessary inputs in the growth process. All these can be achieved through significant investment in infrastructure depending on the state of infrastructure in a particular country or region. In various areas, considerable research has focused on analysing the relationship between infrastructure development and economic growth (Fedderke and Garlick 2008; Aschauer 1989; Meyer, Breitenbach, Fenyes and Jooste 2009; Zaaruk 2012). However, there is limited research done in infrastructure and population growth. Infrastructure is developed mainly for people and the process of infrastructure accumulation and economic growth requires both physical capital (infrastructure) and human capital (population). On the same breath, human capital precedes physical capital.

The availability of infrastructure such as water, sanitation, roads and energy in households is critical in improving human living conditions. High population growth may put pressure on municipal infrastructure which may ultimately lead to infrastructure decay. Such high growth also requires the municipality to provide basic services which come at a cost. This is despite that due to current economic conditions, sufficient budget may not be available to keep pace with increasing demand for basic services as a result of high population growth. Failure to provide infrastructure that could cater for the entire municipal population may result in human living conditions deteriorating.

1.3 Research Objectives

This research study aims to:

1.3.1 Understand the effects of population growth on infrastructure for basic service provision; and

1.3.2 Explore remedies and responses to population growth and infrastructure challenges in the Bojanala Platinum District Municipality.

1.4 Scope of the Study

This research is designed to review relevant literature and develop and appropriate analytical tools such as panel regression analysis on quantitative data to analyse the effects of population growth on infrastructure for basic services provision in the Bojanala Platinum District Municipality with specific focus on electricity and water infrastructure.

According to the Development Bank of Southern Africa (2012), there are two types of infrastructure. These are Economic Infrastructure and Social Infrastructure. Economic Infrastructure is defined as an infrastructure that promotes economic activity, including roads, electrical lines and water pipes, while social infrastructure promotes health, educational and cultural standards of the population, which include schools, clinics, parks and statue (Development Bank of Southern Africa, 2012). The two types of infrastructure are necessary and equally important for human survival and achievement of acceptable standard of living. Though this study is mainly focused on electricity and water, a municipal service review on chapter two and literature review in chapter three give broader details on electricity, water, housing, sanitation, roads and refuse removal.

1.5 Importance of the Study

This study assesses both the short and long-term impact of population growth on infrastructure for basic service delivery in the Bojanala Platinum District Municipality. The study will provide an indication of whether population growth has worsened or contributed positively to the state of infrastructure and to what extent has it contributed to such. Most studies have focused on different aspects of population and infrastructure with emphasis on economic growth, environment and some specifically infrastructure investment and population growth from different dimensions within respective fields of study, but very few if none, have paid a closer attention to infrastructure, service

delivery and population growth especially in South Africa. Therefore, this study aims to contribute towards closing that gap.

It is evident from the existing body of literature that the topic remains under-studied. It is against this backdrop that this study intends to cultivate an interest in population growth, infrastructure and basic service provision in South Africa. With the application of panel data analysis, the study will further introduce the new dimension of literature in the field of population sciences.

1.6 Limitations of the Study

One of the limitations of this study is the insufficient amount of literature in population growth, infrastructure and provision of basic services. In South Africa and Africa at large, very few studies have been conducted in these areas of research. Another challenge is the readily available data for analysis. The available time series data has many observations which are less than 21 years and is captured as annual data; however, econometric techniques can be applied to disaggregate such data to half yearly or quarterly basis. In this case, panel data will be applied which will cater for all five local municipalities in the Bojanala Platinum District Municipality.

1.7 Plan of the Study

The study is organised such that chapter one (1) introduces the study, outlines the problem statement, objectives and research questions and why is it important to undertake this study. Chapter two (2) provides a background on the state of population, infrastructure and service delivery in Bojanala District Municipality. Chapter three (3) entails the theoretical foundation where infrastructure related theories as well as population growth theories are explored. The chapter also presents a literature review which explores different topical issues regarding this study with reference to other similar

studies, referring to recognised journals and periodicals, textbooks and other writers (researcher) and a critical approach or outlook on the work already done in the same field. Chapter Four (4) discusses the research methodology and model specification. Chapter five (5) reports on the results of the empirical analysis and interpretation thereof. Finally, chapter six (6) provides the study conclusions and recommendations.

1.8 Conclusion

The importance of population factors in sustainable development cannot be over-emphasised. An understanding of population factors enables policy makers to make sound policy decisions. It also makes planners to be intellectually sound and evidence orientated and practitioners to be more proactive, efficient and effective. This study effectively is expected to contribute significantly to the scientific body of knowledge in infrastructure with specific reference to basic service provision and population growth at municipal level in South Africa. This chapter did provide clarity on what the study intends to achieve and serves as a navigator through-out the study.

Chapter 2: Background on Bojanala Platinum District Municipality

2.1 Introduction

An understanding of the complexity and dimensions of municipalities in the context of current service delivery challenges and most importantly demographic factors cannot be over-emphasised. Population size continues to grow in South Africa and the Bojanala Platinum District Municipality within the North West Province is not an exception to this. The more the people you have the more infrastructure development and maintenance thereof is required. To achieve this, more investment is required. As argued by the Development Bank of Southern Africa (2011) in its report on Municipal Infrastructure Investment Framework (MIIF 7) for South Africa Round 7 (2009 – 2010), indicated that capital investment in municipalities is required in housing (human settlements), water services, electricity, municipal solid waste, roads, public transport and municipal public services. This clearly provides a broader view of what is meant by infrastructure in local municipalities in relation to their mandate.

As a municipality, BPDM operate within policy and legislative parameters as outlined in the Municipal Systems Act. Thus, the local government is fundamentally conceptualised with sound governance and sustainable development in mind. As argued and pre-ambled in the Local Government: Municipal Systems Act 32 of 2000 (2000), it stipulates that the Act seeks to provide for the core principles, mechanisms and processes that are necessary to enable municipalities to move progressively towards the social and economic upliftment of local communities, and ensure universal access to essential services that are affordable to all; to define the legal nature of a municipality as including the local community within the municipal area, working in partnership with the municipality's political and administrative structures; to provide for the manner in which municipal powers and functions are exercised and performed; to provide for community participation; to establish a simple and enabling framework for the core processes of planning, performance management, resource mobilisation and

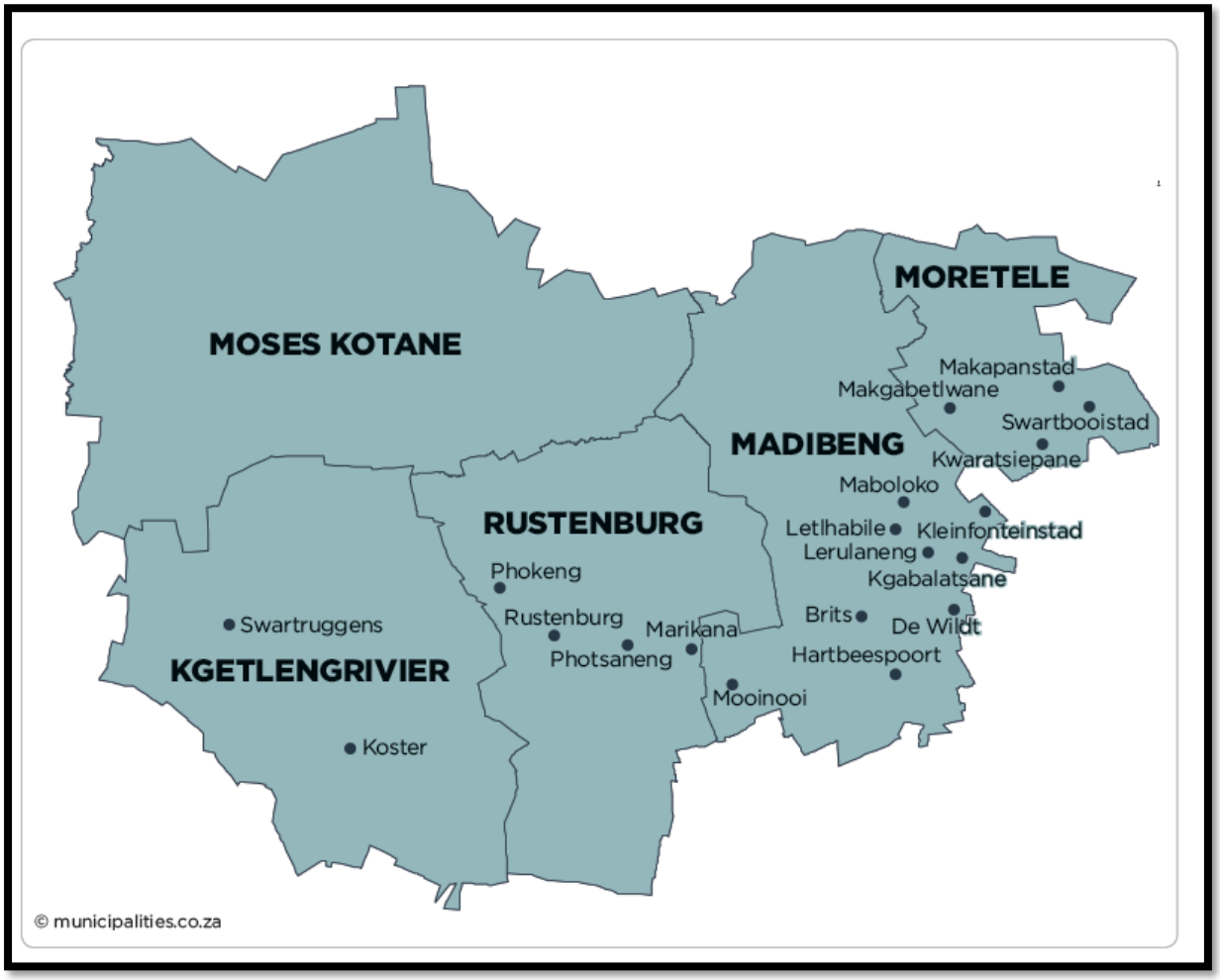
organisational change which underpin the notion of developmental local government; to provide a framework for local public administration and human resource development; to empower the poor and ensure that municipalities put in place service tariffs and credit control policies that take their needs into account by providing a framework for the provision of services, service delivery agreements and municipal service districts; to provide for credit control and debt collection; to establish a framework for support,, monitoring and standard setting by other spheres of government in order to progressively build local government into an efficient, frontline development agency capable of integrating the activities of all spheres of government for the overall social and economic upliftment of communities in harmony with their local natural environment; to provide for legal matters pertaining to local government; and to provide for matters incidental thereto (Municipal Systems Act, 2000).

This chapter explores the state of infrastructure and population in all local municipalities within the Bojanala Platinum District. In addition, other development indicators such as Human Development Index (HDI), Gini Coefficient, Unemployment and poverty are discussed to reflect the developmental status of the local municipalities within the Bojanala District.

2.2 Bojanala District Municipal Background

Bojanala Platinum District Municipality is a Category C municipality situated in the north-eastern part of the North West Province. The District Municipality includes the five Category B municipalities of Kgetleng-rivier, Madibeng, Moretele, Moses Kotane and Rustenburg. Figure 1 below shows the geographic land scape of the Bojanala Platinum District.

Figure 1: *Bojanala District Municipality*



Source: Municipalities.co.za (2018)

Figure 1 shows that there are more formal urban areas located in the southern side of the district. These include Rustenburg and Brits which are vibrant economic nodes. There are other small noticeable nodes in the southern area located in the Kgetleng Municipality namely; Koster and Swartruggens. Large parts of the Bojanala Platinum District Municipality are characterized by high levels of biodiversity as determined in the North West Biodiversity database. These include the areas along the Magaliesberg stretching from the southern parts of Madibeng Local Municipality in the east to Rustenburg and further north-west up to the north western parts of the Rustenburg Local Municipality. It also includes areas in the central parts of the Kgetlengrivier Local Municipality, as well as large parts of the Moses Kotane Local Municipality west of the Pilanesberg National Park.

The political structures and political office bearers of the Bojanala Platinum District Municipality are the following:

- Council, presided over by the Speaker;
- The Executive Mayor; and
- The Mayoral Committee.

The Executive Mayor has established the following committees in terms of Section 80 of the Local Government: Municipal Structures Act No. 117 of 1998:

- IDP, PMS & Evaluation;
- Special Projects;
- Budget & Treasury;
- Sport, Arts and Culture;
- Corporate Support Services;
- Economic Development & Tourism;
- Agriculture & Rural Development;
- Technical Services;
- Community Development Services; and
- Health & Environmental Services.

The municipality has the following administrative structures:

- The Office of the Municipal Manager;
- Department of Corporate Services;
- Department of Economic Development, Tourism, Agriculture & Rural Development,
- Department for Budget and Treasury Office;
- Department of Community Development Services
- Department for Health & Environmental Services; and
- Department of Technical Services.

These are the driving force behind the development in the Bojanala District Municipality which is richly blessed with minerals resource and biodiversity. It is the same municipal council and administration that bears the responsibility to ensure that with limited resources at their disposal, basic service provision takes place to all citizens of the Bojanala Platinum District Municipality (BPDM).

2.3. Population Size and Growth

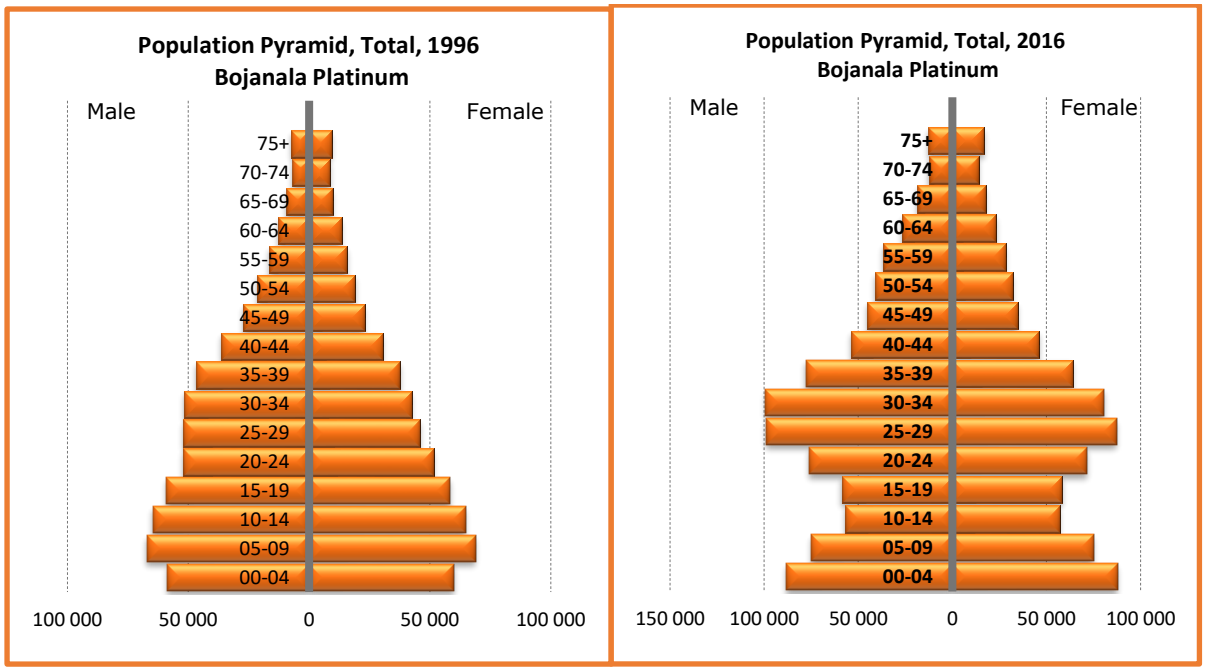
Population statistics measures the changing dynamics of a given population. Births, deaths, migration, the relative population size, composition, and distribution all play key roles in the formation of population statistics. Furthermore, a myriad of social, cultural, political, economic, and ecological factors has an impact on the outcomes of these measures (Khalfani *et al.*, 2005). Various factors have had an impact on the population size of the Bojanala Platinum District Municipality.

Figures 2A and 2B below show, the Bojanala Platinum District Municipality population structure by means of pyramid for the 1996 and 2016, respectively. The total population size of Bojanala was

1 148 397 in 1996 and 1 671 530 in 1996, of the total population in 2016, 877 081 (48%) were males and 794 449 (52%) were female.

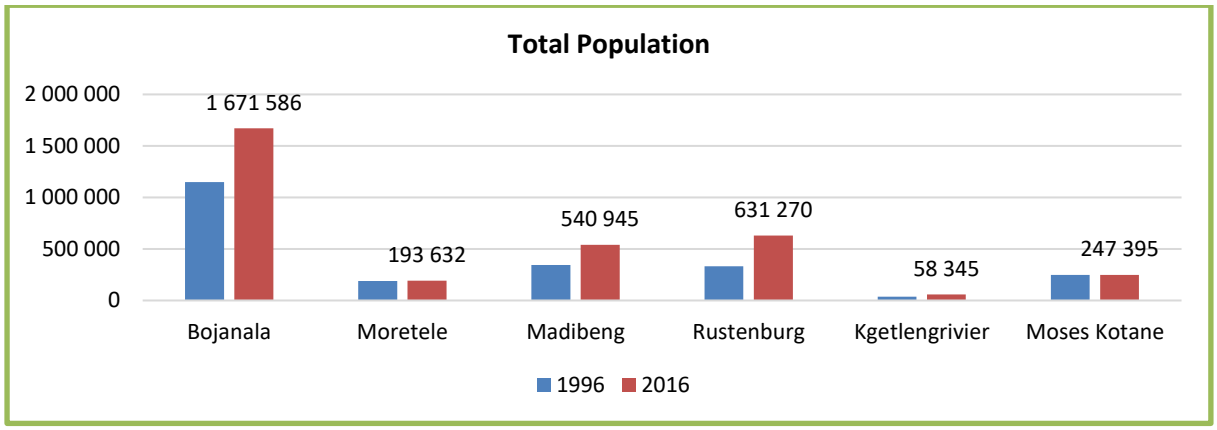
From the 1996 population structure, it is clear that the large population group was young males aged 25 years to 39 years. The population of the BDM remains a youthful population with its large population being at the age group of 20 years to 39 years. Clearly, over time the population structure of the BPDM has changed drastically with more children being born compared to 1996. The structure further shows that for some time between 1996 and 2016, there was a reduction in the children population size.

Figures 2A & 2B: *RLM population pyramid for 1996 & 2016*



Source: IHS Markit (2018)

Figure 3: *Bojanala District Municipality Population Size by Local municipality (1996 & 2016)*

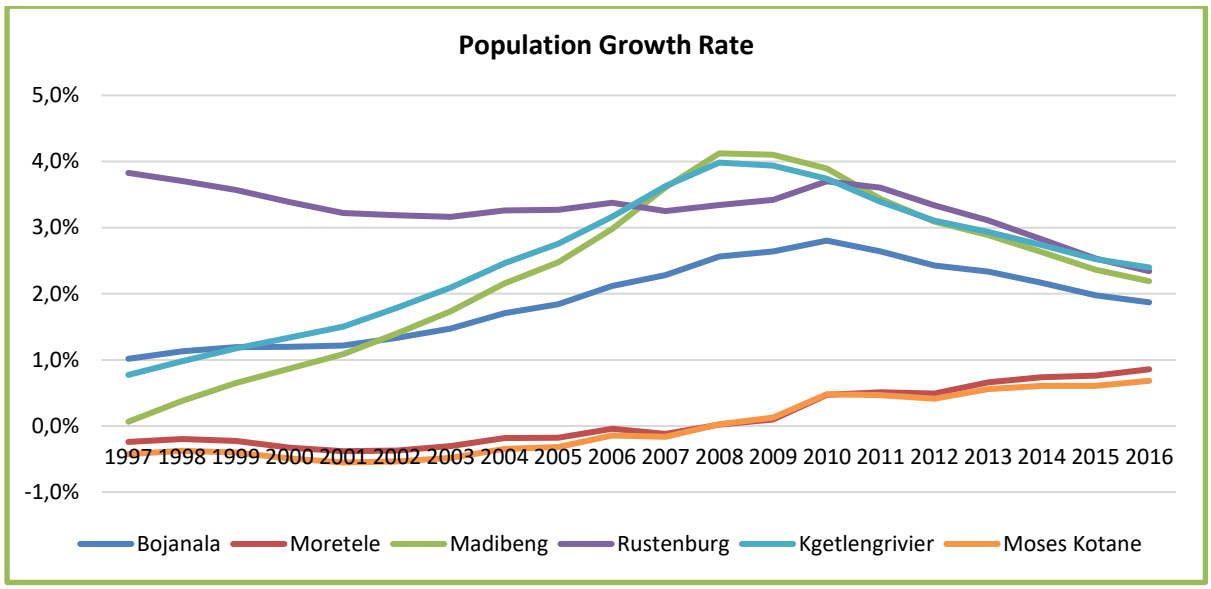


Source: Author's computation using IHS Markit data (2017)

Clearly, Rustenburg Local Municipality (RLM) has the highest population size within the (BPDM) followed by Madibeng, Moses Kotane, Moretele and Kgetlengrivier being the smallest local municipality in 2016. Amongst others, the high population size in RLM is as a result of mining activities within the municipality which drive migration from different places to Rustenburg.

Despite the increase in population in the Bojanala Platinum District Municipality, population growth rate has been on a decline since 2010 from 2.8% to 1.9%. Various factors such as the declining fertility rate and improved literacy rate play a critical role in a declining population growth rate in the Rustenburg Local Municipality. Figure 4 below further shows that population growth rate for the five (5) local municipalities and district municipality. It shows that Rustenburg local municipality has in particular the highest population growth rate in the district and started to be at par with Kgetlengrivier local municipality between 2014 and 2016. Moses Kotane and Moretele local municipalities started recording an increase in population growth rate from 2005 to 2016 moving at the same rate of growth.

Figure 4: *Bojanala District Municipality population growth rate by local municipality; 1997 to 2016*



Source: Author's computation using IHS Markit data (2017)

Figure 4 above further shows that the population growth rate of Moses Kotane and Moretele local municipality follows the same trend and pattern with Moretele (0.9%) being slightly above Moses Kotane local municipality (0.7%) in 2016. From 1997, Madibeng local municipality and Kgetlengrivier followed the same upward pattern and trend until 2008. Both started to decline in 2010 with Rustenburg local municipal being in the same margin of the declining trend with them as well. Generally, as indicated above, the district population growth is on a decline though only two local municipalities out of five shows to be recording an increase in population growth rate.

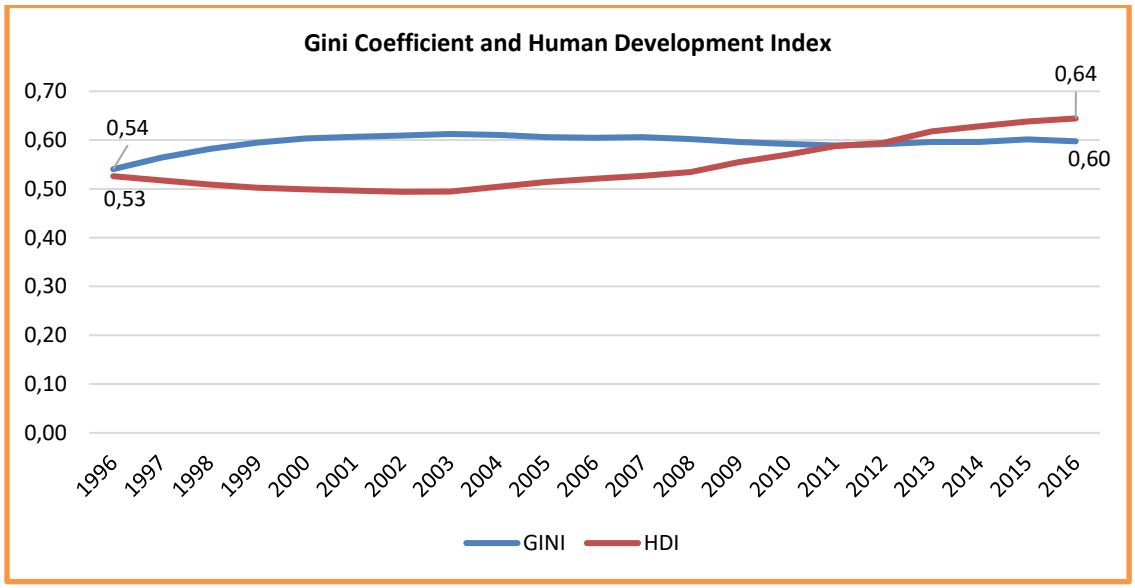
2.4 Some Development Indicators

The Human Development Index (HDI) is a composite statistic (composite index) of life expectancy, education, and one of the per capita income indicators which are used to rank countries into four tiers of human development. A country scores higher HDI when the lifespan is higher, the education level is higher, and the GDP per capita is higher. On the other hand, income inequality is the unequal

distribution of household or individual income across the various participants in an economy. Income inequality is often presented as the percentage of income to a percentage of population.

South Africa's Gini coefficient ranges from 0.66 to 0.69 while human development index was ranked 0.66 in 2015. As shown in figure 4 below, Human development in the Bojanala Platinum District municipality shows to be on a positive trajectory increasing from 0.53 in 1996 to 0.64 in 2016. On the other hand, income inequality has been widening with the Gini coefficient deteriorating from 0.54 in 1996 to 0.60 in 2016 which reflects imbalanced development within the local municipality.

Figure 5: *RLM HDI and Gini coefficient; 1996 to 2016*



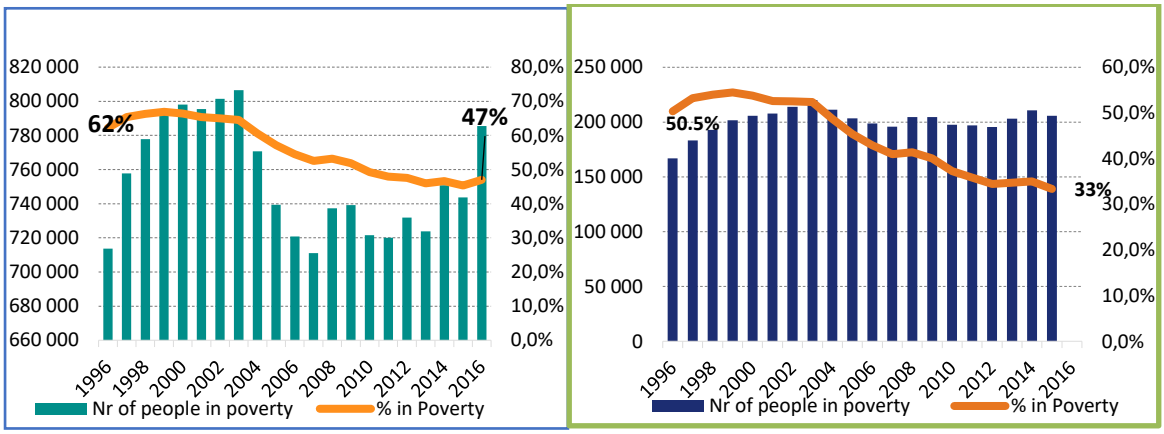
Source: Author's computation using IHS Markit data (2017)

According to Statistics South Africa (2016), the poverty headcount in the North West Province has declined from 9,2% in 2011 to 8,8% in 2016. Such a decline in the poverty headcount was recorded in all district municipalities between 2011 and 2016, except in Bojanala, where it increased from 8,2% in 2011 to 8,8% in 2016. The province's lowest poverty headcount was recorded in the Dr Kenneth Kaunda District (4,9%). About 25,1% (312 324) of households in the North West Province reported

that they had run out of money to buy food in the 12 months before the survey and nearly a fifth (17,4% or 216 088) of households in the province skipped a meal over the same period (Statistics South Africa, 2016).

Poverty is one of the challenges facing South Africa, as outlined in the National Development Plan. Figures 6 below shows the poverty overview of all municipalities within the Bojanala Platinum District Municipality (BPDM). Across the district, the percentage of people living in poverty in 2016 was 47% which is a decline from 62% in 1996 as shown in figure 6A. Figure 6B shows almost 20% decrease in poverty in Rustenburg local municipality which was a decline from 50.5% in 1996 to 33% in 2016. The overall decline in poverty and as argued by Statistics South Africa, is generally amongst others subjected to South African social policy system as adopted by the democratic South Africa.

Figure 6A & 6B: *Bojanala and RLM poverty overview; 1996 to 2016, respectively*

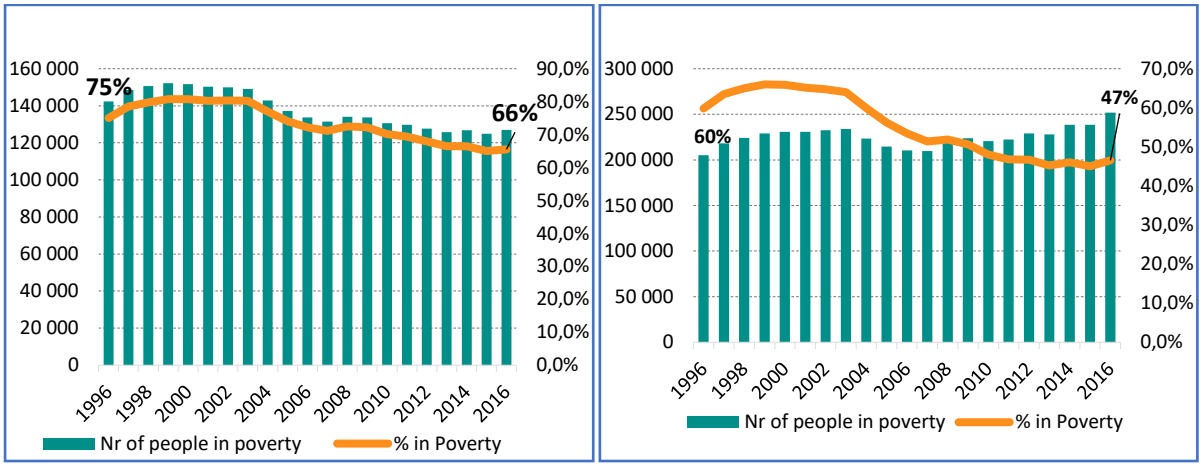


Source: Author's computation using IHS Markit data (2017)

Figures 7A and 7B below show poverty trends in the Moretele and Madibeng local municipalities respectively. Poverty decreased from 75% in 1996 to 66% in 2016 in the Moretele local municipality as shown in figure 7A. In 2016, the percentage of people in poverty within the Madibeng local municipality was 47%, which is a decrease from 60% recorded in 1996. Of great concern is that more

than 50% of the population in the Moretele local municipality is living in poverty and in Madibeng local municipality the percentage of people in poverty is just below 50%.

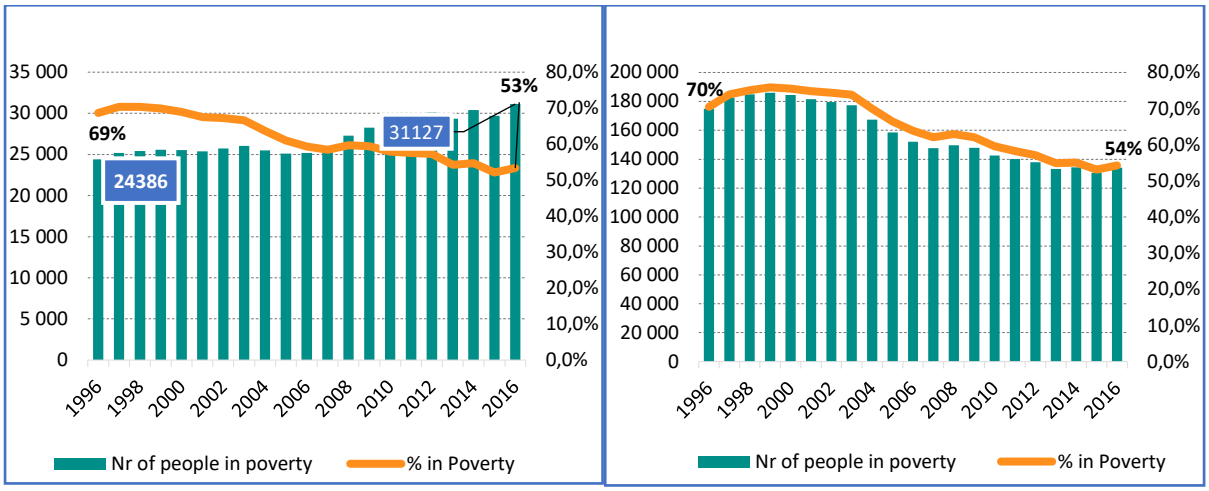
Figure 7A & 7B: *Moretele and Madibeng Poverty Overview (1996 – 2016)*



Source: Author's computation using IHS Markit data (2017)

Figure 8A and 8B below show poverty levels in the Kgetlengrivier and Moses Kotane local municipalities from the year 1996 to 2016. Poverty decreased from 69 in 1996 to 53% in 2016 in the Kgetlengrivier local municipality and from 70% to 54% in Moses Kotane local municipality, respectively. Though there is a percentage decline in poverty in the Kgetlengrivier, the number of people living in poverty increased from 24 386 in 1996 to 31 127 in 2016.

Figure 8A & 8B: *Kgetlengrivier and Moses Kotane local municipalities' poverty overview (1996-2016)*



Source: Author's computation using IHS Markit data (2017)

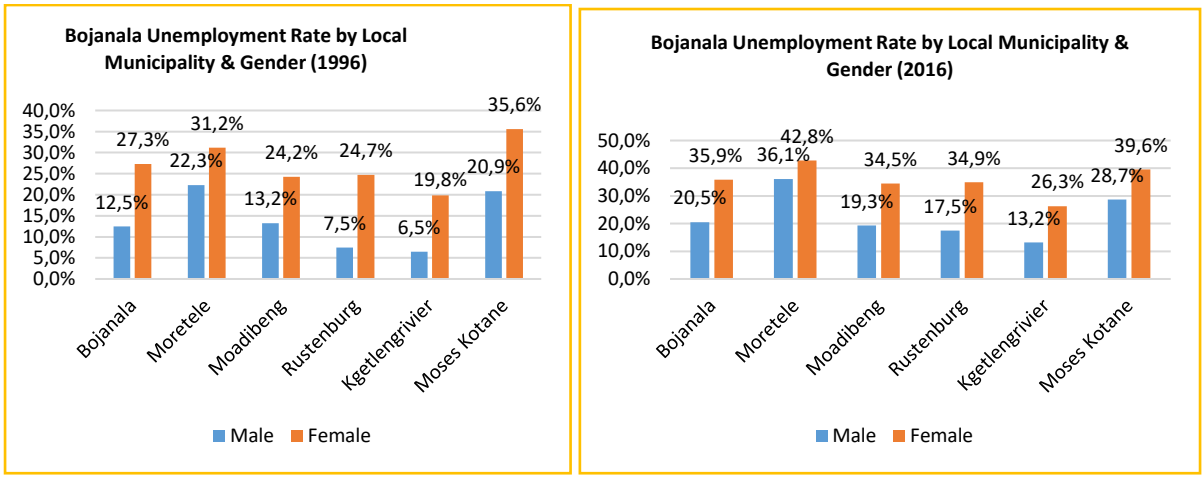
In 2016, BPDM recorded a 47% of people living in poverty with Moretele local municipality being the most poverty stricken local municipality at 66% of people living in poverty followed by Moses Kotane local with 54% and Kgetlengrivier with 53%. Poverty shows to be a serious challenge in the Bojanala Platinum district municipality.

According to Economic Watch (2010), unemployment and poverty are the two major challenges that are confronting the global economy. Unemployment leads to financial crisis and decreases the overall purchasing capacity of a nation. This in turn results in poverty followed by increasing burden of debt and as a result, poverty can be described in several ways. According to the World Bank definition, poverty implies a financial condition where people are unable to maintain the minimum standard of living (Economic Watch, 2010).

Figures 9A and 9B below show unemployment by gender in all local municipalities in the BPDM for the periods 1996 and 2016. In 1996, 12.5% on males compared to 27.3% of females were unemployed in the Bojanala Platinum District Municipality. Unemployment increase for both genders to 20.5% for

males and 35.9% for females. The unemployment gap between males and females in the Bojanala Platinum District Municipality widened from 14.8% in 1996 to 15.4% in 2016.

Figure 9A & 9B: *Bojanala Unemployment Rate by Gender; 1996 to 2016*



Source: Author's computation using IHS Markit data (2017)

The largest contributor to BDM unemployment in 2016 is Moretele Local municipality at 42.8% followed by Moses Kotane, Rustenburg and Madibeng at 39.6%; 34.9% and 34.5%, respectively.

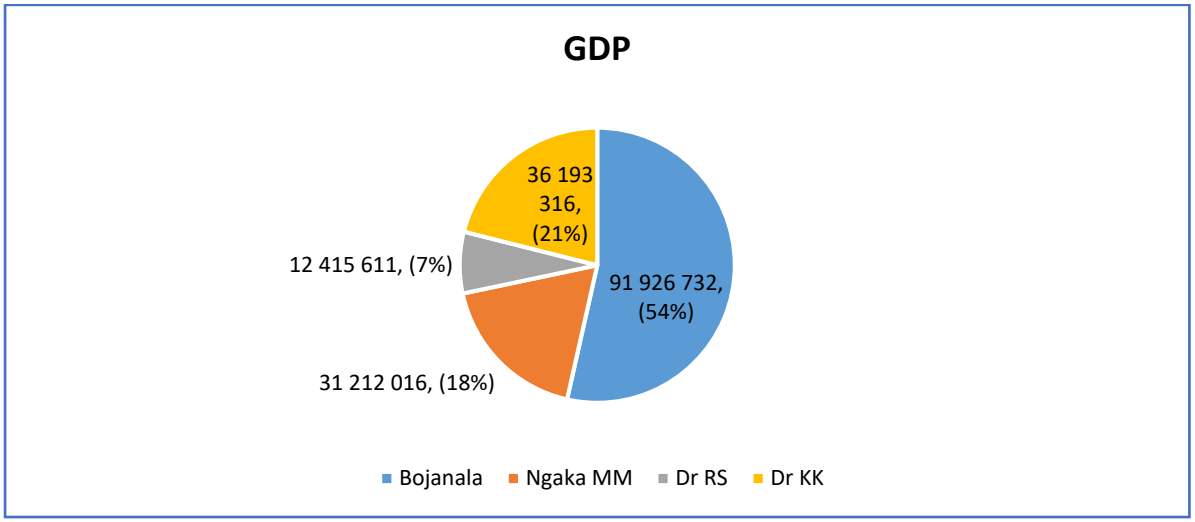
2.5 Economic Growth

According to Barro (1996), for a given starting level of real per capita GDP, the growth rate is enhanced by higher initial schooling and life expectancy, lower fertility, lower government consumption, better maintenance of the rule of law, lower inflation, and improvements in the terms of trade.

Bojanala Platinum District Municipality is the largest district economy in the province with a Gross Domestic Production (GDP) worth R91 926 732 (54%) of the provincial share followed by Dr Kenneth Kaunda District with 21%; Ngaka Modiri Molema District with 18 per cent and the lowest growing economy in the province being Dr Ruth Segomotsi Mompati District with a provincial GDP share of

only 7% in 2016. High economic activities and opportunities in the Bojanala Platinum District are amongst others, population pulling factors to the district.

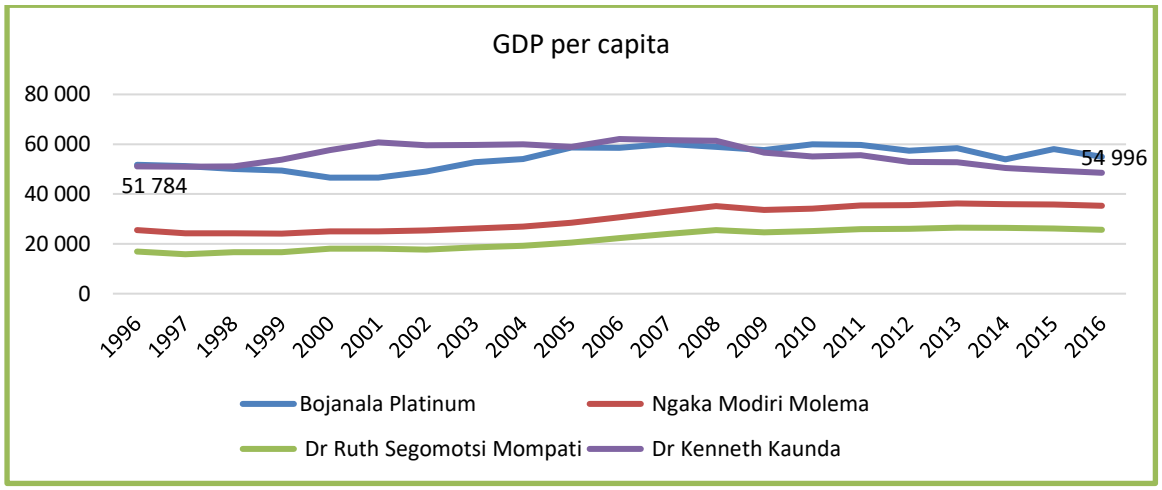
Figure 10: *North West District Municipalities share of provincial economic growth (2016)*



Source: Author's computation using IHS Markit data (2017)

Figure 11 below shows GDP per Capita for the four district municipalities in the North West Province from 1996 to 2016. Dr Kenneth Kaunda District Municipality used to have the highest GDP per Capita in the province from 1996 to 2009 after being over-taken by Bojanala Platinum District Municipality. This made BDM to be the leading district municipality on GDP per capita followed by Dr Kenneth Kaunda and Ngaka Modiri Molema being the third highest. Dr Ruth Segomotsi Mompati shows to be the lowest productive economy amongst the North West Provincial district economies.

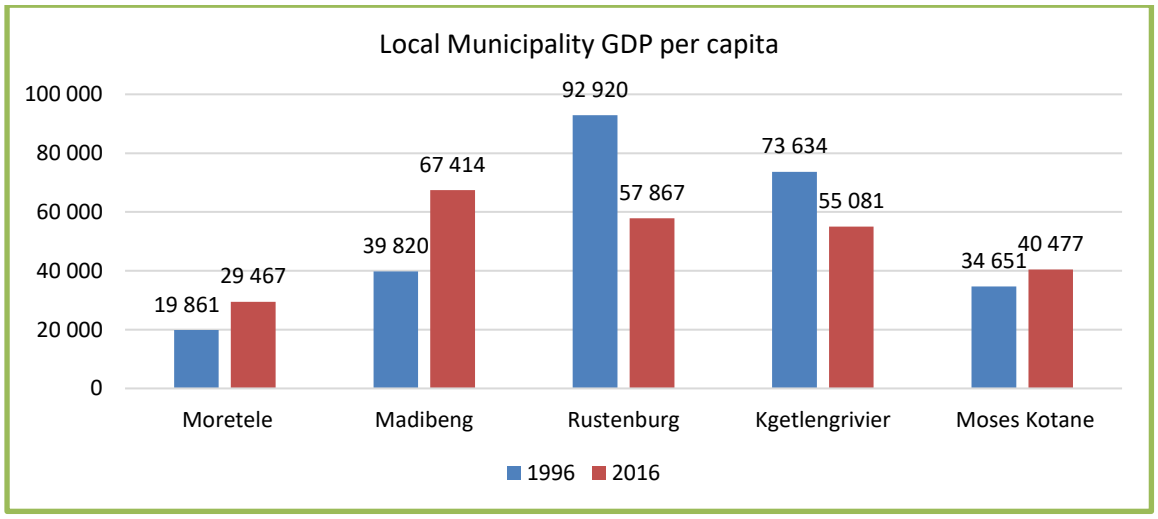
Figure 11: *Districts GDP per capita; 1996 to 2016*



Source: Author's computation using IHS Markit data (2017)

Figure 12 below shows the GDP per capita performance for all local municipalities in the Bojanala District Municipality for the year 1996 and 2016. Rustenburg Local Municipality and Kgetlengrivier experienced a decline while the remaining three municipalities recorded growth with Madibeng Local Municipality being on the lead.

Figure 12: *Bojanala local municipalities GDP per capita; 1996 to 2016*



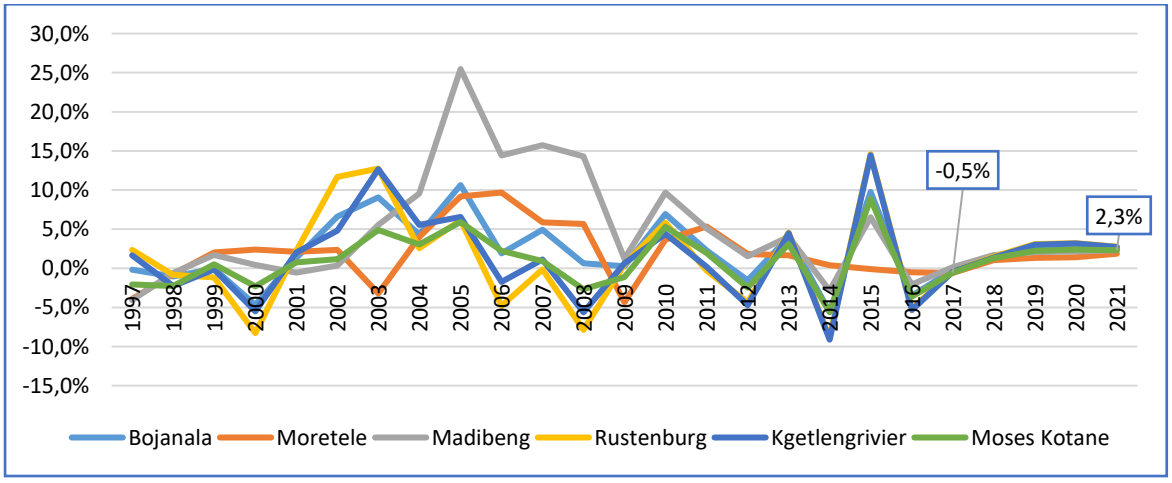
Source: Author's computation using IHS Markit data (2017)

Economic growth in the BDM has been volatile since 1997. As shown in figure 13 below, in 2015 BDM recoded its highest economic growth (9%) since 1997, recovering from both global economic recession which was then followed by protracted mining strikes in the mining belt in 2012. Such recovery proved not to have sustained as it was followed by a drastic decline resulting in the whole district recording economic growth of -3% growth in 2016. Graphical trend from 2017 to 2021 in figure 13 below shows economic growth projections for the entire district of Bojanala with the projection showing economic growth reaching an average of 2.3% in 2021.

As shown in figure 13 below, Madibeng local municipality shows to be the highest contributor to Bojanala district high GDP per capita followed by Rustenburg local municipality and Kgetlengrivier. The GDP per capita of Rustenburg and Kgetlengrivier local municipalities in the BPDM shows to have decreased in the past two decades and with Moretele and Moses Kotane local municipalities recording a small increase compared to Madibeng which shows to have significantly improved.

Figure 13 further shows Gross Domestic Production of BPDM and its local municipalities for the period 1997 to 2016 and economic growth projections from 2017 to 2021.

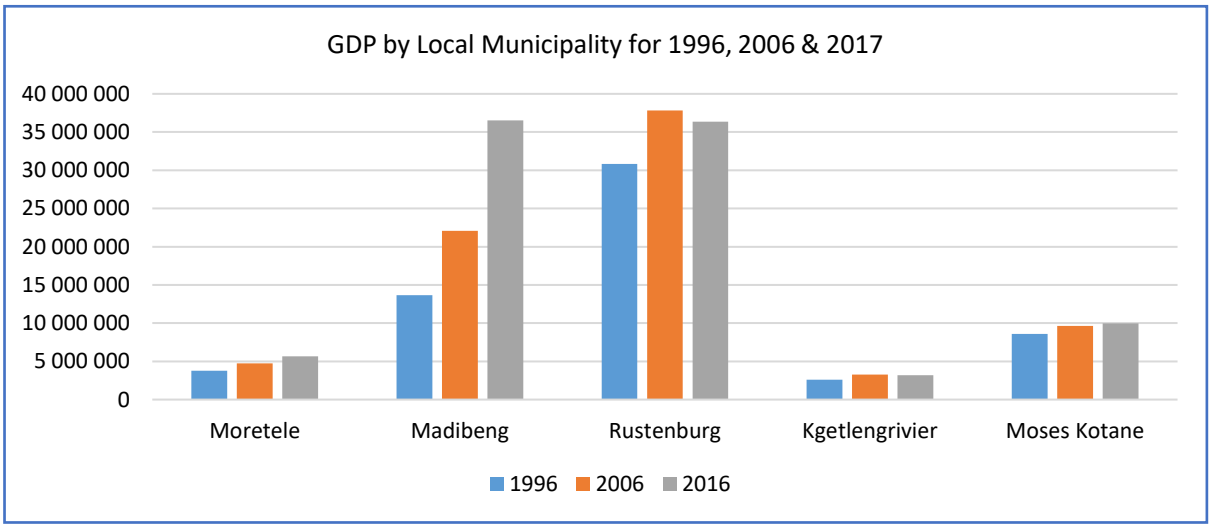
Figure 13*: Bojanala gross domestic production; 1997 to 2016*



Source: Author's computation using IHS Markit data (2017)

For all local municipalities in the Bojanala district, economic growth has been on a positive trajectory over the past two decades except for Rustenburg local municipality which recorded a decline in the last decade (2002 to 2016). While all other municipalities recorded moderate growth, Madibeng has recorded a significant level of GDP growth in the last two decades as shown in figure 14 below.

Figure 14: *Bojanala gross domestic production; 1997 to 2017*

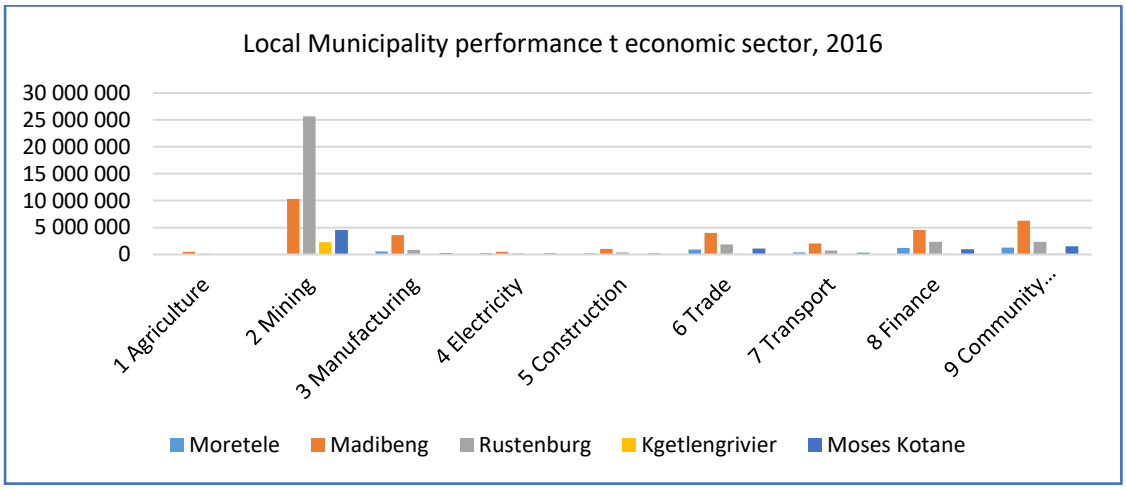


Source: *Author's computation using IHS Markit data (2017)*

Since 2008, the global economy including that of South Africa and the North West Province has been struggling to recover from economic recession and the BPDM is not an exception in this challenge. To make this worse for the district was the mining strike that took place in 2012. The mining sector took some time to recover, hence the successive negative growth for the years 2013 and 2014 as shown in figure 8 above. Figure 15 below further explains the sudden increase of 14.9% in 2015. Clearly this is as a result of the increase in mining performance within the Rustenburg local municipality which is shown to be leading in mining production.

Figure 15 below shows a trend performance of various economic sectors in local municipalities within the BPDM for the year 2016. Madibeng local municipality shows to be a leading municipality in many sectors such as Agriculture, Construction, Trade, manufacturing, Transport, Finance and economic services. Thus, Rustenburg and Madibeng show to be two leading local economies within the BPDM for the year 2016. However, it is worth noting that Madibeng is largely diversified, and Rustenburg is largely dominated by the mining sector.

Figure 15: *Bojanala gross domestic production; 1997 to 2017*



Source: *Author's computation using IHS Markit data (2017)*

2.4 Conclusion

Bojanala Platinum District Municipality is one of the fastest growing district municipalities in the North West Province with its economy booming not only in the mining sector, but also through property development amongst others. Roads infrastructure continues to improve across the municipality, especially in the Rustenburg and Madibeng local municipalities. Service delivery, on the other hand, shows to be improving over time. According to Statistics South Africa (2016), almost nine in every 10 households (86,1%) in the North West Province access water through pipes and almost two-thirds of North West household's access water from either within their yards (39,8%) or in their dwellings (24%). About nine in every ten households (89%) in North West have access to electricity, up 46,3%

from 42,7% in 1996. In 2011, 84% of North West households had access to electricity. The number of households with access to a flush/chemical toilet increased from 491 128 in 2011 to 607 980 in 2016, (Statistics South Africa, 2016).

Globally, population tend to increase, while its rate of population growth tends to decline, and this shows to be the case in BDM Municipality. Both districts and Local municipalities have the responsibility to play a progressive role in local and regional economic growth and development by providing adequate and quality economic and social infrastructure and sound regulatory environment for the private sector to thrive. Bojanala Platinum District Municipality can achieve this despite other challenges it may be facing developmentally.

Chapter 3: Literature Review

3.1 Introduction

This chapter focuses on understanding the existing body of literature on the topic under study. More emphasis is drawn on population growth and infrastructure with specific reference to basic services provision in the South African context in terms of municipal mandate as legislated. This section will also provide a frame of analysis during results interpretation to assess any form of consistency in terms of existing theories and literature thus informing conclusion and recommendations.

In the following section, the study will unpack theories from different schools of thought in population growth, literature on population growth, population growth in relation to water, energy, sanitation and households. All these will be done in the context of basic service provision by a local municipality.

3.2 Theoretical Foundation

3.2.1 Pessimistic Theory

The pessimistic theory traces its lineage to a publication of an English scholar Reverend Thomas Malthus, titled “An Essay on the principle of population” in the year 1798. Malthus asked whether the future improvement of society was possible in the face of ever larger populations. He reached his famously dismal conclusion that the human species would increase in the ratio of 1, 2, 4, 8, 16, 32, 64, 128, 256, 516, etc. and subsistence as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, etc. That is to say, the population would rise geometrically - by factors of four, eight, sixteen and so on while the food production (substances) would rise arithmetically – by factors of three four, five and so on. In two centuries and a quarter the population would be to the means of subsistence as 512 to 10; in three centuries as 4096 to 13, and in two thousand years the difference would be incalculable. Malthus theorized that food production would quickly be swamped by the pressures of a rapidly growing population. In other

words, this scenario of arithmetic increases in food supply coupled with simultaneous exponential or geometric increases in population predicted a future when humans would have no food to survive on.

In 1968, Paul Ehrlich opened his influential book "The Population Bomb" with the words, "The battle is over. In the 1970s hundreds of millions of people are going to starve to death. He claimed that scarce resources will get so bad that people will begin to think of eating the body of their dead. Ehrlich's work can be considered as an extension of Malthus' theory since he asserted that human beings were wrong and going to fail in the battle against hunger. More measured studies undertaken by the US National Academy of Sciences (NAS) in 1971 and the United Nations in 1973 also predicted that the net effect of population growth would be negative.

As further presented by Mahmud (2015), in addition to the effect of total population growth on the fixed resources, pessimistic advocates also explained that there is potential negative relationship between increases in the number of people with capital accumulation of a given economy. Higher population requires more homes to house, more factories to employ and more infrastructures to provide for their needs which may lead to reduced capital per worker and lower the living standards.

3.2.2 Optimistic Theory

Optimistic theories can be traced from the work of Ester Boserup, a Danish economist, who uses similar arguments to turn the Malthusian world-view around. That is, instead of agricultural method determining population as assumed by Malthusians, Boserup argued that population determine agricultural method. A major theme of her work is that "necessity is the mother of invention". Population growth creates pressure on resources. People are resourceful and are stimulated to innovate, especially in adversity. When rising populations swamped traditional hunter-gatherer

arrangements, slash-burn-cultivate agriculture emerged. When that, too, became inadequate, intensive multi-annual cropping was developed. More recently, the world experienced what is known as Green Revolution which has almost quadrupled world food production since 1950 using just 1 percent more land. This was a direct reaction to population pressure.

According Simon to Kuznets (1971), 'an increase in population means, other thing being equal, increase in the labour force'. If the labour force increases at the same rate as the total population, it will be able to turnout as much or more products per worker. Also, an increase in the labour force would permit a greater utilisation of unexploited natural resources. This utilisation, combined with a more specialised division of labour would, in all probability lead to a greater product per worker".

Julian Lincoln Simon's (1981) book "The ultimate Resource" is another criticism of Malthus theory of population growth which predicted a catastrophe to occur as population grows larger. That is to say that economic growth is negatively related to population growth. Simon viewed that population is the solution to resource scarcity and environmental problems with innovation from both the people and the markets.

3.2.3 The Neutralist Theory

According to Kelly (1999), population neutralism has been the predominant school of thinking among academics for the last half century. Even the United Nations and the National Academy of Science reports are becoming more moderate in their views, especially in the 1980s. In those days, it was discovered that the so – called exhaustion of natural resources was found not to be strongly affected by population growth as the pessimists thought. There was no empirical evidence that decreasing in saving which affects economic growth happens because of population growth. Multi-country studies

showed no evidence of diversifying resources from productive physical capital sectors to less productive sectors such as health care, social security and education as assumed by pessimists thought. Kelly opined that the outcomes of these studies together with the argument made by Julian Simon were significant reasons for the development of neutralist school of thought (Mahmud, 2015).

3.3. Population Growth and Infrastructure

In many cases, economists are correct in saying that population growth has a positive effect on the economic growth of a nation (Mahmud, 2015). However, this is dependent on the capacity of the respective state to create a conducive environment for population to unleash its productive capacity.

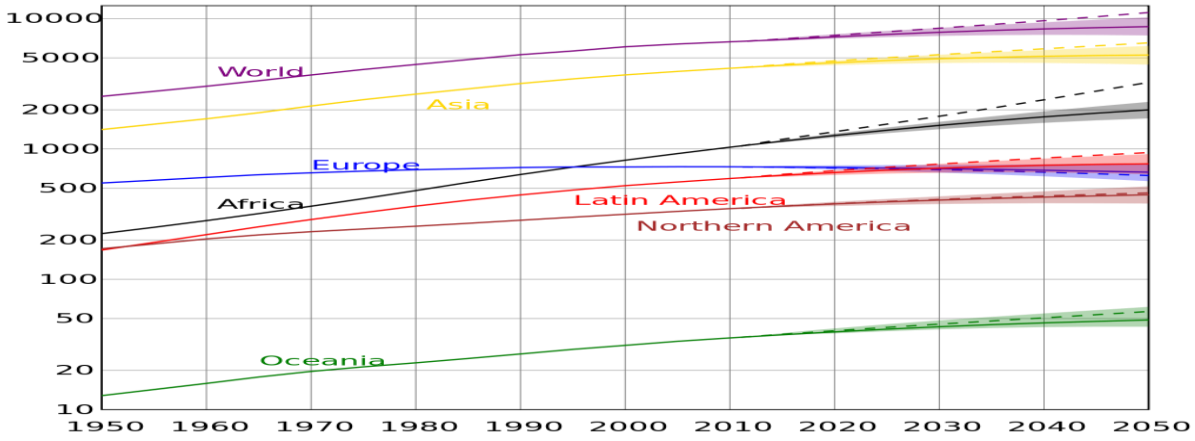
According to the United Nations (2012), world population has experienced continuous growth since the end of the Great Famine of 1315–17 and the Black Death in 1350, when it was near 370 million. The highest population growth rates – global population increases above 1.8 percent per year – occurred between 1955 and 1975, peaking to 2.06 per cent between 1965 and 1970. The growth rate has declined to 1.18 percent between 2010 and 2015 and is projected to decline to 0.13 per cent by the year 2100. Total annual births were highest in the late 1980s at about 139 million and are now expected to remain essentially constant at their 2011 level of 135 million, while deaths number 56 million per year and are expected to increase to 80 million per year by 2040 (United Nations, 2012). The median age of the world's population was estimated to be 30.1 years in 2016, with the male median age estimated at 29.4 years and female at 30.9 years.

These population developments need to be effectively understood in the context of development and policy crafting and development. As argued by KPMG (2017), over the coming year, we expect the more responsible governments to look for new ways to improve alignment and drive integrated

planning across the three sectors[1]. In some cases, this will require the establishment of new structures that encourage shared investment and planning across different government departments. In other cases, it may be driven by focused leadership and strong policy direction (KPMG, 2017). This clearly remains the case in the water, sanitation, refuse removal and housing.

According to the United Nations (2012), projections show a continued increase in population in the near future with a steady decline in population growth rate. The global population is expected to reach between 8.3 and 10.9 billion by 2050. 2003 UN Population Division population projections for the year 2150 range between 3.2 and 24.8 billion. One of many independent mathematical models support the lower estimate, while the 2014 estimate forecasts between 9.3 and 12.6 billion in 2100, and continued growth thereafter. Some analysts have questioned the sustainability of further world population growth, highlighting the growing pressures on the environment, global food supplies, and energy resources (United Nations, 2012).

Figure 16: *Estimates of population evolution in different continents between 1950 and 2050*

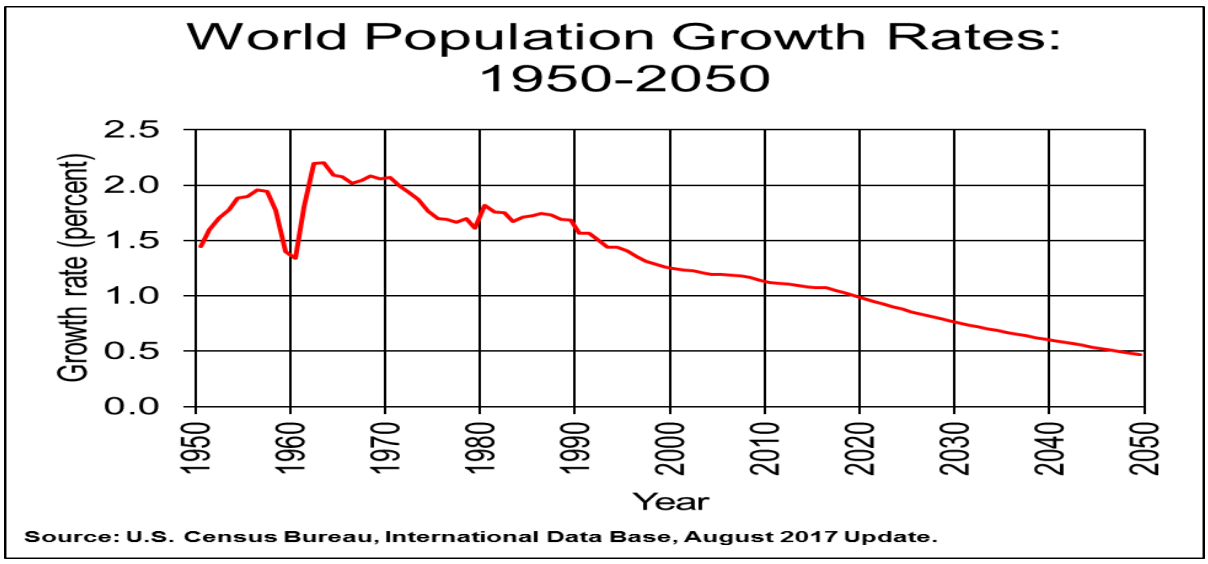


Source: United Nations (2000)

[1] Energy, Transportation and Technology

As shown in figure 14 above, Africa is projected to be next second population growing continent after Asia. Between 1950 and 1995, Europe was the most populous continent until it was over-taken by Africa and is further projected to be over-taken by Latin America just after 2020. In general, the world population is projected to increase.

Figure 17: *World Population Growth Rates: 1950-2050*



According to the United State Census Bureau (2017), the world population growth rate rose from about 1.5 per cent per year from 1950-51 to a peak of over 2 percent in the early 1960s due to reductions in mortality. Growth rates thereafter started to decline due to rising age at marriage as well as increasing availability and use of effective contraceptive methods. Note that changes in population growth have not always been steady. A dip in the growth rate from1959-1960, for instance, was due to the Great Leap Forward in China (United State Census Bureau, 2017). During that time, both natural disasters and decreased agricultural output in the wake of massive social reorganization caused China's death rate to rise sharply and its fertility rate to fall by almost half.

The 21st century saw a continuous transformation of the world's population into urban dwellers. Thus, urban population has increased from less than 30 percent in 1950 to more than 47 percent in 2000. Europe, North America, Latin America and the Caribbean are already largely urbanized regions with 75 percent of their populations residing in cities (Asoka, Thuo & Bunyasani, 2013). South Africa and its respective provinces and municipalities are not an exception to such an increasing in urban dwellers, especially in areas which experiences higher economic growth and increase potential for employment.

This clearly leaves South Africa and Bojanala Platinum District Municipality with serious policy choices going forward in infrastructure development front for basic service provision. As argued by KPMG (2017), what is clear is that the underlying current has shifted towards more populist agendas. And that has pushed infrastructure onto centre stage as a form of policy mitigation. This shift towards populist agendas underpinned by infrastructure will lead to three keys 'sub' trends. The first is obvious: infrastructure budgets should swell. However, we expect many projects will be funded on a taxpayer-pay basis and, as a result, it seems almost certain that public deficits will rise. The second sub-trend is one of protectionism. One can assume that part of the draw of infrastructure is the potential to create local jobs. For various reasons, it is unlikely that the US will want to rely on foreign workers and developers as they strive to 'make America great again' (KPMG, 2017). From concerns about loss of control and national security through to impacts on local labour and consumer protection, various 'reasons' will be offered for closing borders to international players. In most markets, the chances of a regulatory 'sideswipe' that harms international developers and operators will rise.

The third sub-trend will be a shift in infrastructure priorities, not only towards more popular assets and 'people first'. According to KPMG (2017), the long view: Those with national infrastructure strategies that focus on industrial competitiveness will sow the seeds of durable growth in national

income and, in doing so, will support enhanced quality of life for their citizens. Governments will continue to put 'people first' projects at the top of the agenda, thereby allowing social equality and other issues to influence infrastructure planning and shift priorities. Furthermore, KPMG (2017) argues that for governments and international developers, contractors and operators, the long-term challenge will be to articulate a much clearer story about the value they plan to deliver while seeking to allay local concerns. The movement towards new technologies and models that speed up infrastructure delivery remains fundamental for development. However, the infrastructure investment playing field will likely become flatter as developing and developed markets gain simultaneous access to new technologies (KPMG, 2017).

3.4 Population growth and Basic Services

Generally, basic services remain vital daily functionality of all sectors of the society in both urban and rural areas. There is an increasing recognition that the growth of cities is inevitable and the solution to urban problems depends heavily on effective urban planning, infrastructure development and management (Asoka, Thuo and Bunyasi, 2013). According to Jones, Cummings and Nixon (2014), improving service delivery for the urban poor is an urgent priority. By 2030, the worldwide urban population is expected to grow by 1.4 billion people, with city and town dwellers accounting for 60 percent of the total world population. Most of this growth will take place in developing countries, and urban growth and migration is leading to the "urbanisation of poverty" thus the perception of an "urban advantage" in services can obscure great differences among and within urban populations. There are stark inequalities in many urban areas, and correspondingly clear inequities in access to services, with large proportions of the population unable to access quality basic services. This is especially true for the nearly 1 billion people who live in informal settlements (Jones, Cummings and Nixon, 2014).

According to Asoka, Thuo and Bunyasi (2013), rapid and often unplanned population growth is often associated with population demands that outstrip infrastructure and service capacity and leading to environmental degradation. The accelerated growth of urbanisation has amplified the demand for key services. However, the provision of shelter and basic services such as water and sanitation, education, public health, employment and transport has not kept pace with this increasing demand (Hove, Ngwerume and Muchemwa, 2013). As infrastructure needs and gaps expand globally, strategically targeted assistance to countries and communities that seek to improve and sustain their service delivery is critical (USAID, 2013).

On the same breath, according to Statistics South Africa (2016), the North West Province's population increased slightly by 238 482 people between 2011 and 2016, from around 3,5 million in 2011 to 3,7 million in 2016, making it South Africa's third smallest province in terms of population size. The youth account for just more than a third (36 percent) of the province's population. A majority of North West Province's population can be found in the Bojanala District (1,7 million), followed by Ngaka Modiri Molema (889 108) and Dr Kenneth Kaunda (742 821). Dr Ruth Segomotsi Mompati District has the smallest share of the province's population with 459 358 persons. The number of households in the province has increased from 1,1 million in 2011 to 1,2 million in 2016, (Statistics South Africa, 2016).

As argued by Statistics South Africa (2016), almost eight in every ten residents (81,2 percent) of the North West Province residents were born in the province, only about two in every 10 people (18,8 percent) in the province were born elsewhere. Of those born outside North West Province, a large number were born in Gauteng (198 966), followed by those who were born outside South Africa (122 284), Limpopo (94 656), Free State (88 371), Eastern Cape (87 652), Northern Cape (38 393) and Mpumalanga (38 208). KwaZulu-Natal and Western Cape had the least numbers of people who emigrated to the North West Province, with only 22 634 and 8 872 respectively. Between 2011 and

2016, North West experienced a net-migration of 159 135, which was a result of 540 900 people emigrating from the province and 700 035 moving to the province from elsewhere (Statistics South Africa, 1996).

It is of paramount importance to note that such population increase in the province is largely distributed to various local municipalities and Bojanala Platinum District Municipality is one of the largest recipient of population inflow into the province. Such population must therefore be catered for in terms of basic services. According to KPMG (2017), the underlying parameters of infrastructure planning have changed. For the past 50 years, the common wisdom has been that bigger populations require more roads, bigger generation capacity and more transit, all macro solutions and quite appropriate given a 'fixed' technology solution (such as suburbs and the automobile) and 'fixed' consumer behaviour. But over the past decade, both technology and consumer behaviour have begun to change, and such change is evident in the consumer's interaction infrastructure which result in "infrastructure planners" struggling to keep up (KPMG, 2017). Thus, the need for municipalities to constantly engage with communities on their infrastructure needs and the mode of delivery remains of paramount importance in the current era.

3.4.1 Water and population growth

According to the Population Institute (2010), water is a finite natural resource and cannot be created. Instead, the hydrologic cycle recycles water through the atmosphere. The fact that our supply is finite has dire implications on our world population of nearly Seven (7) billion people and growing. Furthermore, as argued by the Population Institute (2010), the world water consumption rate doubles every twenty years, a pace that is double the rate of population growth. If population and consumption trends persist, it is estimated that the demand for water will surpass its availability by 56 per cent, and 1.8 billion people will be living in regions of water scarcity by 2025 (Population

Institute, 2010). This situation is exacerbated by the fact that developing countries, already experiencing water-stress, often have the highest population growth rates—bringing more people into a region that already cannot support them (Population Institute, 2010).

The right of access to sufficient water in South Africa is accorded to everyone in section 27(1)(b) of the Constitution, which states that everyone has the right to have access to sufficient water. furthermore, Section 27(2) requires the State to take reasonable legislative and other measures, within its available resources, to achieve the progressive realisation of the right. As part of other measures, local municipalities are assigned the primary responsibility of water provision (South African Constitution, 1996). Water is a key element of life for everyone on Earth. As the world's population grows, the demand for water mounts and pressure on finite water resources intensifies, (Mogelgaard, 2011). The amount of water used directly by individuals is related to various human attributes such as age, education, cultural background, religious beliefs, and financial status. In general, more people use more water, even if the amount they use individually is reduced by education, the implementation of conservation practices, or technological improvements in water-supply systems (Mogelgaard, 2011).

As argued by Grey and Sadoff (2006), water remains vital for human survival and has over the years been a source for industrial development, the life blood of farming and another pre-requisite for economic growth. This is further supported by the Population Institute (2010) which argues that water is crucial for all life on earth. It plays an essential role in our health, economy, food production, and environment. Safe drinking water and freshwater are imperative for development and public health since 21 of the 37 primary diseases in developing countries are related to water and sanitation. Thus, poor management and lack of investment while population continues growing could result in water shortage. Implicit in the notion of 'water security' is the idea of a 'minimum platform of water

institutions and infrastructure'. Below this minimum platform, society and the economy are not resilient to the impacts of water shocks and/or unreliable water for production or livelihoods, and water is a significant obstacle to growth (Population Institute, 2010).

In their study, Grey and Sadoff (2006) indicates that, water security will be achieved with the acquisition of an appropriate level and combination of management capacity and infrastructure investment. Thus, when 'basic water security' is achieved, societies are resilient to the impacts of water – such that a lack of access to water-related services and vulnerability to water related impacts (drought, flood, disease etc.) no longer create significant obstacles to growth. Until 'basic water security' is achieved, the scale of social impacts (e.g. morbidity, mortality, resource conflict) and related economic impacts (e.g. from institutional failure, production inefficiencies, disaster shocks) can be such that the economy, environment and society are significantly affected, and economic growth cannot be reliably and predictably managed, (Grey and Sadoff, 2006).

The current situation as far as water supply is concerned, is that a large fraction of the population does not have an adequate water supply and/or sanitation facility of an acceptable level (Department of Water Affairs and Forestry, 1994). According to Statistics South Africa (2017c), the number and percentage of households with access to piped water had increased since 2002, and that 14 million households had access to piped water in 2016 compared to 9,3 million in 2005. The increase in the percentage of households with access to water coincided with a decline in the percentage of households who paid for the piped water they received and the proportion of households who reported paying for water has been declining steadily over the past decade, dropping from 61,9 percent in 2005 to only 41,5 percent in 2016 (Statistics South Africa, 2017c).

As argued by Lucas (2017), using a delayed-feedback mathematical model that analyzes historic data to help project future trends, the research identified a regularly recurring pattern of global water use in recent centuries. Periods of increased demand for water — often coinciding with population growth or other major demographic and social changes — were followed by periods of rapid innovation of new water technologies that helped end or ease any shortages.

According to Viessman Jr. (2016), water sources in a specific region vary in the quantity and quality of water they contain at a given time, and in their rate and timing of replenishment. If projected withdrawals to meet population growth exceed the ability of the water sources that may be called upon to meet them, then new sources must be developed, if that is possible; otherwise, cutbacks in water use will be required. Yet, demands can be decreased only so far until the decreases may endanger public health, damage the environment, or adversely influence the region's economy (Viessman Jr., 2016). In the WEF report on water, Lucas (2017) further argues that data on global water use shows that we are currently in a period of relatively stagnant growth. Per-capita water use has been declining since 1980, largely due to improved efficiency measures and heightened public awareness of the importance of conserving Earth's limited supply of freshwater. This has helped to offset the impacts of recent population growth.

Clearly the use of technology to improve water efficiency usage can mitigate high demand for water as result of increasing population. This requires flexibility and willingness, especially at local municipality level to create a conducive platform for innovation and investment in research and development within the water sector. As argued by Grey and Sadoff (2006), there is a re-emerging consensus that water resources development and management are essential to generate wealth, mitigate risk, and alleviate poverty; that poverty demands that many developing countries will need to make large investments in water infrastructure at all levels; and that this development must be

undertaken building on the lessons of experience, with much greater attention to institutional development, to the environment and to more equitable sharing of benefits and costs. The challenge of Responsible Growth is to grow while at the same time embracing both environmental sustainability and social development. A responsible path is particularly important in water development because, given the longevity of water infrastructure, many of these decisions will have long-term consequences (Grey and Sadoff, 2006).

According to the Sustainable Development Goal 6 (2016), in 2011, 41 countries experienced water stress – 10 of which are close to depleting their supply of renewable freshwater and must now rely on alternative sources. Increasing drought and desertification is already worsening these trends and by 2050, it is projected that at least one in four people will be affected by recurring water shortages (Sustainable Development Goal 6, 2016). Thus, a need for infrastructure investment an exploration of new innovative ways in water provision and use thereof.

3.4.2 Housing and population growth

Residential developments should be fully functional and serviced with basic infrastructural facilities to be habitable. Despite the importance of housing and basic services, they are a difficult problem for any country. With the ever-growing global population and urbanization, existing urban housing infrastructure is insufficient in addressing housing needs in many economies (Okoro, Musonda and Agumba, 2016). The relationship between population and housing is two-sided. On the one hand, population change leads to a changing demand for housing. Population growth, and particularly the growth in the number of households, leads to a growth in housing demand. Population decline might, in the long run, lead to a decrease in housing demand. But at the same time, the supply of housing influences the opportunities for population increase through immigration and the opportunities for

people to form new households. Adequate housing supply might attract immigrants or influence their choice of residential location (Mulder, 2008).

The guarantee of the right to access to adequate housing in South African is found in section 26 of the Constitution (1996), in terms of which the State is obliged to take reasonable legislative and other measures within its available resources to achieve the progressive realisation of this right. In addition, section 26 provides for a degree of security of tenure by protecting persons against eviction or the demolition of one's home without an order of court made after considering all relevant circumstances. Furthermore, the National Housing Act provides the enabling framework to give effect to section 26 of the Constitution. Section 2 of the National Housing Act provides the following:

"(1) National, provincial and local spheres of government must –

(a) "*Give priority to the poor in respect of housing development";*

(b) "*Consult meaningfully with individuals and communities affected by housing development";*

(c) "*Ensure that housing development-*

(i) *Provides as wide a choice of housing and tenure as possible;*

(ii) *Is economically, fiscally, socially and financially, affordable and sustainable";*

(iii) Is based on integrated development; and

(iv) *Is administered in a transparent, accountable, and equitable manner, and upholds a practice of good governance";*

(d) "*Encourage and support individuals and communities….in their efforts to fulfil their own housing needs by assisting them in accessing land, services and technical assistance in a way that leads to the transfer of skills to, and empowerment of, the community";*

As argued by the South African Human Rights Commission (2015), despite the recognition of the importance of this right, millions of people around the world still lack adequate housing and live in conditions which fail to uphold their human rights. In South Africa, it is recognised that significant progress has been made since 1994, with the provision of an estimated 3.7 million housing opportunities providing around 12.5 million people with access to housing, along with further improvements in access to other basic services including adequate water, sanitation, electricity, and refuse removal. Furthermore, as argued by the South African Human Rights Commission (2015) despite these gains, the country continues to face significant challenges in providing access to adequate housing to poor and vulnerable persons, many of whom continue to live in deplorable conditions without access to basic services or the economic opportunities required to escape from poverty. Exacerbating these challenges are the continuing population growth in South Africa with some municipalities experiencing higher population growth compared to others across provinces (South African Human Rights Commission, 2015).

According to Statistics South Africa (2016), about eight in every ten North West Province households (78,3 percent) reside in a formal structure whereas nearly a fifth stay in informal dwellings (18,4 percent). The province has the country's third lowest proportion of households living in traditional housing at 1,9 percent. About a fifth of the households in the North West Province have benefited from a government-subsidized dwelling, with 21 per cent of households in the province reporting that they reside in a government-funded dwelling. A majority (56,8 percent) of dwellings in the North West Province are owned and fully paid off, about two in every 10 households (18,1 percent) rent their

dwellings, and nearly a tenth (9,9 percent) stay rent-free in houses they do not own. The North West Province has the country's second lowest proportion of households whose main dwellings are still mortgaged, with only 7,8 percent of households in the province still paying back the home loans for their main dwellings (Statistics South Africa, 2016).

As argued by Karantonis (2008), population growth is a major underlying factor for the demand of housing, and without a new supply of dwellings, it pushes up the prices for both renting and purchasing dwellings. Because of a decline in affordability, this problem is further compounded in many large cities by the change in living preferences that has resulted in a decline in household occupancy rates, particularly in the western part of the globe. Affordability is further eroded in many of the urban cities from the supply side of the equation, as new supply is needed to house the growth of population, which results in urban sprawl, which in turn is putting pressure to upgrade and extend existing infrastructure or provide new infrastructure (Karantonis, 2008). Evidently, for those who do not have houses and cannot even afford this remains the responsibility of government to provide basic shelter through municipal housing programme. High unemployment and poverty levels within a specific municipality will directly translate into higher demand for social housing and related infrastructure from the municipality (Karantonis, 2008).

3.4.3 Electricity and population growth

Is there a sustainable solution for the world and the resources it needs to maintain a decent standard of living for everybody, at a population very much higher than today's? Clearly, there cannot be both a permanent growth in the use of materials and a sustainable future. As argued by Sheffield (1998), energy is used as a factor because it is a proactive agent in facilitating increases in the standard of living and changes in the social conditions which are believed to influence the fertility rate. Historical

trends and near-term projections for energy use and population growth rate are used to indicate a possible path in the future for developing regions (Sheffield, 1998).

According to the National Development Plan (NDP) (2012), South Africa's population is predicted to increase to 68 million people by 2030. A population growth is resulting in strong demand in energy, and the developing population is putting huge pressure on the country's resources. The increased demand on utilities has directly contributed to the increase in South Africa's electricity tariffs, which have risen 170 percent over the past five years (Chien, 2014). According to Statistics South Africa (2017c), the percentage of South African households that were connected to the mains electricity supply increased from 77,1 percent in 2002 to 84,2 per cent in 2016. Mainly, electricity was most common in Limpopo (94,1 percent), Northern Cape (91,8 percent) and Free State (88,2 percent), and least common in Gauteng (80,6 percent), North West (81,0 per cent), and KwaZulu-Natal (81,5 percent). The largest increases between 2002 and 2016 were observed in Eastern Cape (+28,1 percentage points), and Limpopo (+21,6 percentage points) while the percentage of households with access to mains electricity declined in Gauteng (-6,5 percentage points), Western Cape (-1,5 percentage points) and the North West Province (-0,9 percentage points). These declines can be associated with the rapid in-migration experienced by these provinces, (Statistics South Africa, 2017c).

As argued by Darmstadter (2004), to address the issue of the effect of population size and growth on energy demand, the fact that the link between population and energy involves two intermediate connecting elements must be recognized. Furthermore, Darmstadter (2004) argues that the *first connection* "relates to levels and changes in economic development, approximated by income or gross domestic product (GDP) per capita" and the *second point* "to consider in linking population and energy". Even at comparable levels of per capita GDP, the quantity of energy use will differ among countries and regions, depending on structural characteristics of the economy, spatial features,

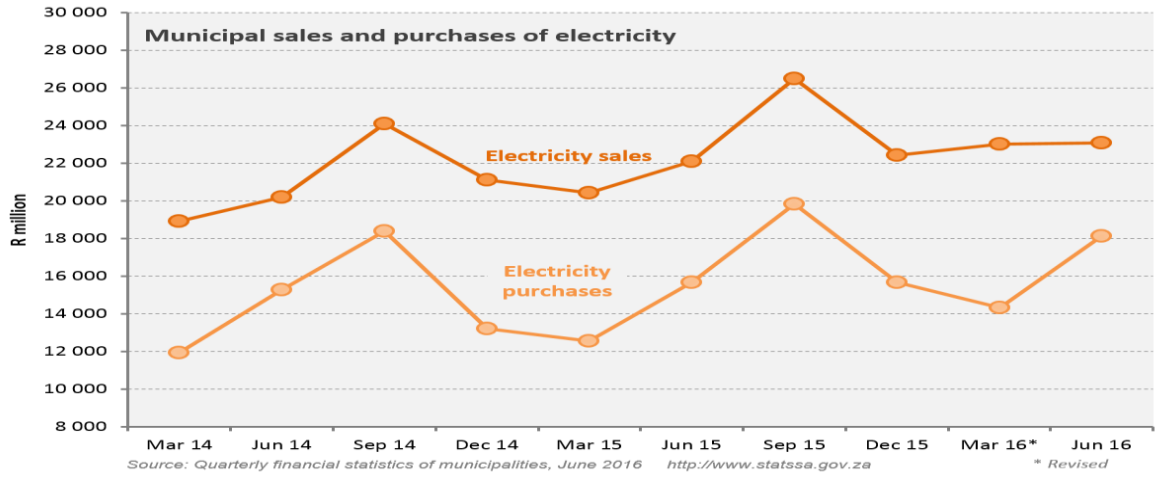
climate, fuel and power prices, government conservation policies, and other factors (Darmstadter, 2004).

Sheffield (1998) points out that energy is used as a factor because it is a proactive agent in facilitating increases in the standard of living and changes in the social conditions which are believed to influence the fertility rate. Historical trends and near-term projections for energy use and population growth rate are used to indicate a possible path in the future for developing regions. In his study, Sheffield (1998) argues that improvements in the efficiency of energy use and modest cultural changes are invoked in an example projection of coupled energy use and population growth. For each decade, the incremental increase in annual commercial energy use per capita and a corresponding decrease in population growth rate are chosen to continue the historical trends for developing regions of the world, (Sheffield, 1998). Electricity plays a key role in enhancing productivity within the economy and is critical Bojanala Platinum District Municipality due to high mining activities.

A growing population must be coupled with an increase in investment in electricity by government to cater for both household and industry growing consumption. Amongst others, the electricity sector has always been leading in terms of capital expenditure by government in South Africa. According to Statistics South Africa (2017a), investment in electricity trumped all else in 2016. Just over a quarter of public-sector capital expenditure was on new electricity infrastructure. There was a cumulative contribution of 18 percent from non-residential buildings (6 percent), roads and bridges (6 percent) and water (6 percent). Not surprisingly, Eskom topped the list as the biggest capital spender of the 772 public-sector entities. The power utility contributed 25,7 percent (R73,0 billion) to total capital expenditure, focusing mainly on the continued construction of the Kusile and the Medupi power stations, and the Ingula Pumped Storage Scheme (Statistics South Africa, 2017a).

Over and above electricity infrastructure investment, municipalities have the responsibility to supply electricity to consumers and they procure from Eskom. According to Statistics South Africa (2017b), Eskom increased the price of electricity by 9,4 percent on 1 April 2016, shortly after the National Energy Regulator of South Africa (NERSA) approved the tariff rise for the 2016/17 financial year. Thus, municipalities being significant traders of electricity, it comes as no surprise that any jump in electricity tariffs would have an immediate impact on their statement of financial performance. The tariff increase contributed to municipalities spending R3,8 billion more on electricity in the June 2016 quarter compared with the March 2016 quarter, a rise of 26,6 percent from R14,3 billion to R18,1 billion (Statistics South Africa, 2017b).

Figure 18: *Municipal Electricity Sales and Purchases, March 2014 – June 2016*



Source: Statistics South Africa (2017)

The other contributing factor to the rise in electricity spending is related to the weather: the June quarter covers part of winter, and municipalities purchase more electricity over this period to meet higher demand. Thus quarter-on-quarter changes should be seen in the context of seasonal patterns. It is in this context that energy consumption should be understood in the context of demand and supply which are primarily driven by needs of different consumers and industries. As argued by

Sheffield (1998), the absence of energy can condemn people to a poor quality of life and deny them those services that contribute to lowering the population growth rate. This is because an energy unit, unlike a monetary unit, has the same value anywhere it is used. Because many energy sources are not infinite, and they are not distributed uniformly, and if they influence population growth rate, there can be significant impacts from variations in their availability and deployment (Sheffield, 1998).

3.4.4 Sanitation and Population Growth

Poor sanitation infrastructure disrupts economic activity; compounds the problems of poor housing, particularly for low-income families; and increases health risks to the population. According to Devarajan (2014), sanitation is one of the most productive investments a government can make. There is now rigorous empirical evidence that improved sanitation systems reduce the incidence of diarrhea among children. Diarrhea, in turn, harms children's nutritional status (by affecting their ability to retain nutrients). An inadequate nutrition (stunting, etc.) affects children's cognitive skills, lifetime health and earnings. In short, the benefits of sanitation investment are huge. Cost-benefit analyses show rates of return of 17-55 percent, or benefit/cost ratios between 2 and 8 (Devarajan, 2014).

According to Statistics South Africa (2017c), percentage of households per province that had access to improved sanitation facilities. These facilities are defined as flush toilets connected to a public sewerage system or a septic tank, and a pit toilet with a ventilation pipe. Nationally, the percentage of households with access to 'RDP–standard' sanitation increased from 62,3 percent in 2002 to 80,9 per cent in 2016. Most households in Western Cape (94,3 percent) and Gauteng (90,7 percent) had access to adequate sanitation. Improved sanitation facilities were least common in Limpopo (57,1 percent) and Mpumalanga (67,4 percent). In the Eastern Cape, household access to improved sanitation facilities increased by 51,3 percentage points between 2002 and 2016, growing from 33,5

percent to 84,8 per cent and the North West Province improved from 54,5 percent in 2002 to 68,7 in 2016 (Statistics South Africa, 2017c).

Water and Sanitation are among the most basic of services, with major social and economic implications (Irigoyen, 2011). Evidently and amongst others, this is highlighted in the World Health Organisation study by Haller et al. (2007) which points out that the economic gains of meeting the sanitation MDG in the countries currently off-track ($35 billion per annum) can primarily be attributed to non-health benefits; predominantly in saved time due to better access to sanitation facilities (90 percent). Society's expectations of the state may be limited in the sanitation subsector, associated with a lack of spontaneous demand for sanitation services on the part of communities. This demand gap has two potential implications for state-society relations: ***First,*** "that there may be no strong negative reaction if sanitation services are not provided (at least until there is a disease outbreak)"; ***Second,*** "that the state has an assumed role to stimulate demand, if it is informed of the health implications of inadequate sanitation" (Ndaruhutse *et al.,* 2011).

The need for the state to provide an enabling framework, including policies and a coherent approach to delineate private and public roles, is often attested to by the case of Bangladesh – a country that has made significant progress on sanitation, and, on reducing open defecation with high level political support and adoption of community-led total sanitation into policy (Ahmed, 2009). It is however important that policy implementation must be done in an integrated approach to ensure sustainability thereof. As argued by Mjoli (2010), the literature review identified improvement in health, affordability, environmental sustainability and management of sanitation services at the lowest appropriate levels as four fundamental principles of sustainable sanitation programmes. International experience of subsidized sanitation programmes showed that supply driven sanitation delivery approaches led to unsustainable sanitation services because they focused on toilet construction

without considering hygiene education, community mobilisation and meeting sanitation demands of the beneficiary communities. The adoption of a Community Led Total Sanitation (CLTS) approach resulted in a rapid increase in sanitation coverage in South Asia and India after decades of failed supply-driven toilet construction programmes. The success of this approach was possible because the local communities took the lead in ensuring that their villages were 'open defecation free' and they used peer pressure to enforce compliance by all households (Mjoli, 2010).

According to Mjoli (2010), the following policy gaps exist in South Africa:

- *"Lack of sanitation policy guidelines for basic sanitation service delivery to dense urban informal settlements".*
- *"No sanitation policy guidelines for the provision of basic sanitation services to severely marginalized groups such as people with physical disabilities, elderly, women, children, HIV/AIDS infected individuals and child-headed households".*
- *"Lack of policy for operation and maintenance of VIP toilets and other on-site sanitation technologies, especially the emptying of full pits and safe disposal of pit sludge".*
- *"Sanitation policy guidelines for the integration of water conservation and water demand management strategies into the delivery of basic sanitation infrastructure and development of economic and legal instruments for enforcing compliance".*
- *"Policy guidelines for solid waste management in all types of settlements, especially the settlements that were currently neglected".*
- *"Sanitation policy for institutional sanitation including public toilets for urban and rural areas".*

As argued by Pearson and Mcphedran (2008), the health benefits are usually considered to be the most significant impacts of sanitation, but other factors are also important. There are social impacts of sanitation on women, adolescent girls, children, the disabled and the environment which are often over-looked in research and policy development. Safe private sanitation facilities can help women and girls to be secure and healthy. They can encourage girls' attendance in school past puberty. They can also help preserve the dignity of disabled people and can improve the environment. Policy development must consider such factors in the context of growing population being it as result of migration, increased life expectancy or high fertility in the province and most importantly at local municipalities. It is on these bases that in the process of developing municipal Integrated Development Plan (IDP), municipalities are mandated in conduct demographic analysis and community consultation.

3.4.5 Refuse removal

As the world's population size has grown, waste generation has increased rapidly. This has had a significant effect on humanity, wildlife and the environment (Population matters, 2016). As further argued by South African Cities Network (2014), urbanisation and population growth have resulted in increased generation of solid waste, which places increasing pressure on waste management within cities. Total accumulated waste levels can only be minimised if population levels are stabilised or reduced. In the meantime, sustainability policies and technological advancements can reduce the generated waste per capita and restore some of the damage that is already caused by excessive waste levels (Population matters, 2016).

The Constitution of the Republic of South Africa under Chapter 2 the Bill of Rights stipulates that; everyone has the constitutional right to have an environment that is not harmful to his or her health and to have the environment protected for the benefit of present and future generations through reasonable legislative and other measures that —

a) "Prevent pollution and ecological degradation";

b) "Promote conservation": and

c) "Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development";

Waste in South Africa is currently governed by means of many pieces of legislation, including but not limited to:

- *'The South African Constitution (Act 108 Of 1996)",*
- *"Environment Conservation Act (Act 73 of 1989)",*
- *"The National Environmental Management Act (Act 107 of 1998)",*
- *"Air Quality Act (Act 39 of 2004)",*
- *"National Environmental Management: Waste Act, 2008 (Act 59 of 2008)",*
- *"National Waste Management Strategy, (Department of environmental affairs, 2017)".*

As argued by Collins and Mbebe (2013), waste production is driven by factors such as the growing population and increasing demands for goods. As consumerism, industrialisation and urbanisation continue to increase, so too does waste generation and this places significant pressure on a finite ability of natural and man-made systems to process waste material.

In their report, Collins and Mbebe (2013) further argue that typically waste is disposed of by concentrating it in landfills of various sizes, incinerating or burning it, or by scattering it in the general environment (e.g. illegal dumping, littering or incorrect landfilling). All three means result in the

concentration and release of pollutants to the water, air and soil, and hence are detrimental to the natural environment.

As indicated above, waste collection and disposal of remains the responsibility of government at municipal level. Lack of capacity may therefore result in the inability of a municipality to collect waste and effectively dispose or re-cycle it. According to Statistics South (2017c), the percentage of households for which refuse was removed at least once per week increased from 56,7 percent in 2002 to 64,9 percent in 2016, while the percentage of households that had to rely on their own or communal rubbish dumps, or who had no facilities at all, decreased over the same period. The national figures, however, hide large discrepancies between particularly rural and urban areas, but also between urban and metropolitan areas. Households in urban areas were much more likely to receive some rubbish removal service than those in rural areas, and rural households were therefore much more likely to rely on their own rubbish dumps (Statistics South Africa, 2017c).

Though population growth in relation to waste could appear as a challenge to various regions, there are still opportunities that are presented by waste that is being collected as indicated by above mention statistics. In its report on the state of waste management in cities, South African Cities Network (2014) argues that strategies toward waste minimisation drives should be effectively assessed to encourage reduced waste to landfill and direct community behavioural patterns towards waste disposal. The availability of the current footprints of the landfill sites presents an ideal opportunity to develop an integrated waste management facility, i.e. Waste to Energy facility, MRF, Composting plant and a crushing and screening plant. This should be investigated and implemented if feasible. It is also suggested that the following be implemented:

- *"Consider operational intervention, i.e. "Back to basics" on landfills";*
- *"More planning directives for It is recommended waste collection and separation";*
- *"Weak resources and skills at municipal level to carry out or support policies";*
- *"Develop a socio-model to engage the reclaimers to be "on-boarded" in the recycling programme at the landfill sites";*
- *"Greater education and awareness initiatives at community level in order too";*
- *"Excessive number of reclaimers, safety is a key concern";*
- *"Mixing of different waste streams e.g. builders rubble mixed with organics"; and*
- *"Initiative to establish cooperatives for reclaimers".*

According to Gwebu (2003), the combined effect of population dynamics and economic development are having a noticeable imprint on the environment in the form of increased waste generation. Poor waste management poses a real threat to environmental sustainability in general and climate change in particular because of inadequate technology, weak institutional mechanisms to enforce regulations, and low levels of sensitization among the public to deal with the problem. Mitigation measures are suggested to minimize the negative effects of waste management on climate change (Gwebu, 2003). Thus, development in its entirety require balance and sustainable growth, hence the need for municipalities to consider, amongst others, demographic factors when developing Integrated Development Strategies.

3.5 Service Delivery, Free basic Service and Population Growth

Rapid population growth is creating unprecedented challenges for infrastructure and service delivery. Planning for population growth often focuses on transport and infrastructure, such as major rail and road projects, as these require significant funding and land allocations. However, planning for other key services, such as those for babies and young children, is also required when young families move into an area in significant numbers (Victorian Auditor-General Report, 2017). Clearly planning for population growth should be totally inclusive and cater for services required by the population.

It is widely recognized that the greatest backlogs in services are in the rural areas. Service delivery conducted in a democratic mode will bring resources to rural communities which could in turn encourage empowerment and alleviate poverty. This much has been acknowledged in many policy documents and government statements (Hemson, Meyer and Maphunye, 2004). Since 1994 the RDP has had specific targets relating to rural areas in a macro-economic framework which was regarded as generally expansionary. This has been followed by GEAR which stressed the limits to state expenditure and a more restrictive framework. Although the targets of service delivery still stand, the institutional framework has been constantly evolving and the financial resources to reach these targets are subject to budgetary priorities. The results have been mixed. The rollout of services has been more successful in some sectors than in others. Water provision is widely regarded as a success while land resettlement is far from the Reconstruction and Development Program (RDP) target of resettling the rural poor and black farmers on 30 percent of the land (Hemson, Meyer and Maphunye, 2004).

Since 1994 the South African government has introduced numerous laws, policies and strategies to improve the socio-economic conditions of poor households in South Africa. As argued by Larkin and Tissington (2013), at the national level there is social assistance in the form of cash grants that target

different groups e.g. children, foster children, people with disabilities, older persons and the unemployed. These social grants have been very successful, contributing in large part to combating absolute poverty in the country. There is also another system that operates at the local government level, relating to the provision of benefits in respect of basic municipal services e.g. water, sanitation, electricity, and refuse removal, (Larkin & Tissington, 2013).

According to SAHR (2015), the National Indigent Policy Framework guides the implementation of policies aimed to give effect to the provision of Free Basic Services (FBS) at the provincial and local government level, which must complement national policies and the policy implementation thus remains the responsibility of the local government at municipal level.

It is, therefore, clear that there is a link between poverty and state of service delivery. According to Hemson, Meyer and Maphunye (2004), the constraints to rural service delivery appear to fall under three headings:

- *"Budgetary",*
- *"State capacity",*
- *"Institutional and Constitutional".*

According to Victorian Auditor-General Report (2017), planning for services and related infrastructure needs to be based on a sound understanding of the population. Planners need to understand where growth is occurring, at what rate, and the ages, cultural backgrounds and socio-economic circumstances of those living in an area. These factors influence decisions about how land is to be

used, what services and related infrastructure are needed for future communities, and when these services will be provided.

3.6 Infrastructure status and Investment

To provide sustainable and quality basic service in every local municipality requires, amongst others, quality and reliable state of infrastructure. Infrastructure is not an end but is an abler to the provision of quality basic services in municipalities amongst others. To attain such a quality state of infrastructure that will cater for the growing population and considering the backlog thereof in South African, increased investment is required. According to Keller (2010), there are at least six (6) factors that influence decisions about infrastructure investment:

First, "the provision of infrastructure may facilitate or stimulate **economic growth**, by providing complementary capital inputs to the private sector. Conversely, the absence of high-quality infrastructure—in telecommunications, transport, power generation, water supply, and port facilities—is widely seen as a costly obstacle deterring foreign private investment. For example, erratic power generation substantially increases the cost of production and reduces productivity. A key policy issue confronting countries with low-quality infrastructure is to determine which investments are the most important prerequisites for growth. Is leapfrogging to the most advanced technology appropriate in the absence of the conjoining availability of human and private capital? Or is there a natural sequencing of infrastructural provision that is more appropriate for encouraging foreign direct investment"?

While infrastructure can help to spur economic growth, the reverse causality also holds: growth and rising per capita income bring increased demand for more and better-quality infrastructure. For

example, the International Monetary Fund (IMF), in a recent World Economic Outlook (IMF, 2008a) notes that once a country's per capita income crosses a given threshold, there is a sharp increase in demand for car ownership. This, of course, intensifies the demand for associated infrastructure for urban and inter-urban transport. As people become richer, investments that upgrade existing infrastructure become increasingly profitable and politically urgent.

"In short, income levels influence the demand for infrastructure. But when there is significant poverty, low-income groups may be unable to afford even the minimal payments required to cover the marginal cost of supply. Such demand-side constraints may make it difficult to recover costs for new infrastructural investments in low-income countries in the absence of significant subsidies. Hence, in low- and middle-income countries, quality differentials exist in infrastructure—whether water and sanitation, health, education, and transport—between urban and rural areas while such differentials typically do not exist in high-income countries".

***Secondly*, Technology "**is another important factor that drives investments in infrastructure. This is most obvious for the ICT sector, where demand for cell phones and internet requires satellites, satellite dishes, cell phone towers, and fiber optic cables, among other things. The private sector has been able to leapfrog the government and profitably provide this kind of infrastructure in a competitive market (unlike the largely monopolistic infrastructure associated with traditional communications technologies)".

"Technological innovations (for example, the development of renewable energy sources and ways to lower carbon emissions) will also create pressure for new infrastructure that can replace outmoded technologies. But, even in the absence of new technologies, the demand for infrastructure may be

shaped by innovative approaches to the *delivery* of infrastructural services. For example, some cities (notably Bogotá, Lagos, and Curitiba, Brazil) have pioneered the use of dedicated urban bus lanes in order to rationalize urban transport systems and encourage the use of public transport, thereby reducing the pressure of vehicular traffic and urban sprawl on existing infrastructure".

The ***third "***factor influencing infrastructural investment in and for developing countries is the positive pressure of the internationally agreed-upon UN **Millennium Development Goals (MDG)**. Target 7c seeks to reduce —by half the proportion of people without sustainable access to safe drinking water and basic sanitation. The specific indicators of achievement relate to the —proportion of population using an improved drinking water source, —the proportion of population using an improved sanitation facility, and to —achieving significant improvement in the lives of at least 100 million slum dwellers by 2020. To meet this target, particularly in the context of rapidly growing urban populations, governments will need to invest significant sums on infrastructure for water, sanitation, and housing. The UN Millennium Project estimates the global financial costs of meeting the MDG related to water supply alone would range from $51 to $102 billion; for sanitation, the equivalent figures are $24 billion to $42 billion".

Fourthly, "Infrastructure investments are also related to **societal considerations,** which in turn relate both to poverty reduction and economic growth. In the absence of physical infrastructure, households are forced to adapt in significant ways. For example, without piped water or a village well, women and children may spend hours each day hauling water. Their energy (and associated nutritional requirements) essentially makes up for the absence of electricity, but the value of their —services is rarely reflected in GDP estimates and is often ignored in considering the costs and benefits of infrastructure provision. The payoff to the provision of infrastructure may thus be understated".

***Fifth*, Fiscal constraints "**have a significant impact on infrastructure investments. With few exceptions, private provision of infrastructure has been relatively limited, confined mainly to such things as ICT, toll roads, and some forms of renewable energy. Commercial profitability is hindered by the —free-rider problem.5 Thus, the public sector's ability to access financial resources often determines the level of overall investment. Fiscal constraints are most binding for aid-dependent low-income countries with low tax ratios, and limited capacity to borrow on global capital markets".

"Many countries view public-private partnerships (PPPs) as a means of financing infrastructure. PPPs entail private financing of the construction and often operation and maintenance of an infrastructure project. Public guarantees are provided in relation to specified risks and usually with a commitment by the public sector to acquire the assets of the project at some time in the future. Although PPPs can alleviate the immediate liquidity constraints that limit the government's ability to invest in infrastructure, they may also entail contingent liabilities that potentially threaten a country's fiscal sustainability. Indeed, PPPs may imply as much sovereign risk as would direct public borrowing for a project" (see IMF, 2004).

The final and "crucial factor affecting investments in infrastructure, which will increasingly confront many governments in coming years, is **climate change**. Over the next several decades, climate change will result in both rising sea levels and more frequent and intense storms, with an associated higher level of storm surge. Climate change may thus undercut the viability of some areas for settlement in the absence of coastal protection infrastructure. In some cities, it may affect the viability of existing housing infrastructure and settlements and lead to migration or resettlement,

creating new demands for infrastructure. It may also lead to an increased risk of periodic flooding, requiring both emergency welfare outlays and infrastructural rehabilitation outlays".

For Africa, hydrological variability will exacerbate the challenge of providing infrastructure for water storage, where storage capacities (now at about 200 cubic meters per capita) are already far below levels in Asia (which are on the order of 1,000 cubic meters per capita or higher). In Latin America, the melting of the Andean glaciers and decreased precipitation will force countries to seek alternative sources of energy generation to replace hydropower energy plants. In both Latin America and Africa, changes in precipitation patterns are expected to lead to a need to replace easily washed out gravel roads with costlier, though more durable, bitumen roads (Heller, 2010).

3.7 Urbanisation and Population Growth

Urbanisation "is the increase in the proportion of people living in towns and cities. Urbanisation occurs because people move from rural areas (countryside) to urban areas (towns and cities)". This usually occurs when a country is still developing. According to Muzondi (2014), urbanisation has in recent years epitomized the developing world's human movement landscapes. The increased concentration of populations into developing countries' cities was, however, devoid of the attendant planning for service delivery, with the result that the urban system became incrementally overwhelmed. The resultant conditions have commonly bred social ills ranging from overcrowding, crime, spread of water-borne diseases, and dearth of sanitation and deterioration of the urban delivery systems, which are often transposed into the planned sections of the cities. According to USAID (2013), urbanisation also entails a host of major development challenges: one billion people currently live in slums without basic services like clean water; 28 percent of urban under-five children are chronically malnourished; 60 percent of urban dwellers are exposed to natural disasters; some infectious diseases, such as tuberculosis (TB), disproportionately affect dense urban populations; and a lack of formal property

rights make many vulnerable to forcible evictions, displacement, and lost livelihoods. Compared with men, women in cities face unequal access to work, housing, health, education and representation in urban governance (USAID, 2013).

As argued by Internet geography (2016), prior to 1950 the majority of urbanisation occurred in MEDCs (more economically developed countries). Rapid urbanisation took place during the period of industrialisation that took place in Europe and North America in the nineteenth and early twentieth centuries. Many people moved from rural to urban areas to get jobs in the rapidly expanding industries in many large towns and cities. Since 1950 urbanisation has slowed in most MEDCs, and now some of the biggest cities are losing population as people move away from the city to rural environments. This is known as counter-urbanisation (Internetgeography, 2016).

According to Internetgeography (2016), since 1950 the most rapid growth in urbanisation has occurred in LEDCs (Less Economically Developed Countries) in South America, Africa and Asia. Between 1950 and 1990 the urban population living in LEDCs doubled. In developed countries the increase was less than half. As argued by Internetgeography (2016), the three main causes of urbanisation in LEDCs since 1950 are:

- *"Rural to urban migration is happening on a massive scale due to population pressure and lack of resources in rural areas. These are 'push' factors".*
- *"People living in rural areas are 'pulled' to the city. Often, they believe that the standard of living in urban areas will be much better than in rural areas. They are usually wrong. People also hope for well-paid jobs, the greater opportunities to find casual or 'informal' work, better health care and education".*

- *"Natural increase caused by a decrease in death rates while birth rates remain high".*

The UN predicts that by 2030, 60 percent of the world's population will live in urban environments. As argued by Heller (2010), another important demographic factor that shapes the demand for infrastructure is the extent and character of the urbanization process, particularly the size of a city and the density of its settlement. The larger the urban agglomeration, the greater the possibility for economies of scale in the provision of many kinds of infrastructure, which significantly reduces the unit cost of provision, particularly relative to rural areas. This applies to water, sanitation, power, transportation, and even social services. The density of an urban area further reinforces these technological possibilities. Higher (lower) densities significantly augment (constrain) the options for more efficient infrastructure networks that embody economies of scale, particularly for infrastructure of higher quality (see World Bank Group, 2010). As further agued by World Bank Group (2010), there are five factors which qualify these relationships.

The *first* "is that there is typically a demand for higher and more costly standards of infrastructure in urban areas, particularly in large or mega cities. This creates many challenges. Though urban densities may be sufficiently high to create a popular demand for higher quality infrastructure, they may not be high enough to allow significant economies of scale in their delivery. Essentially, in low-density areas, economies of scale may be difficult to achieve, and this is particularly the case in low-density —secondary urban areas".

Second, "capital costs and salaries are likely to be higher in urban areas, raising the cost of infrastructure provision".

Third, "urbanization is often associated with a shift toward manufacturing and services production, which calls for greater provision of economically productive infrastructure in addition to universal services (such as ITC, transport links, electricity)".

Fourth, "the fact of urbanization may not translate into increased infrastructure if fiscal constraints prove binding. Many of the world's larger cities in low-income and emerging market countries have dramatic differentials in the quality and quantity of infrastructure available. Many low- and even middle-income groups live in slums or low-income housing developments with far fewer (if any) and much lower-quality infrastructure services than those provided to upper-income groups. The water wars experienced in some Latin American and Asian cities in the last decade (e.g., Cochabamba, Manila) highlight this phenomenon. Indeed, differentials in the quality of the infrastructure available between rural areas and urban slums are often minimal (Montgomery et al., 2003). However, in net terms, there is likely to be an increased need for infrastructure with urbanization".

Finally, "the pressures for infrastructure that urbanization creates do not determine by themselves the cost or nature of the infrastructure required. Significant differences in the quality of infrastructure exist. Water can be accessed with boreholes and hand pumps, stand-posts, or through private taps. In providing sanitation, traditional or improved latrines may be provided, or septic tanks, or sewage networks. Flexibility in the technology (and quality) decided upon for such basic services can significantly reduce the unit cost of infrastructure". There are few other ways in which urbanization and density affect the demand for infrastructure. Urban populations shift the consumption locus for both the domestic agricultural sector and imports, spurring demand for storage, distribution, and transport and port infrastructure associated with distant agricultural production (Heller, 2010).

As argued by Khuluse-Makhanya *et al.*, (2016), in urban planning, it is important to understand settlements in terms of demographic, socio-economic, physical and political environmental characteristics. The objective is often to support municipalities, regional and national governments with long-term planning tools for the development of infrastructure, facilities and services. In a municipal context, planning relies on spatially explicit estimates of the future demand for services, which depend largely on where households will live, where they will work and how they will commute using the transportation networks available to them (Waddell, 2005).

3.8 Conclusion

Both economic and social infrastructure play a key role in economic development and human development across the globe. While there are different theories on population growth, it remains a fact that any country or region with large number of youthful population has the potential of population dividend and this is the case in Bojanala Platinum District Municipality. As reflected in the literature above, the provision of all types of infrastructure including water, sanitation, electricity and housing amongst others as enabling factors which are vital in unleashing economic potential of young people and the entire population of BPDM. It is evident that population growth can place a burden of municipal infrastructure and other non-renewable resources. Thus, the need to innovatively, efficiently and effectively use available resources to meet demands for the population.

Chapter 4: Methodology

4.1 Introduction

Chapter four (4) explorers a model to be used for this study. Due to the nature of data available for this study, panel data shows to be the most relevant econometric approach. Prior to model selection, a detail description of panel data approaches will be explored. This chapter will further look at advantages and limitations of panel data. This chapter will further outline the research methodology and specify the model selected for this study.

4.2 Research Design

Various approaches can be applied in academic research and amongst them are is qualitative, quantitative and mixed method approach. Due to the availability of quantitative data on variables under study, this study therefore applies quantitative method using panel data approach. According to SIS International Research (2018), Quantitative Research is a structured way of collecting and analysing data obtained from different sources. Quantitative Research involves the use of computational, statistical, and mathematical tools to derive results. It is conclusive in its purpose as it tries to quantify the problem and understand how prevalent it is by looking for projectable results to a larger population.

As Argued by Study.com (2018), quantitative data has several advantages. One major one is that the outcome of quantitative research is easy to measure, and the results can be clearly shown through objective data. It is harder to argue with the results of quantitative research than qualitative research, which is based more on observation and less on numerical data. It can also be easier to make predictions based on quantitative data because of its numerical basis. The ability to expand quantitative data into predictions is a major advantage.

One disadvantage of quantitative data is that it cannot be used to explain social phenomena, which makes it less useful in fields like sociology. Quantitative data can tell you what is happening, but it cannot give any insight into why. For this kind of insight, you need the observation-based qualitative research. Quantitative research cannot account for non-numerical information, such as human emotions, beliefs or imaginations (Study.com, 2018).

In recent years, panel data has become widely utilized in econometric analysis in many social sciences. Panel data combines cross-sectional and time-series data and, therefore, provides a more appealing structure of data analysis than either cross sectional or time-series data, alone (Jirata, 2014). Panel data, also known as cross-sectional time series data, are repeated observations on the same set of cross-section units. Two-types of information are represented in cross-sectional data: the cross-sectional information, reflected in the differences between subjects, and the time-series or within-subject information, reflected in the changes within subjects over time. Panel data regression techniques allow researchers to take advantage of these different types of information (Cancado, 2005).

According to Jirata (2014), a panel data set contains N entities or subjects (e.g., firms and states), each of which includes T observations measured at i through t time period. Thus, the total number of observations is NT. Ideally, panel data are measured at regular time intervals (e.g., year, quarter, and month). Otherwise, panel data should be analysed with caution. A short panel data set has many entities but few time periods (small T), while a long panel has many time periods (large T) but few entities Cameron, Colin and Trivedi (2009).

There are advantages and limitation on panel data. The section below therefore explorers these prons and cons of panel data.

4.2.1 Advantages of Panel Data

As argued by Hsiao (2007), panel data, by blending the inter-individual differences and intra-individual dynamics have several advantages over cross-sectional or time-series data. These are some of the advantages of Panel Data.

I. **Controlling for individual heterogeneity:** Panel data suggest that individuals, firms, states or countries are heterogeneous. Time series and cross section studies not controlling for this heterogeneity run the risk of obtaining biased results.

II. **Panel data give more informative data, more variability, less co-linearity among the variables, more degrees of freedom and more efficiency:** Time-series studies are plagued with multi-collinearity. With additional, more informative data, one can product more reliable parameter estimates.

III. **Panel data are better able to study the dynamics of adjustment:** Cross sectional distributions that look relatively stable hide a multitude of changes. Spells of unemployment, job turnover, residential and income mobility are better studied with panels. Panel data are also well suited to study the duration of economic states like unemployment and poverty, and if these panels are long enough, they can shed light on the speed of adjustments to economic policy changes, for example in measuring unemployed at a point in time. Only panel data can estimate what proportion of those who are unemployed in one period remain unemployed in another period.

IV. **Panel data are better able to identify and measure effects that are simply not detectable in pure cross-sections or pure time-series data:** Ben-Porath (1973) gives an example. Suppose that we have a cross-section of women with a 50 per cent average yearly labour force participation rate. This might be due to (a) each woman having a 50 per cent chance of being in the labour force, in any given year, or (b) 50 per cent of the women work all the time and 50 per cent do not. Case (a) has high turnover, while case (b) has no turnover. Only panel data could discriminate between these cases.

V. **Panel data models allow us to construct and test more complicated behavioural models than purely cross-section or time-series data:** For example, technical efficiency is better studied and modelled with panel data models. In addition, fewer restrictions can be imposed in panels on a distributed lag model than in a purely time-series study.

VI. **Panel data are usually gathered on micro units, like individuals, firms and households:** Many variables can be more accurately measured at the micro level and biases resulting from aggregation over firms or individuals are eliminated

4.3 Data Source

4.3.1 IHS Markit Regional Explorer

Though there is development in data generation globally, availability of data remains a challenge in developing countries and South Africa is not an exception to this. While this remains a challenge for some variables, it remains more challenging when looking for data on district and local municipalities. There are very few institutions which produce modelled data for local municipalities such as Quantec

and IHS Markit Regional Explorer and such data does not provide N-Value acceptable for time series regression analysis.

In this research, qualitative secondary time series data for all variables is obtained from IHS Markit Regional Explorer database (2018). The data is sourced directly from the online system as produced by IHS Markit Regional Explorer. The N value for all variables in the study is 21, hence the application of panel data approach. This data is available for all variables which are Population growth from all local municipalities within Bojanala District Municipality by race, electricity, households with water backlog, unemployment, gross domestic production by region and people living below poverty line. The data will be applied in multivariate analysis using panel approach and will greatly assist in addressing research objectives.

IHS Markit is a private owned international company which combines information, analytics and expertise to provide solutions for business, finance and government. Through its statistical capabilities, the company has developed a database known as IHS Markit Regional Explorer. IHS Markit's Regional eXplorer (ReX) is a system of integrated databases that can provide you with accurate and up-to-date economic, marketing and development information for each magisterial district and province in South Africa. The database provides data on demography, development, household infrastructure, labour, income & expenditure, economic, tourism, international trade, environment and crime. Various institutions and individuals can, therefore, subscribe at a fee to access the database.

To produce municipal data, the company source its data from various sources from Statistics South Africa. In developing a database for demographic household infrastructure data, these sources are

Census 1996, The 1996 Population Census was enumerated on a de facto basis, that is, according to the place where persons were located during the census. ALL persons who were present on Republic of South African territory during census night (i.e. at midnight between 7 and 8 March 1991) were therefore enumerated and included in the data. Census 1996, every person in South Africa on Census night, 9-10 October 1996, should have been enumerated in Census '96. The enumeration generally took place over the period of 10 October to 30 October although, in some situations, it was necessary to continue enumeration through to December to ensure that as many people possible were included.

Census 2001, the 2001 Population Census, was enumerated on a de facto basis, that is, according to the place where persons were located during the census. All persons who were present on the Republic of South African territory during census night (9-10 October 2001) were therefore enumerated and included in the data. In February 2007, a large-scale Community Survey 2007 was conducted in all provinces. The main objective of the survey was to provide demographic and socio-economic data at municipal level. 949 105 persons were enumerated. 246 618 households were covered during enumeration.

The Labour Force Survey publication contains results of a rotating panel household survey first conducted in 2000. It was specifically designed to measure the dynamics of employment and unemployment in the country. It measures a variety of issues related to the labour market, including unemployment rates. October Household survey statistical release presents a selection of indicative findings and additional tables from the October household survey (OHS), which was conducted from 1995-1999, with emphasis on poverty indicators. The survey gathered detailed information on a sample of people living in households across the country. This was discontinued and- replaced by the Labour Force Survey and the General Household Survey.

In summary, data used in this study is polled from statistics South Africa Labour Force Survey; Household Survey; Community Survey and Population Census. Such data is, therefore, produced by Statistics South Africa over time and used by IHS Markit to produce different modelled demographic data sets such as population data at local municipality level.

4.3. 2 Sampling Design

Sampling is a fundamental part of statistics. Samples are collected to achieve an understanding of a population because it is typically not feasible to observe all members of the population, as argued by Wills, Roecker and D'Avello (2018). The goal is to collect samples that provide an accurate representation of the population. Constraints on time and money dictate that the sampling effort must be efficient. More samples are needed to characterize the nature of highly variable populations than less variable populations (Wills, Roecker and D'Avello, 2018).

According to Stat Trek (2018), a sample design is made up of two elements:

Sampling method. Sampling method refers to the rules and procedures by which some elements of the population are included in the sample. Some common sampling methods are simple random sampling, stratified sampling, and cluster sampling.

Estimator. The estimation process for calculating sample statistics is called the estimator. Different sampling methods may use different estimators. For example, the formula for computing a mean score with a simple random sample is different from the formula for computing a mean score with a stratified sample. Similarly, the formula for the standard error may vary from one sampling method to the next.

Data used in this study is from a sampling design estimator as produced by IHS Markit Regional Explorer. It is, therefore, worth noting that the source of data produced IHS Markit Regional Explorer database is Statistics South Africa and as elaborated above, these sources are Census, Labour force survey, Community Survey and General Household Survey. These surveys generally apply stratified and cluster sampling approach.

4.4 Types of Panel Data Models

This sub-section presents a brief overview of the static linear, non-linear and dynamic panel data models.

4.4.1 Static Linear Panel Data Models

As argued by Jirata (2014), this type of panel data models does not allow inclusion of the lagged, current and future value of dependent variable as one of the regressors for time periods of the same individual. This is a strong assumption which for example, rules out lagged dependent variables from the model. The linear is the part of the designation relates to the appearance of the regression coefficients. Therefore, the model is linear in parameters in β, individual effect αi and error term E.

4.4.2 Static Non-Linear Panel data models

The nonlinearity is defined in terms of the techniques needed to estimate the parameters, not the shape of the regression function. A nonlinear panel data regression model is one for which the first-order conditions for least squares estimation of the parameters are nonlinear functions of the parameters.

4.4.3 Dynamic linear panel data models

This approach to panel data models involves the use of a dynamic effect, in this case adding a lagged dependent variable to the explanatory variables. These models consider the dynamic processes by allowing the lagged value of the dependent variable as one of the explanatory variables as well as containing observed and unobserved permanent (heterogeneous) or transitory (serially-correlated) individual differences. The main theoretical reason for the dynamic panel is that it is modelling a partial adjustment-based approach. If it is a partial adjustment process, the coefficient on the lagged dependent variable measures the speed of adjustment (i.e. 1 – coefficient is speed of adjustment). In addition, the lagged dependent variable can remove any autocorrelation.

When explanatory variables contain lagged dependent variables, because a typical panel contains many cross-sectional units followed over a short period of time, it turns out that how the initial value of the dependent variable is modelled plays a crucial role with regard to the consistency and efficiency of an estimator (Jirata, 2014; Anderson and Hsiao, 1981 & 1982; Bhargava and Sargan, 1983; Blundell and Bond, 1998).

Each of these models can be either fixed-effect or random-effect, i.e., have both fixed and random effects depending some specified assumptions. A fixed effect model examines if intercepts vary across group or time, whereas a random effect model explores differences in error variance components across individual or period (Jirata, 2014).

Panel data models are becoming increasingly common as compared to cross-sectional and time-series models due to the advantages of panel data. In addition, panel data models examine group (individual-

specific) effects, time effects, or both to deal with heterogeneity or individual effect that may or may not be observed (Jirata, 2014).

4.5 Methods

Section 4.3 presented an overview of three types of panel data models being Static Linear, Non-Linear, and Dynamic Panel data models. Our research, however, focuses on the ***Static Linear Panel data model*** which has been discussed above. Within the Static liner panel data model, we further explore two techniques which are Fixes Effect Model and Random Effect Model. Section 4.4.1 and 4.4.2 therefore gives a brief overview of these two models.

4.5.1 Fixed Effect (EF) Model

Fixed-effects (FE) model is used whenever you are only interested in analysing the impact of variables that vary over time. FE explores the relationship between predictor and outcome variables within an entity (country, person, company, etc.). Each entity has its own individual characteristics that may or may not influence the predictor variables (for example, being a male or female could influence the opinion toward certain issue; or the political system of a country could have some effect on trade or GDP; or the business practices of a company may influence its stock price).

When using FE, we assume that something within the individual may impact or bias the predictor or outcome variables and we need to control for this. This is the rationale behind the assumption of the correlation between entity's error term and predictor variables. FE removes the effect of those time-invariant characteristics, so we can assess the net effect of the predictors on the outcome variable.

Another important assumption of the FE model is that those time-invariant characteristics are unique to the individual and should not be correlated with other individual characteristics. Each entity is different, therefore, the entity's error term and the constant (which captures individual characteristics) should not be correlated with the others. If the error terms are correlated, then FE is no suitable since inferences may not be correct and you need to model that relationship (probably using random-effects), this is the main rationale for the Hausman test (presented later in this document).

The equation for the fixed effects model becomes:

$$Y_{it} = \beta_1 X_{it} + \alpha_i + u_{it} \qquad \text{[eq.1]}$$

where

– α_i (i=1….n) is the unknown intercept for each entity (n entity-specific intercepts).

– Y_{it} is the dependent variable (DV) where i = entity and t = time.

– X_{it} represents one independent variable (IV),

– β_1 is the coefficient for that IV,

– u_{it} is the error term

"The key insight is that if the unobserved variable does not change over time, then any changes in the dependent variable must be due to influences other than these fixed characteristics" (Stock and Watson, 2003: 289-290).

In the case of time-series cross-sectional data the interpretation of the beta coefficients would be "…for a given country, as X varies across time by one unit, Y increases or decreases by β units" (Bartels, Brandom, "Beyond "Fixed Versus Random Effects": A framework for improving substantive and statistical analysis of panel, time-series cross-sectional, and multilevel data" (Stony Brook University, working paper, 2008).

Fixed-effects will not work well with data for which within-cluster variation is minimal or for slow changing variables over time.

Another way to see the fixed effects model is by using binary variables. The equation for the fixed effects model becomes:

$$Y_{it} = \beta_0 + \beta_1 X_{1,it} + \ldots + \beta_k X_{k,it} + \gamma_2 E_2 + \ldots + \gamma_n E_n + u_{it} \quad \text{[eq.2]}$$

where

–Y_{it} is the dependent variable (DV) where i = entity and t = time.

–$X_{k,it}$ represents independent variables (IV),

–βk is the coefficient for the IVs,

– u_{it} is the error term

–E_n is the entity n. Since they are binary (dummies) you have n-1 entities included in the model.

– γ_2 Is the coefficient for the binary repressors (entities)

Both eq.1 and eq.2 are equivalents:

"The slope coefficient on X is the same from one [entity] to the next. The [entity]-specific intercepts in [eq.1] and the binary regressors in [eq.2] have the same source: the unobserved variable Z_i that varies across states but not over time" (Stock and Watson, 2003:280).

You could add time effects to the entity effects model to have a time and entity fixed effects regression model:

$$Y_{it} = \beta_0 + \beta_1 X_{1,it} + \ldots + \beta_k X_{k,it} + \gamma_2 E_2 + \ldots + \gamma_n E_n + \delta_2 T_2 + \ldots + \delta_t T_t + u_{it} \quad \text{[eq.3]}$$

where

–Y_{it} is the dependent variable (DV) where i = entity and t = time.

–$X_{k,it}$ represents independent variables (IV),

–β_k is the coefficient for the IVs,

– u_{it} is the error term

–E_n is the entity n. Since they are binary (dummies) you have n-1 entities included in the model.

– γ_2 is the coefficient for the binary regressors (entities).

–T_t is time as binary variable (dummy), so we have t-1-time periods.

– δ_t is the coefficient for the binary time regressors.

Control for time effects whenever unexpected variation or special events my affect the outcome variable.

"…The fixed-effects model controls for all time-invariant differences between the individuals, so the estimated coefficients of the fixed-effects models cannot be biased because of omitted time-invariant characteristics… [like culture, religion, gender, race, etc]. One side effect of the features of fixed-effects models is that they cannot be used to investigate time-invariant causes of the dependent variables. Technically, time-invariant characteristics of the individuals are perfectly collinear with the person [or entity] dummies. Substantively, fixed-effects models are designed to study the causes of changes within a person [or entity]. A time-invariant characteristic cannot cause such a change, because it is constant for each person" (Kohler, Ulrich, Frauke Kreuter, 2009).

4.5.2 Random Effects Model

The rationale behind random effects model is that, unlike the fixed effects model, the variation across entities is assumed to be random and uncorrelated with the predictor or independent variables included in the model: "…the crucial distinction between fixed and random effects is whether the unobserved individual effect embodies elements that are correlated with the regressors in the model, not whether these effects are stochastic or not" (Green, 2008:183). If you have reason to believe that differences across entities have some influence on your dependent variable, then you should use random effects. An advantage of random effects is that you can include time invariant variables (i.e. gender). In the fixed effects model these variables are absorbed by the intercept. The random effects model is:

$$Y_{it} = \beta X_{it} + \alpha + u_{it} + \varepsilon_{it} \qquad \text{[eq.4]}$$

Random effects assume that the entity's error term is not correlated with the predictors which allows for time-invariant variables to play a role as explanatory variables. In random-affects you need to

specify those individual characteristics that may or may not influence the predictor variables. The problem with this is that some variables may not be available therefore leading to omitted variable bias in the model. RE allows to generalize the inferences beyond the sample used in the model.

4.6 Model Selection

The generally accepted way of choosing between the fixed and random effects is running a Hausman (1978) test. Furthermore, the Hausman test can also be used for the decision on whether the HT-IV estimator is the more appropriated estimator to apply to the data (Cancado, 2005). As clearly described by O'Brien and Patacchini (2006), the Hausman test is the standard procedure used in empirical panel data analysis to discriminate between the fixed effects and random effects model. Therefore, the Hausman test principle Hausman tests can be used in all situations where two model specifications and two estimators are available with the following properties:

- In the restricted model (null), the estimator $\hat{\theta}$ is efficient, the estimator $\tilde{\theta}$ is consistent though typically not efficient; and
- In the unrestricted model (alternative), the estimator $\hat{\theta}$ is inconsistent, the estimator $\tilde{\theta}$ is consistent.

Then, the difference $q = \hat{\theta} - \tilde{\theta}$ should diverge under the alternative and it should converge to zero under the null. Moreover, under the null q and $\hat{\theta}$ should be uncorrelated. According to Cancado (2005), statistically, fixed effects are always a reasonable thing to do with panel data (they always give consistent results), but they may not be the most efficient model to run. Random effects will give you better P-values as they are a more efficient estimator, so you should run random effects if it is statistically justifiable to do so (Cancado, 2005). The Hausman tests checks a more efficient model

against a less efficient but consistent model to make sure that the more efficient model also gives consistent results. It is against this backdrop that this study chose to apply the fixed effect model.

4.7 Model Specification – Fixed Effect Model (FEM)

As argued previously, "…The fixed-effects model controls for all time-invariant differences between the individuals, so the estimated coefficients of the fixed-effects models cannot be biased because of omitted time-invariant characteristics… [like culture, religion, gender, race, etc.]. Before regression we take logs of the variables to allow for an easier interpretation and comparison of the size of the estimated coefficients, and to control for heteroskedasticity and achieve linearity.

The model for the study is specified as follows:

For No Electricity Connection (NEC), the model analyses the relationship between electricity and different population groups under the following specifications (specified as model 5):

$$\log NEC_{it} = \alpha + \beta_1 \log BPL_{it} + \beta 2 \log GDPR_{it} + \beta 2 \log UNEMT_{it} + \beta 2 \log APOP_{it} + \tau_i + \gamma_i + \varepsilon_{it} \quad \textbf{with } \boldsymbol{\varepsilon_{it} = \rho\, \varepsilon_{it-1} + \eta_{it}} \qquad (5.1)$$

$$\log NEC_{it} = \alpha + \beta_1 \log BPL_{it} + \beta 2 \log GDPR_{it} + \beta 2 \log UNEMT_{it} + \beta 2 \log WPOP_{it} + \ + \tau_i + \gamma_i + \varepsilon_{it} \qquad (5.2)$$

$$\log NEC_{it} = \alpha + \beta_1 \log BPL_{it} + \beta 2 \log GDPR_{it} + \beta 2 \log UNEMT_{it} + \beta 2 \log INPOP_{it} + \ + \tau_i + \gamma_i + \varepsilon_{it} \qquad (5.3)$$

$$\log NEC_{it} = \alpha + \beta_1 \log BPL_{it} + \beta 2 \log GDPR_{it} + \beta 2 \log UNEMT_{it} + \beta 2 \log CPOP_{it} + \ + \tau_i + \gamma_i + \varepsilon_{it} \qquad (5.4)$$

For Households with Water Backlog (WBL), the model analyses the relationship between electricity and different population groups under the following specifications (specified as model 6):

$$logHWB_{it} = \alpha + \beta_1 logBPL_{it} + \beta 2\ logGDPR_{it} + \beta 2\ logUNEMT_{it} + \beta 2\ logAPOP_{it} + \tau_i + \gamma_i + \varepsilon_{it} \quad (6.1)$$

$$logHWB_{it} = \alpha + \beta_1 logBPL_{it} + \beta 2\ logGDPR_{it} + \beta 2\ logUNEMT_{it} + \beta 2\ logWPOP_{it} + \tau_i + \gamma_i + \varepsilon_{it} \quad (6.2)$$

$$logHWB_{it} = \alpha + \beta_1 logBPL_{it} + \beta 2\ logGDPR_{it} + \beta 2\ logUNEMT_{it} + \beta 2\ logINPOP_{it} + \tau_i + \gamma_i + \varepsilon_{it} \quad (6.3)$$

$$logHWB_{it} = \alpha + \beta_1 logBPL_{it} + \beta 2\ logGDPR_{it} + \beta 2\ logUNEMT_{it} + \beta 2\ logCPOP_{it} + \tau_i + \gamma_i + \varepsilon_{it} \quad (6.4)$$

where $logNEC_{it}$ is No Electricity Connection and $logHWB_{it}$ represents Households with Water Backlog for all local municipalities within the Bojanala District Municipality. $logBPL_{it}$ represents People Living Below the Poverty Line with $logGDPR_{it}$ representing pooled data for Gross Domestic Production at Region and $logUNEMT_{it}$ represents Total Unemployment in the Bojanala District Municipality. Rationality from economic point suggests that as GDP increases more people will be employed, disposable income will increase and dependency on the state for the provision of basic services will decrease. This will translate into an increase in municipal revenue which should place the municipality in a better position to provide infrastructure for basic service for the population living below poverty line.

Population factors are dynamic. A blanket approach in dealing with population factors can lead to incorrect results or may provide limited understanding of relationship amongst variables under observation. It is for this reason that in this study, population for all local municipalities is disaggregated by race to clearly determine the effects of each population group on infrastructure for basic service provision. $logAPOP_{it}$ represents African population which constitutes 92% of the total population in the Bojanala District Municipality. $logWPOP_{it}$ represents White population group which constitutes 7% while $logINPOP_{it}$ and $logCPOP_{it}$ both constitute less than 2% of the total population of Bojanala District Municipality and representing Indian and Coloured Population groups, respectively.

Due to a number of variables under study a multivariate analysis is applied in this study in a panel data approach. Various approaches have been explored to determine the relevant approach that will assist in providing reliable results in addressing the research objectives. Amongst others is a pure multivariate regression analysis, however, due to limited sample simple this approach proved high risk in results reliability. Panel approach has as a result become the most reliable method left and within panel approach fixed effect model was selected due to its assumptions compared to random effects which assumes uniformity across all local municipalities.

4.8 Limitations

A fixed effects model would not eliminate potential omitted variable bias. One potentially significant limitation of fixed effects models is that you cannot assess the effect of variables that have little within-group variation. As argued by Rossi (2013), we live in a non-experimental world or our experiments are imperfect and don't have full randomization. This means that there can be an asymptotic bias or inconsistency from omission of variables and this remain a serious dilemma to eliminate. However, to ensure that there is no biasedness in our results, population and economic theory is studied and applied in selecting a large number of variables and elimination process is applied through causality tests and or significance test and the results of the study in chapter 5 will clearly illustrate that.

4.9 Conclusion

In this chapter model discussion, selection and presentation were undertaken. Due to the nature of the study and available data a panel data regression analysis was adopted and after extensive discussion a fixed effect approach has been selected. This chapter also clearly specified regression models to assess the extent at which population growth has effects on infrastructure for basic service

provision. All statistical tests will be applied to assess the model robustness prior application to ensure reliability of results.

Chapter 5: Data Analysis and Results

5.1 Introduction

Chapter five (5) presents the analysis and results of panel data regression model. 8 different models are designed separately to assess the effects of population growth by 4 racial group on both electricity and water. A fixed effect model is applied to assess such an effect and the regression results attempt to effectively quantify how independent variables impact the provision of basic infrastructure service for the five local municipalities within the Bojanala Platinum District Municipality. Effectively, we assess the effects and relationship between no electricity and household with water backlog to total unemployment, regional gross domestic production, people below poverty line, and population groups by race. Given the nature of this study and considering the historical injustices of the past in terms of racial policies of the then government, population is disaggregated by race to understand population growth patterns by race and basic service required by different racial groups because of such growth. Table 1 below provide a brief description of variables in the study.

Table 1: *Variables Description & Construction of the Study (IHS Markit, 2018)*

Variable	**Variable Description & Construction**	**Source of Data**
GDPR (Real)	*Description:* Real Gross Domestic Product by Region (GDP-R) represents the value of all goods and services produced within a region, over a period of one year, plus taxes and minus subsidies. *Construction:* In order to calculate a GDP-R figure, a regional breakdown for "Other Taxes on products" and "Other subsidies on products" is required. Adding this figure to total GVA in each region per sector will result in output GDP-R. We start with the national figure on taxes less subsidies as published by StatsSA in their quarterly GDP publications which is equal to value added at market prices less value added at basic prices. This figure is thus made up of the following three components: • Fuel tax. • Excise duties (taxes on alcohol and tobacco.) • Other net "taxes less subsidies on products", which includes all subsidies and "customs duties".	Regional Explorer (ReX). IHS Markit

	We remove the excise duties and fuel tax (which are published by the South African Reserve Bank) to calculate a final figure for the third component, other net taxes less subsidies. This figure is distributed to the various economic sectors using the Supply and Use Tables published annually by StatsSA. The result is a national number for each of the three components, with the third component broken down by economic sub-sector as a percentage of GVA per sector. Regional taxes less subsidies figures are calculated as follows: • **Fuel taxes** and **excise duties** are distributed based on each region's share of national expenditure for those specific product categories as output from the *ReX Expenditure Model*. • **Other net taxes less subsidies** are distributed by making the assumption that both Custom duties and Subsidies are distributed equally across regions, allowing a breakdown proportionally across all regions that contribute to each specific sector. • **Total taxes less subsidies per region** is calculated by adding the three categories together for each region	
UNEMT	*Description:* Throughout the ReX labour model, we make use of the strict (also known as the narrow) definition of unemployment. This is in contrast to the expanded (or broad) definition. The implications are discussed at the relevant points in the definitions below. This number represents the total number of unemployed people in a region, according to the strict definition. In other words, it considers all people who are currently not working, but who are actively looking for work. It therefore excludes those who and not actively seeking work. These people, if they would like to work, are referred to as discouraged work seekers and form part of the non-economically active population. *Construction:* The regional distribution of unemployment is best taken from the Census Datasets Unfortunately, these datasets do not accurately measure the absolute number of unemployed people - especially for the strict definition of unemployment. Nonetheless, the distribution here is more important than the absolute number, which we benchmark to the provincial level using provincial numbers estimated above. However, it is likely that a different distribution of unemployment exists depending upon whether one is measuring the expanded or strict definitions. We therefore need to account for this on a regional level in the base year. The first step is to measure the distribution of the expanded definition of unemployment, and then account for the strict definition distribution ex post. In the StatsSA Census metadata, it is recommended that the category "Unemployed and looking for work" be used as the "equivalent of the expanded definition of unemployment used for other surveys." We use this distribution as a starting point and adjust for discouraged work	Regional Explorer (ReX). IHS Markit

	seekers by using the category "Not working, not looking for work but would accept a job." This adjusted distribution is used as the regional key for unemployment in the base years. The top-level numbers are taken from the provincial results calculated above. It is important to note that the base years, being based on the household Census datasets, are thus distributed according to place of residence for unemployment. In order to estimate unemployment between the base years, growth in the number of unemployed people for each successive year was calculated as the inverse of the growth in total employment per region, calculated in the employment Error Distribution Model, described elsewhere in this document. This growth rate was applied to the base year estimates to arrive at a draft estimate for each year. This figure is termed a draft EAP figure in that it still needs to be adjusted to account for these problems. Fixing the Imbalanced Equation The final adjustment factors are thus derived from the Error Distribution Model which first converts employment, unemployment and the EAP all to place of residence variables, under which the following identity should hold: Unemployment + Employment = EAP In regions where the identity does not hold, the Error Distribution Model returns an error adjustment factor, which is applied to unemployment for each region, resulting in the final regional output unemployment.	
PBL	*Description:* The food poverty line is defined by StatsSA as the level of consumption below which individuals are unable to purchase sufficient food to provide them with an adequate diet. Those below this line are either consuming insufficient calories for their nourishment or must change their consumption patterns from those preferred by low income households. This variable measures the number of individuals living below that particular level of consumption for the given area and is balanced directly to the official food poverty rate as measured by StatsSA. Construction: The ReX Poverty model inherits not only the definition of poverty from StatsSA but also the published *poverty rate*. In other words, outputs from the ReX Income model do not determine the national poverty rate. These outputs are used solely for the geographic distribution of poverty. Three steps are therefore applied to construct municipal data sets on poverty: 1. <u>Estimate National Level Poverty Lines</u> The ReX model aims to inherit both the StatsSA poverty lines and the StatsSA poverty rates as is. However, the poverty lines as published both	Regional Explorer (ReX). IHS Markit

	do not cover the entire period and are not set to the mid-year of each period under review. The ReX model therefore uses the StatsSA Consumer Price Index to both balance each poverty line to a mid-year line number, and to back- and fore-cast for years outside of the available period. The model uses the food CPI rate to adjust the food poverty line, and the official CPI rate for the lower and upper poverty lines. These poverty lines are further calibrated such that when they are imposed on top of the income distribution data from the ReX income model, the precise rate of people in poverty will match the rate of people in poverty as declared by StatsSA. This is done for each population group. The implication of this step is that the ReX income data and the calculated poverty rates will not align with each other. In other words, the national poverty rates are derived directly from StatsSA and not from any internal calculation within the ReX suite of models. 2. <u>Converting from Households to Individuals</u> Income is measured on a household level, whilst poverty is expressed on an individual level. The poverty model therefore needs to convert from household income to individual income before calculating regional poverty rates. This is achieved with data from the various StatsSA Income and Expenditure and Living Conditions Surveys alongside outputs from the ReX household and population models. Specifically, the number of households by household size and income category are extracted from the StatsSA surveys, creating a conversion table into which one can place the total number of households by income category and output the total number of individuals by income category. This table is further constrained by household and population outputs and is recreated for every region and population group covered in the model. The final output of this work is therefore a separate table for every population group and region covered in the model that pivots household income by household size - and in such a way that multiplying the number of households by the size of each household will yield the known population of the area, and simultaneously sum to the known number of households in the area. These tables for each region are used for converting from households to individuals by income category. This is carried out four times; once for each population group. 3. <u>Estimating Regional Poverty Rates</u> Using the tables created above, alongside the ReX household income distribution for each region, we derive the total number of individuals by income category and region. Overlaying the adjusted poverty lines on top of the individual income distributions the model estimates a draft poverty number for each region. This draft number is summed across all regions and divided by the total South African population, giving a national poverty rate. This rate is required to exactly match the national poverty rate published by StatsSA, which implies a certain level of adjustment in order to estimate a final output poverty rate.	

	Adjustment factors are constrained by carrying the entire methodology from above for households and ensuring that the output households' poverty rates also match those published by StatsSA.	
APOP	Description: The population of a region is the total number of people within that region in the middle of the respective year, categorised according to population group. The population groups output is **African**, White, Coloured and Asian. *Construction (for all population by race)*: The national and provincial population estimates are obtained using a *Cohort-Component Population Projection*. These projections are determined by five fundamental population variables: • Size of population in the base year, $\mathbf{P^t}$ • Number of deaths occurring between the base and projected years, $\mathbf{D^t}$ • Number of births occurring between the base and projected years, $\mathbf{B^t}$ • Immigrants arriving in the country between the base and projected years, $\mathbf{I^t}$ • Emigrants leaving the country between the base and projected years, $\mathbf{E^t}$ The above variables contribute to the projected population, $\mathbf{P^{t+1}}$, within the constraints of the following demographic balancing identity: $P^{t+1} = P^t + B^t - D^t + I^t - E^t$ The final population figures are based on a set of cohort-component models, with a separate balancing equation for each population group and province. We sum the individual results to arrive at the total national population. This is done because fertility, mortality and migration factors vary largely between the different population groups and provinces. This methodology ensures an accurate representation of the grouping breakdowns within and across the country. The total national population itself is derived from an additional four cohort-component models, one for each population group. This ensures that population projections on a national level are realistically captured. We used Spectrum to run the population projections. The inputs were obtained using various models and assumptions, as discussed below. Due to the nature of correctly balancing and benchmarking a population model, many of these steps are carried out simultaneously and not necessarily in the following order.	Regional Explorer (ReX). IHS Markit
WPOP	The population of a region is the total number of people within that region in the middle of the respective year, categorised according to population group. The population groups output is African, **White**, Coloured and Asian.	Regional Explorer (ReX). IHS Markit

INPOP	*Description:* The population of a region is the total number of people within that region in the middle of the respective year, categorised according to population group. The population groups output is African, White, Coloured and **Asian**. It is important to note that the 'Asian' population (herein referred to as "INPOP") to is made up of all people groups originating from Asia – this includes those of Indian and Chinese origin.	Regional Explorer (ReX). IHS Markit
CPOP	*Description:* The population of a region is the total number of people within that region in the middle of the respective year, categorised according to population group. The population groups output is African, White, **Coloured** and Asian.	Regional Explorer (ReX). IHS Markit
NEC	*Description:* A household has no electrical connection if they do not make use of electricity for cooking, heating or lighting. The number of households without access to an electrical connection is often referred to as the electricity backlog, or the number of non-electrified households. Construction: three key elements are used to construct municipal database on No Electricity Connection – 1. <u>Using StatsSA Household Data</u> On a local municipal level, we make use of the StatsSA Non-Financial census data to capture the number of connections that municipalities are billing dwelling units for. Nonetheless, the biggest problem with all of these datasets is that they are not comparable, in any respect, to the existing StatsSA survey-based data. The number of household connections that are officially billed are far less than those households reporting receiving electricity. This is considered due to a number of factors: • The differences in the definition of a 'household' and a 'billing unit.' • Illegal connections. • Provision of Free Basic Electricity, which is not paid for and thus not counted as being billed. • Undercounting of in-home electrical meters. The second problem with these datasets is that municipalities often underreport their billed connections or fail to report at all. This is a common problem across the NERSA, DME and StatsSA indicators for this type of measure. We therefore only make use of this type of data for local municipal distributions, and only in order to distribute the already modelled number of connections on the provincial level. 2. <u>Considering Electrification Projects</u> By monitoring the number of connections installed over time, we should be able to model the number of connections in an area over time.	Regional Explorer (ReX). IHS Markit

	However, this data is once again of poor quality on anything lower than national level. ReX therefore makes use of the conditional grants for electrification projects per local municipality, as well as the capital expenditure data on electricity per municipality. By modelling the cost per connection (based on national level costs and distributed by regional urbanisation) we were able to create a distribution of the number of government supplied connections on a local municipal level based on spending by government per region. The Department of Energy uses a similar approach. However, their estimates make the following problematic assumptions: • Local municipalities spend their entire allocated budget. • Electrical connections cost the same in all local municipalities. • All local municipalities are equally efficient. Nonetheless, working backwards from their assumptions, we can confirm our estimates from the expenditure data. 3. <u>Census Datasets</u> The Census household datasets provide very good estimates on the usage of different types of electrical connections. These figures, combined with the various other estimates derived above, we are able to create stable base years from which we interpolate to arrive at the intervening years' data. As constraints on the interpolation, we make use of each regions total households from the ReX *Demographic Model*, as well as the provincial electrical connections data. The other data above also provide additional direction and trend for the interpolated years.	
HWB	*Description:* Houses that have access to piped water further than 200 metres from the dwelling, or households that do not have access to formal piped water are considered to form part of the backlog. This is in line with the definition of a household that falls below the RDP level of access to water infrastructure. *Construction*: A number of StatsSA surveys measure the distance of the water supply from a household by asking the respondent either a) how long it takes them to walk to the water supply, or b) how far away the water supply is. Both of these methods are likely to cause inaccuracies as a) different people walk at different speeds and b) different people perceive distances and / or time differently. Three steps are followed to construct data sets in this area for municipalities- 1. <u>Estimate National Access to Water</u> Naturally, each household survey has its own unique characteristics. When measuring access to water, much work needs to be done on each survey in order to combine the various categories into a meaningful time series comparison. For example, the October Household Survey from 1995 had a massive 76 distinct categories of water access. The following year, the OHS used 66 categories of access to water. By 2010, the General Household Survey was down to using only 50. We therefore standardised	Regional Explorer (ReX). IHS Markit

	each survey over time to conform to the five basic water access types outlined above. We then estimate the national level of water access by each type of access. This is done by considering the relevant adjusted household surveys as well as the Censuses. Once all surveys were balanced to the total national level of households as estimated by the ReX Demographic Model, we were able to use the census and community surveys to provide base year estimates and interpolate for the remainder. We used a polynomial distribution for the purpose of the interpolation - which is done for each water access category. Each household survey was then weighted for the intervening years according to its historical accuracy and, comparing that to the interpolated figure proceeded with a pattern of best fit between all the available data. The final outcome of this exercise was a stable national level of access to water infrastructure. 2. Estimate Provincial Access to Water The first hurdle to overcome in estimating provincial numbers from the old StatsSA household surveys are the boundary changes made in December 2005. Although it is possible to simply recode the Census data, the household surveys cannot be converted in this way. We therefore constructed a conversion matrix that compared the census 1996 old provincial distribution to the census 1996 new provincial distribution, for each type of water access. By multiplying the provincial results from the pre-2005 surveys through the matrix, we are able to convert the old provincial results to the new December 2005 provincial boundaries. Since 2008, StatsSA has moved to a new master sample and therefore household surveys since this date no longer suffer from the boundary-change issues. We then estimate each province's level of access to water by each category by considering the relevant household surveys as well as the Censuses. Once all surveys are balanced to the provincial number of households, as estimated by the ReX Demographic Model, we are able to use the census and community surveys to provide base year estimates and interpolate for the remainder. We use a polynomial distribution for the purpose of the interpolation. Each household survey was then weighted for the intervening years according to its historical accuracy and, comparing that to the interpolated figure proceeded with a pattern of best fit between all the available data. This was carried out forty-five times, five water access categories per nine provinces. The final outcome of this exercise was thus forty-five stable time series on provincial access to sanitation infrastructure by each type of access category. 3. <u>Estimate Regional Access to Water</u>	

	The first hurdle to overcome in estimating provincial numbers from the old StatsSA household surveys are the boundary changes made in December 2005. Although it is possible to simply recode the Census data, the household surveys cannot be converted in this way. We therefore constructed a conversion matrix that compared the census 1996 old provincial distribution to the census 1996 new provincial distribution, for each type of water access. By multiplying the provincial results from the pre-2005 surveys through the matrix, we are able to convert the old provincial results to the new December 2005 provincial boundaries. Since 2008, StatsSA has moved to a new master sample and therefore household surveys since this date no longer suffer from the boundary-change issues. We then estimate each province's level of access to water by each category by considering the relevant household surveys as well as the Censuses. Once all surveys are balanced to the provincial number of households, as estimated by the ReX Demographic Model, we are able to use the census and community surveys to provide base year estimates and interpolate for the remainder. We use a polynomial distribution for the purpose of the interpolation. Each household survey was then weighted for the intervening years according to its historical accuracy and, comparing that to the interpolated figure proceeded with a pattern of best fit between all the available data. This was carried out forty-five times, five water access categories per nine provinces. The final outcome of this exercise was thus forty-five stable time series on provincial access to sanitation infrastructure by each type of access category.	

Source: Designed by Author from IHS Markit Regional Explorer (2018)

5.2 Results Presentation and Interpretation

5.2.1 Descriptive Statistics

Table 2 below presents descriptive statistics results for all nine variables under study. The results show that there is no huge variation for No electricity connection and households with water backlog.

Table 2: *Descriptive Statistics Results*

	NEC	HWB	GDPR	UNEMT	BPL	WPOP	APOP	INPOP	CPOP
Mean	9.237699	9.542474	1.849083	25.82067	98701.82	19357.92	250349.2	1641.866	293947.5
Median	9.288999	9.826663	1.165756	24.70856	110302.9	7298.425	237823.6	654.0111	201893.0
Maximum	10.67074	10.85118	25.46982	40.17919	162628.4	53735.88	566391.5	5633.818	981605.0
Minimum	7.683491	7.394175	-9.125991	10.71829	16885.12	187.6365	28859.54	170.2275	1966.985
Std. Dev.	1.000003	0.967686	5.901726	8.131198	44522.48	20673.43	144810.0	1567.192	293102.6
Skewness	-0.105505	-1.115507	0.959008	0.223741	-0.831681	0.589776	0.102358	0.894862	0.484948
Kurtosis	1.367898	2.972168	4.699159	1.836085	2.476748	1.620096	2.289396	2.482645	1.915584
Jarque-Bera	11.84873	21.77961	28.72592	6.802854	13.30248	14.41771	2.392538	15.18460	9.260377
Probality	0.002674	0.000019	0.000001	0.033326	0.001292	0.000740	0.302320	0.000504	0.009753
Sum	969.9584	1001.960	194.1537	2711.170	10363691	2032582.	26286671	172395.9	30864485
Sum Sq. Dev.	104.0006	97.38728	3622.359	6876.104	2.06E+11	4.44E+10	2.18E+12	2.55E+08	8.93E+12
Observations	105	105	105	105	105	105	105	105	105
Cross sections	5	5	5	5	5	5	5	5	5

Table 2 above further shows that for GDRP and all other variables, the variance between minimum and maximum values is across board more than 50% for the period 1996 to 2016. The mean for no electricity connection and that of household with water backlog are 9.24 and 9.54, respectively. For both dependent variables, the results show to be the same. However, there is no any scientific evidence which such mean could be compared to in literature or any other international standard.

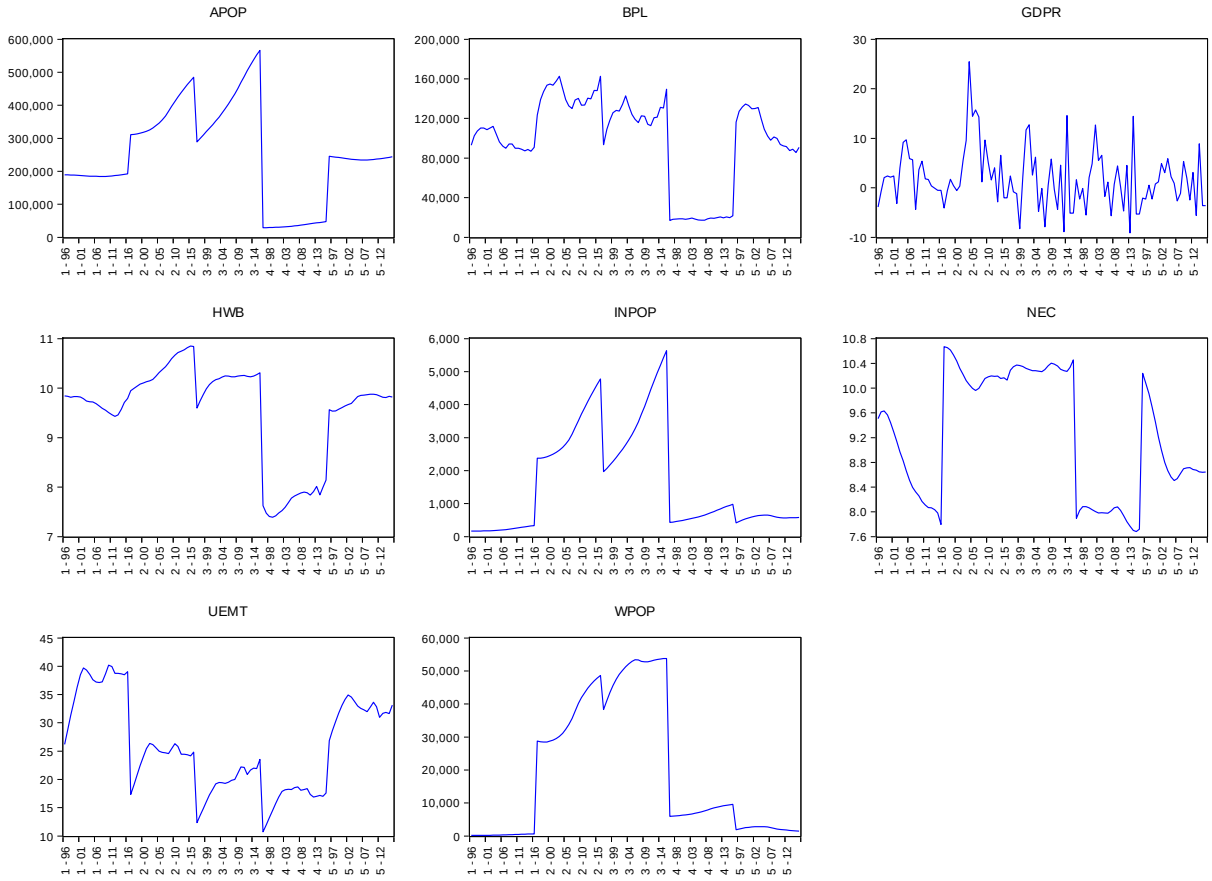
5.2.2 Unit Root Testing Results

Prior to performing regression analysis, it is important to test data stationarity for variables involved in the study. As argued by Hall and Mairesse (2002), testing for stationarity in panel data models is also per se a matter of interest and it can be more directly motivated. It seems fairly intuitive that, within the general class of models where heterogeneity is restricted to an individual fixed effect, the times series behaviour of an individual variable should often be well approximated either as an autoregressive process with a small positive coefficient and large fixed effects, or as an autoregressive process with a near-unit root and negligible individual fixed effects. Both alternatives can be nested in a single model, in which the test of the former against the latter is a panel data unit root test. One expects, however, that such test might not perform well in a short panel, owing in particular to the problem of unobserved initial conditions and incidental parameter estimation. Trying to assess the properties of the available tests in a realistic setting is therefore of practical importance (Hall and Mairesse, 2002).

Application of visual inspection is performed for all variables as shown in figure 17 below. Visual inspection of data cannot be conclusive evidence of stationarity of data but gives an eye-view of data trends and nature. Following visual inspection, further unit root test is performed.

5.2.3.1 Visual Inspection

Figure 19: *Visual Inspection*



5.2.3.2 Unit Root Test

According to Bellos and Subasat (2012), panel data involves a much larger degree of freedom, which increased the accuracy of regression analysis. It also has a strong capacity to capture complex social behaviour than other cross-section and time series data (Mosikari, Nthebe and Eita, 2018). As argued previously and despite the strengths of panel data, this study applied unit root test. In the first instance, Levin, Lin and Chu (LLC) unit root test is applied to all variables. The power of a test is the probability of rejecting the null when it is false, and the null hypothesis is unit root (Kunst, 2011). Table 3 below presents the results of LLC unit root test and reveals that all variable is stationary at level. It is on these basis that the study implies all variable to be integrated of order zero.

Table 3: *Unit Root Testing Results (LCC)*

		Equation	Statistic	P-Value
APOP	Levels	Intercepts	-1.03793	0.1497
		Indv. Intercepts	-3.47471	0.0003***
		None	3.90507	1.0000
	First Difference	Intercepts	-1.26884	0.1022
		Indv. Intercepts	0.26451	0.6043
		None	-0.62441	0.2662
BPL	Levels	Intercepts	0.90011	0.8160
		Indv. Intercepts	-0.05712	0.4772
		None	0.83486	0.7981
	First Difference	Intercepts	-3.84099	0.0001***
		Indv. Intercepts	-4.68639	0.0000***
		None	-6.96294	0.0000***
GDPR	Levels	Intercepts	-4.01379	0.0000***
		Indv. Intercepts	-2.80943	0.0025**
		None	-7.01121	0.0000***
	First Difference	Intercepts	-15.6320	0.0000***
		Indv. Intercepts	-14.0796	0.0000***
		None	-16.9311	0.0000***
HWB	Levels	Intercepts	-2.39955	0.0082**
		Indv. Intercepts	2.06050	0.9803
		None	0.25040	0.5989
	First Difference	Intercepts	-1.92494	0.0271
		Indv. Intercepts	-1.05776	0.1451
		None	-3.87927	0.0001***
INPOP	Levels	Intercepts	-0.06154	0.4755
		Indv. Intercepts	-6.44913	0.0000***
		None	1.97482	0.9759
	First Difference	Intercepts	-2.45572	0.0070**

		Indv. Intercepts	1.25385	0.8951
		None	-0.52040	0.3014
NEC	Levels	Intercepts	-3.23202	0.0006***
		Indv. Intercepts	-4.30260	0.0000***
		None	-0.49574	0.3100
	First Difference	Intercepts	-0.68413	0.2469
		Indv. Intercepts	1.22748	0.8902
		None	-3.22325	0.0006***
UNEMT	Levels	Intercepts	-3.07522	0.0011**
		Indv. Intercepts	-2.91112	0.0018**
		None	1.92326	0.9728
	First Difference	Intercepts	-3.07891	0.0010***
		Indv. Intercepts	-0.38451	0.3503
		None	-4.88396	0.0000***
WPOP	Levels	Intercepts	-0.4920	0.3099
		Indv. Intercepts	-4.99572	0.0000***
		None	0.54947	0.7087
	First Difference	Intercepts	-3.02178	0.0013
		Indv. Intercepts	0.37903	0.6477
		None	-2.65920	0.0039**
CPOP	Levels	Intercepts	2.73192	0.9969
		Indv. Intercepts	-1.14515	0.1261
		None	1.493554	0.9324
	First Difference	Intercepts	-1.09827	0.1360
		Indv. Intercepts	-0.98762	0.1617
		None	0.01995	0.5080

Different to the previous first-generation tests, the test proposed by Hadri (2000) is based on the null hypothesis of stationarity. It is an extension of the stationarity test developed by Kwiatkowski *et al*. (1992) in the time series context. Hadri proposes a residual-based Lagrange multiplier test for the null

hypothesis that the individual series $y_{i,t}$ (for i = 1; ……, N) are stationary around a deterministic level or around a deterministic trend, against the alternative of a unit root in panel data. Handri approach is, therefore, applied to further test unit root for all variable and test consistency with LLC before regression analysis is performed. Table 4 below presents the results of Handri unit root test and reveals that all variable is stationary at level. It is on these basis that the study implies all variable to be integrated of order zero.

Table 4: *Unit Root Testing Results (Hadri)*

		Equation	**Statistic**	**P-Value**
APOP	Levels	Intercepts	6.86451	0.0000***
		Indv. Intercepts	5.51622	0.0000***
	First Difference	Intercepts	4.91587	0.0000***
		Indv. Intercepts	3.88081	0.0001***
BPL	Levels	Intercepts	3.95020	0.0000***
		Indv. Intercepts	2.20000	0.0139**
	First Difference	Intercepts	0.22932	0.4093
		Indv. Intercepts	5.54095	0.0000***
GDPR	Levels	Intercepts	-0.46327	0.6784
		Indv. Intercepts	2.87402	0.0020**
	First Difference	Intercepts	-0.95302	0.8297
		Indv. Intercepts	-0.72237	0.7650
HWB	Levels	Intercepts	6.02872	0.0000***
		Indv. Intercepts	3.63290	0.0001***
	First Difference	Intercepts	2.05827	0.0198**
		Indv. Intercepts	4.18645	0.0000***
INPOP	Levels	Intercepts	6.78680	0.0000***
		Indv. Intercepts	5.60755	0.0000***
	First Difference	Intercepts	5.27669	0.0000***

		Indv. Intercepts	3.35294	0.0004***
NEC	Levels	Intercepts	5.60008	0.0000***
		Indv. Intercepts	4.84394	0.0000***
	First Difference	Intercepts	2.64426	0.0041**
		Indv. Intercepts	2.18158	0.0146**
UNEMT	Levels	Intercepts	4.00331	0.0000***
		Indv. Intercepts	4.65509	0.0000***
	First Difference	Intercepts	3.16661	0.0008***
		Indv. Intercepts	3.78198	0.0001***
WPOP	Levels	Intercepts	6.21982	0.0000***
		Indv. Intercepts	5.03498	0.0000***
	First Difference	Intercepts	4.20991	0.0000***
		Indv. Intercepts	4.56879	0.0000***
CPOP	Levels	Intercepts	1.56711	0.0585
		Indv. Intercepts	3.63310	0.0001***
	First Difference	Intercepts	3.16483	0.0008***
		Indv. Intercepts	6.55770	0.0000***

5.3 Fixed Effects Regression Analysis Results

Data limitations remain the challenge, more especially at district and local municipality levels. It is for this reason this study applies panel data approach and making the use of the available data. GDPR, UNEMT and BPL are used as control variables while population is disaggregated into 4 (African population, Indian population, Coloured population and White population) for the Bojanala District Municipality. No Access to Electricity (NEC) and Household with Water Backlog (HWB) are dependent variables, hence two sets of results with each containing 4 models to assess clear effects of population by race on basic infrastructure. Tables 4 and 5 below present results for fixed effect regression on dependent variable NEC and table 6 and 7 presents results on dependent variable HWB.

5.3.1 Fixed Effects Regression: No Electricity Connection (NEC)

This section presents panel results on no electricity connect as a dependent variable. Results a presented in table 5 below. According to the results shown in table 4 below, the African population and the White population are positively and significantly related to no electricity connection. A 1% increase in the above-mentioned population groups will lead to an increase of 3.4% and 1.34% on no electricity connection, respectively. Though Ithe ndian population growth shows to be positively related to no electricity connection, its growth is not necessarily significant. The Coloured population is negatively and insignificantly related to no electricity connection and further indicating that a 1% increase in the Coloured population would result in a 5.1% decrease in no electricity connection. Considering the fact that in 2016, Coloured population group account for only 1% of the total Bojanala District Municipality population, the extent of insignificant can be accepted in terms of the effect it has on electricity connection and infrastructure thereof.

Table 5: *Fixed Effects Regression Results: NEC – () t-Statistic*

NEC (No Electricity Connection) – Dependent Variable				
Independent Variables	Model (1)	Model (2)	Model (3)	Model (4)
GDPR	-0.003749 (-0.81705)	-0.001568 (-0.34590)	-0.002250 (-0.48789)	-0.006400 (-1.512614)
UNEMT	-0.085624 (-8.10113)	-0.094792 (-8.91186)	-0.092198 (-8.36535)	-0.069672 (-7.182244)
BPL	1.97E-05 (8.86395)	1.94E-05 (8.91389)	1.96E-05 (8.91829)	1.87E-05 (8.947428)
WPOP	3.40E-06 (7.07E-06)	-	-	-
APOP	-	1.34E-06 (2.24759)	-	-
INPOP	-	-	7.06E-05 (1.55585)	-
CPOP	-	-	-	-6.99E-07 (-5.136199)
R2	0.9405	0.9434	0.9418	0.9481
Adjusted R2	(0.9356)	(0.9386)	(0.9369)	(0.9437)

The results show that there is a negative and insignificant relationship between Gross Domestic Product at regional level with No Electricity Connection. A 1% increase in Gross Domestic Product will lead to 0% decrease in No Electricity Connection. This support the theory that economic growth is likely to result in increased access to resources such improved access to energy. The results further show that in the Bojanala Platinum District Municipality, total unemployment is negatively and insignificantly related to no electricity connection. Thus, a 1% increase in total unemployment will result in a 0.09% decrease in no electricity connection. Considering the role of the municipality as enshrined in the constitution, municipalities are likely to provide and prioritised the unemployed population in terms of infrastructure development and electricity connection.

In addition, the study finds that there is a positive and strongly significant relation between people living below the poverty line and no electricity connection. Accordingly, a 1% increase in people living below the poverty line will lead to 1.97% in no electricity connection. This could be explained by the extent of rural-ness and vastness in the Bojanala Platinum District Municipality where provision of service becomes costlier. Thus, the first population-based theory was elaborated by Malthus (1798) in his influential essay in which he highlighted that exponential population growth is inherent in all societies, and massive starvation is the general mechanism that keeps populations in check. The focus of his work was on the depletion of natural resources which may lead to the decrease of productivity of human labour (Kosamu et al., 2016). The latter tended to fall below-subsistence wages for the poor and causing their death. The logic of scarcity of resource can therefore be applicable in explaining the resource constrained emanating from poverty on the state more especially at local government level.

Table 6: *Local Municipality – Specific Fixed Effect (cross) Results: NEC*

NEC (No Electricity Connection) – Dependent Variable				
Local Municipality	Model (1) -WPOP-	Model (2) -APOP-	Model (3) -INPOP-	Model (4)
Moretele (MOD)	0.481235	0.602104	0.588987	0.162917
Madibeng (MAD)	-0.090462	-0.206845	-0.155569	-0.273214
Rustenburg (RUS)	-0.072498	-0.237320	-0.137928	-0.161631
Kgetleng (KGE)	-0.457199	-0.319433	-0.496502	-0.028722
Moses Kotane (MSK)	0.138924	0.161494	0.201012	0.300650

After estimating the fixed effect model for the Bojanala Platinum District Municipality, local municipality specific effects are estimated and presented in table 6 above. The results show that there are some unique characteristics that impact on no electricity connection positively and some negatively. Within Moretele and Moses Kotane local municipalities, there are characteristics that encourages no electricity connection while in Madibeng, Rustenburg and Kgetleng river local municipalities there are factors which discourages no electricity connections.

5.3.2 Fixed Effects Regression: Households with Water Backlog (HWB)

This section presents panel results on households with water backlog as a dependent variable. Results are presented in table 7 below. According to the results shown in table 6 below, the African population, the Indian population and the White population are positively and significantly related to households with water backlog. A 1% increase in the above-mentioned population groups will lead to an increase of 2.63%, 0% and 4.26% on households with water backlog, respectively. However, a 1% increase in Coloured population would result in a decrease of 7% in households with water backlog. As Argued by Megbolugbe, Marks and Schwartz (1991), the most feasible and conceptually correct research strategy to advance our understanding of housing consumption decisions is to analyse the impact of demographic and social processes on housing consumption decisions. Demand for houses comes hand in glove with water and electricity demand. The more houses the municipality builds will

require water services and it is in this context that dealing with households with water backlogs will take time to address. Clearly, growing population will place more burden on municipal infrastructure delivery programme.

Table 7: *Fixed Effects Regression: HWB – () t-Statistic*

HWB (Households with Water Backlog) – Dependent Variable				
Independent Variables	Model (1)	Model (2)	Model (3)	Model (4)
GDPR	-4.58E-05 (-1.56E-06)	-0.000673 (-0.22445)	-0.000175 (-0.05921)	-0.004466 (-1.321879)
UNEMT	0.002375 (0.46702)	0.006744 (0.95885)	0.003710 (0.52482)	0.020059 (2.589674)
BPL	-1.56E-06 (-1.45399)	-1.36E-06 (-0.94901)	-1.12E-06 (-0.79130)	1.75E-05 (0.104497)
WPOP	4.26E-05 (12.50915)	-	-	-
APOP	-	2.63E-06 (2.63E-06)	-	-
INPOP	-	-	0.000204 (7.02239)	-
CP				-7.04E-07 (3.004264)
R2	0.9853	0.9736	0.9744	0.9646
Adjusted R2	(0.9841)	(0.9714)	(0.9723)	(0.9617)

As indicated in table 6 above, economic growth and people living below poverty level have negative relationship with households with water backlog. A 1% increase in economic growth and people living below poverty line in the Bojanala Platinum District Municipality will result in a decrease on household with water backlog by 4. 58% and 1.56%, respectively. It should, however, be noted that, for the three independent variables in tables 7, they are insignificantly related to households with water backlogs. The study further finds that there is a positive relationship between total unemployment and household water backlog. This means that a 1% increase in total unemployment will result in 0%

household water backlog. This indicates that the provision of water is not necessarily dependent on employment but largely the population size and municipal resources. It is logically clear that water is a necessity both the employed and unemployed population and a status thereof cannot demand and supply of water significantly.

Table 8: *Local Municipality – Specific Fixed Effect (cross) Results: HWB*

HWB (Households with Water Backlog)				
Local Municipality	Model (1) -WPOP-	Model (2) -APOP-	Model (3) -INPOP-	Model (4) -CPOP-
Moretele (MOD)	0.921487	0.231085	0.388070	-0.031138
Madibeng (MAD)	0.216398	0.609489	0.594239	1.106529
Rustenburg (RUS)	-0.665567	0.243503	0.268273	0.926007
Kgetleng (KGE)	-1.407619	-1.291402	-1.661689	-1.871909
Moses Kotane (MSK)	0.935301	0.207325	0.411106	-0.129489

After estimating the fixed effect model for Bojanala Platinum District Municipality, local municipality specific effects are estimated and presented in table 8 above. The results show that there are some unique characteristics that impacts on households with water backlog positively and some negatively. Within BPDM, Moretele, Madibeng and Moses Kotane local municipalities, there are population characteristics that encourage no electricity connection while in Rustenburg and Kgetleng river local municipalities there are factors which discourage no electricity connections.

5.4 Conclusion

The purpose of this study was to examine the effects of population growth on basic infrastructure for basic services provision within the Bojanala Platinum District Municipality. Though the study was mainly interested in infrastructure and population growth, other control variables such as economic growth, unemployment and poverty were included in the analysis. Population was further

disaggregated by race to effectively determine growth trends and effects thereof on infrastructure with specific reference to electricity and water provision. The study applied panel data approach with fixed effect modelling considering all five (5) local municipalities within the Bojanala Platinum District Municipality, where all four (4) racial groups, three (3) control variables, and two (2) independent variables, hence a total of 8 models.

The main findings of the study demonstrate the racial disparities in terms of access to basic services with African population being the largest racial group in BPDM and most affected. Bearing in mind that BPDM is largely dominated by mining industry, an increase in population for African population is not only because of fertility but further increased by migration by many African population group within South Africa and neighbouring countries with the hope of finding jobs. The effect of African population growth is therefore felt by the municipality and more basic services are therefore required. The importance of integrating population by race and location in development and service delivery policy can therefore not be over-emphasised. It is against this backdrop that, though White population group shows to have also been affected by population growth, a more focused policy intervention is required for African population group to ensure that the level of inequality in basic service provision is narrowed.

Chapter 6: Conclusion and Recommendations

6.1 Introduction

Chapter six (6) provides conclusions of the study based on the fixed effect model analysis and results presented in chapter five (5) above. The chapter further provides recommendations which are hoped to add value in future research and policy decision making at both provincial and municipal level for better improvement of service delivery. It is indeed the hope of this study that in future, demographic variables will be integrated in development planning and policy and ultimately inform resource allocation.

6.2 Conclusion

Various concerns have been expressed about the ability of the world economy to sustain the ever-expanding world population (Furuoka, 2010). Understanding population dynamics remains vital for sustainable development, economic growth and basic service provision which is largely dependent on the state of infrastructure. The crux of this study was to establish evidence on the relationship between population growth and basic service provision infrastructure as population scientists, policy makers and economists are perambulating between three theories. First, basic services infrastructure and population growth are negatively related, which means that if population increases, the ability of the state to provide basic service decreases. Second, basic service infrastructure and population growth are positively related, which implies that when population increases basic service provision also increases, and third, population growth is neutral to basic service provision infrastructure.

Noting that population growth was studied by racial groups in this study, the results have proved to be mixed in terms of three scenarios presented above. The African population and the White population are positively and significantly related to households with water backlog and no electricity

connection. This implies that an increase in African and White population groups will result in more household not having water and electricity translating into higher demand and increased burden on municipal resources and basic infrastructure for service provision. The higher level of significance of these two races could largely be informed by their higher growth rate compared others and higher population share. In 2016, the African population accounted for 92% of the population size of Bojanala District Municipality, while the White population accounted for 7%. An increase in the Indian population also shows to be exerting pressure on both water and electricity infrastructure though not significantly on electricity as the previous two. Combined, the Indian and Coloured population groups account for less than 3% of Bojanala Platinum District Municipality population.

Conclusively, African and White population growth proves the first scenario. Population growth negatively affects infrastructure for provision of basic services. The Indian population largely proves that population growth is neutral to infrastructure for basic service provision. Finally, the second scenario is proved by Coloured population growth showing that increasing population will translate into government increasing provision of basic services.

The study further concludes that economic growth and unemployment do not have any negative impact on infrastructure for electricity provision, while an increase in people in poverty would result in an increased demand for basic infrastructure for electricity connection. Furthermore, the in-Bojanala Platinum District Municipality, unemployment, economic growth and poverty do not negatively impact basic infrastructure demand for provision of water service.

Finally, there are various characteristics that affect infrastructure for basic service and provision thereof in various local municipalities within the Bojanala Platinum District Municipality. Some are

negative and some positive and as indicated above, the focus of this study was primarily on population growth and infrastructure for basic service provision, but not on other factors contributing to the provision on none-provision of infrastructure for basic services.

6.3 Recommendations

Different population groups have different impact on infrastructure and the demand for basic services differs accordingly. In exploring remedies and responses to population growth and infrastructure challenges in the Bojanala Platinum District Municipality research, policy development and capacity build are recommended. Furthermore, local municipalities within the BPDM have different characteristics which contribute to the ability or inability to provide infrastructure for basic services. It is on these bases that this study firstly recommends that further research be conducted on understanding factors or characteristics that distinguishes one municipality from the other in providing infrastructure for basic services.

Secondly, good development planning must also be responsive to the needs and aspirations of citizens to use resources efficiently and promote the sustainable development of communities (Nsiah-Peprah, 2006). The study recommends the need to train policy makers and development planners and practitioners to understand the importance of integrating demographic factors in development planning and more specifically in infrastructure development.

Thirdly, there is a need for the Bojanala Platinum District Municipality to develop a policy on population and development which will provide a guide on municipal development planning and research into population dynamics. It is, therefore, prudent for local municipalities to continuously understand population trends and dynamics in their respective municipalities and the effects thereof

on infrastructure for basic service provision. Thus, the policy must be used as guiding tool to integrate population in basic service provision planning.

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