

AN INVESTIGATION INTO THE RELATIONSHIP BETWEEN
INFRASTRUCTURE DEVELOPMENT AND ECONOMIC GROWTH IN
NAMIBIA

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ABSTRACT

The study investigated the causal relationship between infrastructure development and economic growth in Namibia for the period Q₁1991- Q₄2020. Data used was sourced from the World Bank development indicators, Namibia Statistics Agency as well as COMSTAT and was converted to quarterly data using EViews. Time-series econometric techniques such as unit root, ARDL bound test as well as VAR framework has been used. The results of the ARDL bounds test revealed that there is a long run relationship between infrastructure development and economic growth. The vector error correction provided both short and long run estimates. The findings revealed a positive long run and short run relationship between infrastructure development and economic growth in Namibia. The study recommends that the Namibian government needs to increase infrastructure funding in Namibia, enforce monitoring and evaluation and promote Public Private Partnership (PPP).

KEY WORDS: Infrastructure development, government capital expenditure, economic growth, Namibia, Unit root, VECM, ARDL, cointegration.

DEDICATION

I dedicate this mini thesis to dearest family, most notably my mother in heaven, Christofina Kavetu and my dearest brother, Mbumbijazo Katjivena who have supported me throughout my academic journey, without them this would not have been possible.

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Finally, I would like to thank my family members, especially my mother in heaven, Christofina Kavetu and my dearest brother, Mbumbijazo Katjivena for supporting and encouraging me to pursue this important degree, to honour and give back to our dearest mother who sacrificed everything to ensure that we are able to get an education. Without her, none of this would have been possible as her wisdom, guidance and immense support made all this a reality.

DECLARATION BY CANDIDATE

I, Tjizomundu Kavetu, hereby declare that this study is my own work and is a true reflection of my research, and that this work, or any part thereof has not been submitted for a degree at any other institution.

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Table of Contents

ABSTRACT	II
DEDICATION	III
ACKNOWLEDGEMENT	IV
DECLARATION BY CANDIDATE	V
CHAPTER 1: INTRODUCTION AND BACKGROUND.....	1
1.1 BACKGROUND OF THE STUDY.....	1
1.2 STATEMENT OF THE PROBLEM.....	5
1.3 OBJECTIVES OF THE STUDY	6
1.4 HYPOTHESIS OF THE STUDY	6
1.5 SIGNIFICANCE OF THE STUDY	6
1.6 LIMITATION OF THE STUDY.....	7
1.7 DELIMITATION OF THE STUDY	7
1.8 STRUCTURE OF THE PAPER.....	7
CHAPTER 2: OVERVIEW OF THE NAMIBIAN ECONOMY	8
2.1 INTRODUCTION	8
2.2 ECONOMIC PROFILE.....	8
2.2 STATE OF INFRASTRUCTURE DEVELOPMENT IN NAMIBIA.....	9
2.3 ECONOMIC GROWTH NEXUS INFRASTRUCTURE DEVELOPMENT IN NAMIBIA.....	14
CHAPTER 3: LITERATURE REVIEW	16
3.1 INTRODUCTION	16
3.2 THEORETICAL LITERATURE.....	16
3.3 EMPIRICAL LITERATURE	21
3.4 CONCLUSION	32
CHAPTER 4: RESEARCH METHODOLOGY.....	33
4.1 INTRODUCTION	33
4.2 THEORETICAL FRAMEWORK	33
4.3 EMPIRICAL MODEL	35
4.4 ECONOMETRIC FRAMEWORK.....	36
4.4.1 <i>Unit Root Test</i>	36
4.4.2 <i>Lag Length Selection</i>	38
4.4.3 <i>Autoregressive Distributed Lag Model or Bound Cointegration Test</i>	38
4.4.5 <i>Vector Error Correction Model</i>	42
4.4.6 <i>Variance Decomposition and Impulse Response</i>	44
4.4.7 <i>Diagnostics</i>	45
4.4.6 DATA MEASUREMENT AND DATA SOURCES.....	47
CHAPTER 5: EMPIRICAL RESULT AND FINDINGS	48
5.1 INTRODUCTION	48
5.2 EMPIRICAL ANALYSIS.....	48
5.2.1 DESCRIPTIVE STATISTIC	48
5.2.2 UNIT ROOT TEST	49
5.2.3 DETERMINATION OF THE LAG LENGTH.....	51
5.2.4 ARDL BOUND TEST.....	52
5.2.5 ESTIMATED LONG-RUN AND SHORT-RUN	53

5.2.6	DIAGNOSTICS	57
5.2.6.1	<i>Stability Test</i>	57
5.2.6.2	<i>Serial Correlation Test</i>	59
5.2.6.3	<i>Stability Test</i>	60
5.2.7	VECTOR ERROR CORRECTION MODEL	61
5.2.8	<i>Impulse response function</i>	63
5.2.9	<i>Structural analyses</i>	65
5.3	CONCLUSION	68
CHAPTER 6: SUMMARY, CONCLUSION AND RECOMMENDATIONS		69
6.1	INTRODCUTION.....	69
6.2	SUMMARY OF FINDINGS	69
6.3	CONCLUSION	70
6.4	RECOMMENDATIONS	71
6.5	AREAS FOR FURTHER RESEARCH	72
REFERENCES		74

LIST OF FIGURES

Figure 1.1: Relationship between Government Capital Expenditure and GDP.....	15.
Figure 5.1: Plots of CUSUM.....	58.
Figure 5.2: Fitter verse Actual graph.....	59.
Figure 5.3: Normality Test.....	60.
Figure 5.4: Impulse response.....	64.

LIST OF TABLES

Table 5.1: Descriptive Statistics.....	48.
Table 5.2: Unit root tests:.....	49.
Table 5.3: Lag-Length Criteria.....	51.
Table 5.4: Bound Test for co-integration.....	52.

Table 5.5: Estimated ARDL Model.....	54.
Table 5.6: Long-run estimated co-efficient.....	55.
Table 5.7: Short-run estimated co-efficient.....	56.
Table 5.8: Breusch-Godfrey Serial Correlation LM Test.....	60.
Table 5.9: VECM Results.....	61.
Table 5.10: Variance Decomposition of RGDP	65.
Table 5.11: Variance Decomposition of GCFP.....	67.
Table 5.12: Variance Decomposition of GCFG.....	68.

LIST OF ACRONYMS AND ABBREVIATION

ARDL	Autoregressive Distributive Lags
RGDP	Gross Domestic Product growth rate
GCE	Government Capital Expenditure Government as a % of GDP
GCP	Gross Capital Formation Private as a % of GDP
VECM	Vector Error Correction Model
OLS	Ordinary Least Squares
VAR	Vector Autoregressive
ECM	Error Correction Model
SVAR	Structural Vector Autoregressive

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Background of the study

Infrastructure is an asset that is often underappreciated in developed countries. The relationship between infrastructure development and economic growth has been studied in an immense range of papers and has become a debatable issue among economists the world over.

The relationship between the two variables, infrastructure development and economic growth is a central subject in both macroeconomics and development economics and further raises a key question as to whether infrastructure development causes economic growth? The answer to this question is critical for long-term development strategies and short-term stabilization programs and furthermore, this potentially exerts a great influence on the growth of a country's private sector and therefore long-term economic growth (Xu and Yan, 2014).

The theoretical literature on the nexus between infrastructure and economic growth is heavily influenced by the early work of (Barro, 1990) showing that infrastructural development might be offset by negative impact of additional tax introduced to finance them. The negative impact of public spending on growth is due to distortions to choose and disincentive effects (Abur, 2019). Infrastructure can be divided into two categories: Social and Economic. Social includes health recreational, healthcare,

cultural and educational facilities while economic includes water supply, transport, power generation, communications and sanitation facilities (Abur, 2019).

Government investment in infrastructure development as a percentage of GDP hangs around 15.74 percent. This is much lower when compared to growing economies such as China that invest about 43 percent of their GDP in infrastructure development and other developing countries 2021. The current infrastructure investment-to-GDP ratio is an indication that more investment in infrastructure is required to make a significant impact on economic growth. Every economy requires effective investment in electricity and water supply, public health, communications and transportation to achieve better living standards for its citizens. Unfortunately, the infrastructure gap in Namibia hinders development and growth, this transforms into a major constraint to achieving developmental goals such as the Vision 2030.

Egbo (2018) argues that although the impact of infrastructure on economic growth is a proven topic, the causal relationship between these two indicators remains unclear especially in the Sub-Saharan countries. According to (Estache & Limi, 2010) it is indeed common knowledge that developing countries lack access to electricity, water, telecommunication facilities as well as common transport infrastructures such as roads and ports.

Furthermore, investment in roads reduces the transportation cost while ports, airports and other logistics infrastructure facilities, reduce the cost associated with trade. In fact, infrastructure development supports most of the economic activities, such as an input into production and also increases the marginal productivity of other capital that are used in the production process (Daido & Tabata, 2013). To further highlight this, (National Planning Commission, 2014) points that investment in infrastructure helps

to spur economic productivity, create employment, improve trade flows, and overall enhance economic competitiveness. Moreover, Namibia faces various socio-economic challenges including poverty, income inequality and high levels of unemployment. The (National Planning Commission, 2014), states that the expansion of infrastructure in Namibia will apart from the long-term benefits mentioned already, also make a meaningful contribution towards eradication of poverty and creation of jobs. According to (National Planning Commission, 2012), if Namibia does not increase investment in infrastructure, industries across the board will be affected, including the nascent transport and logistics sector, the manufacturing sector, the agricultural sector, the mineral sector, and the tourism and hospitality sector – all of which have high potential for economic growth and job creation.

It is perhaps helpful from the outset to clarify what is being considered as “infrastructure” and “economic growth” in the context of this study, as the definitions used in the available literature vary widely. The definition adopted in this study is based on (O’Fallon, 2003) and focuses on the services provided by the physical networks or “infrastructure systems” associated with energy (gas, thermal, and water-based), water supply, transport, telecommunications, sanitation and waste facilities, and flood protection and drainage. On the other hand, economic growth refers to a sustained increase in productive capacity of a nation and this increases the ability of the country to produce more goods and services. Economic growth is measured by using the GDP ((Njiru, et al., 2020).

Infrastructure development is the construction and improvement of foundational services (roads, power, ICT, water and sanitation) with the goal of sparking economic growth and improvements in the quality of life. Namibia lacks some basic

infrastructure, in terms of education, some learners are taught in dilapidated structures and health infrastructures are aging especially in the bigger hospitals (National Planning Commission, 2017). Infrastructure development is critical for high and sustained economic growth and social progression thereby contributing to employment generation, investment attraction, and global competitiveness (Republic of Namibia, 2020). Namibia has seen a growth in GDP from just over N\$ 7.2 billion in 1990 to over N\$ 177 billion by 2018 driven by an increased government expenditure from N\$ 2 billion in 1990 to over N\$ 65 billion in 2018 (National Planning Commission, 2017). Some of the key highlights of this spending in infrastructure are: Namibia has 3 desalination plants in 2019, compared to none in 1990; 2 additional power stations were built after independence bringing the total power stations to 4 in 2019; Bitumen roads nearly doubled from 4,572 Km in 1990 to the current status of 8,259 Km (National Planning Commission, 2017).

Economic models identify five (5) channels through which infrastructure development can positively impact economics growth; (i) infrastructure may be regarded a direct input process, (ii) infrastructure might be regarded as a complement to other inputs in the production process, (iii) infrastructure may stimulate factor accumulation, (iv) infrastructure can boost aggregate demand and (v) infrastructure can also serve as tool to guide industrial policy (Kumo, 2012). To enhance explanation of these channels, a short and brief deviation of the basic growth theory is required. Development economists usually define growth in terms of the production function for goods and services, where joint economic production is a function of production factors of production. Although models differ as to which factors of production are regarded as key determinants of joint output. The determinants of total output are positively related to inputs. An increase in the stock of physical capital will result in an increase of

aggregate output. Therefore, economic growth arises due to additional factors of production available and are used. However, it is also possible that some factors such as political uncertainty may exercise negative impact of aggregate output. It is therefore against this background that this paper studied the relationship between infrastructural development and economic growth in Namibia.

1.2 Statement of the problem

The growing need to address problems such as poverty and unemployment in various countries has made governments to take deliberate actions to stimulate growth in economic sectors. In Namibia, the main policy blueprint in history is the Vision 2030 which lays a heavy emphasis on infrastructure development as the key driver for overcoming economic backwardness that has rocked the country in the last two decades. (Straub & Terada-Hagiwara, 2010) state that the relevance of infrastructure for development outcomes comes from the fact that it provides both final consumption services to households and key intermediate consumption items for production. According to the (National Planning Commission, 2017) infrastructure investment of N\$69 billion is needed in the energy, water, transport and logistics, as well as ICT in order to bring Namibia's infrastructure to the desired level.

Some studies showed that the causality direction is from GDP to infrastructure rather than the other way around (Gramlich, 2013) and this is not sufficient to establish an empirical link between the two variables. The problem of the positive long run relationship between economic growth and infrastructure investment must be explicitly addressed. It might well be the case that high GDP and high infrastructure investments are correlated, but that there is no long run relationship, which has

important implications for public policy. This study therefore assessed the impact of infrastructure on economic growth.

1.3 Objectives of the study

The main objective of the study was to investigate the relationship between infrastructure development and economic growth in Namibia covering the period from 1991-2020.

Specific Objectives:

- To examine the long-run relationship between infrastructure development and economic growth in Namibia.
- To make policy recommendations based on study findings.

1.4 Hypothesis of the study

The following hypothesis was tested:

H_{0a}: There is no long run relationship between infrastructure development and economic growth in Namibia.

H_{1a}: There is a long run relationship between infrastructure development and economic growth in Namibia.

1.5 Significance of the study

Understanding the impact of infrastructure development on the economy can go a long way with enhancing proper forward-looking policies that can also contribute to improving

the livelihoods of the countries inhabitants. This study is crucial for government policy but will also help future researchers and academics get more insights on impact of infrastructure development on economic growth. The study will provide the much-needed empirical literature on the use of the ARDL model in the Namibian Context.

1.6 Limitation of the study

The study suffered from a dearth of literature and data in Namibia that relates to infrastructure developments. However, the study had to borrow methodologies used by regional and international studies to assess the Namibian trends.

1.7 Delimitation of the study

This study is restricted solely to the infrastructure development and economic growth in Namibia.

1.8 Structure of the paper

The rest of the paper is organized as follows: Chapter 2 focuses on the state of infrastructure in Namibia. Chapter 3 deals with the literature review, in Chapter 4, the study presents the methodology which comprises of the description of the data, the presentation and explanation of the variables as well the econometric model adopted in the study. Chapter 5 contains the statistical and economic interpretation of the results. Chapter 6 draws conclusion from the findings and suggests policy recommendations.

CHAPTER 2: OVERVIEW OF THE NAMIBIAN ECONOMY

2.1 Introduction

This chapter is going to discuss the overview of the Namibian economy and provide context on the current state of infrastructure Development in Namibia. The chapter will end with a look on how economic growth nexus infrastructure development in the Namibian context.

2.2 Economic profile

Namibia is a sparsely populated country situated in the South western Africa, bordering Angola and Zambia to the north, Botswana on the east and South Africa on the south. The country consists of 14 regions and two major ports: Walvis Bay and Luderitz. Namibia's population size is estimated to be above 2, 5 million, with an annual growth rate of 2.1% (Bobek, et al., 2019). There are 10 ethnic groups, and more than half of the population lives in the northern part of the country. English is the official language.

Namibia is a small, upper-middle income country with ambitions to become a high-income industrialized country by the year 2030. According to the World Bank, Namibia's Gross Domestic Product (GDP) is estimated to grow by 2.4 percent in 2022. Namibia's Gini coefficient based on the latest available data from the World Bank is the second most unequal distribution of income in the world after South Africa. Unlike the poverty headcount, the Gini coefficient has not declined substantially over the past two decades. In 1993/94, it stood at 0.646, declining to 0.600 in 2003/04, 0.597 in

2009/10 and 0.591 in 2015. By all standards, social, economic and development indicators sensitive to difference in status, inequalities in Namibia are extreme by international comparisons. According to the (The World Bank, 2022), geographical disparities in both economic opportunities and access to services are large and widening. High levels of inequality result in unambiguously different poverty rates across different groups, including by age and gender. Relatively high poverty, poor human capital, and poor access to basic services are interrelated problems. Namibia's poverty rapidly declined from 1993/94 to 2015/16, but it remains high for the country's level of development. Despite recent progress, Namibia ranked 117th among 157 countries on the Human Capital Index. The duality of the labor market, combined with slow job creation and low primary-sector productivity, results in very high unemployment (World Bank, 2022).

In addition, Namibia is a small open economy closely linked to South Africa with the Namibian dollar (N\$) pegged at par to the South African Rand. Over the years, the Namibian government and the monetary authorities have managed to maintain sound macroeconomic policies over the past two decades.

2.2 State of Infrastructure Development in Namibia

Infrastructure development is a priority for any economy. It is every nation's desire to attain the highest level of infrastructure development. The Namibian government recognises the importance of efficient provision of public infrastructure and utilities to support productivity and competitiveness. This has been in the national objectives since independence in 1990. Namibia is considered a developing country, and this is also highlighted by the current state of infrastructure in the country. According to

(Mingeli, 2020), the expansion and modernization of physical infrastructure in sectors, such as energy, water, transport and logistics and information and communication technology, facilitates rapid industrialization, economic progression and social transformation form a vital part of Namibia's Vision 2030 goals to develop the country into an industrialized nation by 2030.

Namibia has to date ranked well in economic infrastructure development such as roads, rail, ports and airports in African rankings and some elements (e.g. roads, ports) in global rankings (Government of the Republic of Namibia, 2021) Despite all the achievements, one of the main challenges facing Namibia's developmental agenda is infrastructure development and upgrading of dilapidated infrastructure.

The country is coming from a colonial-era where the infrastructure that was put in place in those years has started to deteriorate due to poor management and moreover the need for additional infrastructure to stimulate economic growth and social well-being have also contributed significantly to the current state on infrastructure in the country. To put this into context, taking the energy sector, the (Republic of Namibia, 2020) states that the country's own internal sources only supply one third of its needed energy requirements. Additionally, according to the (National Planning Commission, 2019) about 53% of the road network is gravel, while 17% is bitumen, upgrading of the road network from gravel to bitumen standard has not been fast as desired, mostly because of funding limitations; the railway connection in Namibia has only increased by 13.28% since independence; the number of airports has remained 8 since independence.

For the Information and Communication Technology Infrastructure, the country has made significant strides, the 2G population increased from nil to 94%; 3G population

increased from nil to 91%; 4G population increased from nil to 48%; radio coverage from 77% to 78% whilst the TV network increased from 31% to 74.5% (National Planning Commission, 2019). The water infrastructure in Namibia has seen quite impressive improvements due to large investments made by the government to ensure that all citizens have access to safe and clean water which is an imperative to basic human life. The National Planning Commission,(2019) highlights that 97.7% of all Namibian households in the urban area and 68.6% in the rural area have access to safe water.

Furthermore, according to (UNDP, 2021) based on the WEF's Global Competitiveness Index (2019), Namibia's infrastructure performance is ranked 94 out of 114 countries. The Index further indicates that between the country's utility and transport infrastructure, Namibia is lagging the most on transport infrastructure, scoring 48.3 out of 100 and performance of railroad density and efficiency of train services is seen to be the weakest. In terms of the country's utility infrastructure (includes access to electricity, quality of electricity supply, exposure to unsafe drinking water and reliability of water supply) Namibia scored 68.7 out of 100. It should, however, be noted that although Namibia lags on certain infrastructure fronts, it has recently been ranked as the African country with the best roads for the fifth consecutive year by the WEF, therefore increasing investment appeal. In terms of quality of roads in Africa, Namibia remains unchallenged when compared to neighbouring regional countries. On the WEF's rankings Namibia scores 5.2 out of 7.

According to (Sheehama, 2022), some challenges facing infrastructure development include a combination of factors such as inadequate public sector capacity, funding and insufficiently progressed policy frameworks to support private investment and

PPPs. In addition, (Baporika, 2016), outlines the following as the main impediment to infrastructure development in Namibia; lack of integration across government systems; existing internal systems; integrating capabilities restriction; lack of knowledge; poor interoperability and non-availability and or compatibility of software, systems and applications.

The World Bank estimates that investments in infrastructure can generate economic returns of up to 11% for electricity projects and 29% for road building. This serves to create a strong context for new and enhanced investment, with the Namibian Government committing to spend ± N\$ 74 billion, or rather, 42% of its national GDP on infrastructure investment projects over the next NDP by making use of public, private and development financing. Namibia is expected leverage on its geographic advantages and position itself favourably to capitalise on the establishment of the largest free trade area (UNPD, 2021). The AfCFTA agreement aims to eliminate tariffs on most goods, liberalise the trade of services and address obstacles to trade between African countries. The AfCFTA is expected to increase market efficiency and reduce the cost of doing business by offering opportunities for economies of scale and Namibia, through the AfCFTA, can expand the Logistics Hub Project to include land-locked African countries that fall under the AfCFTA through joint venture between several African countries to avoid excessive costs. Critical components to ensure the realisation of the logistics master plan include the logistics hub centre development, upgrading of road and rail infrastructure, a truck-stop development programme, a market promotion programme, as well as an integrated border management programme for the major border posts. Additionally, in order to fully take advantage of the opportunities that come with being part of the AfCFTA economic bloc, Namibia would need to increase intra-Africa trade, as Namibia's exports to non-SACU and non-

SADC tripartite free trade areas account for less than 10% of total exports; diversify exports, as the country's external trade continues to be highly concentrated in a few countries and commodities; and diversify its market, as it is too dependent on the South African economy (UNDP, 2021).

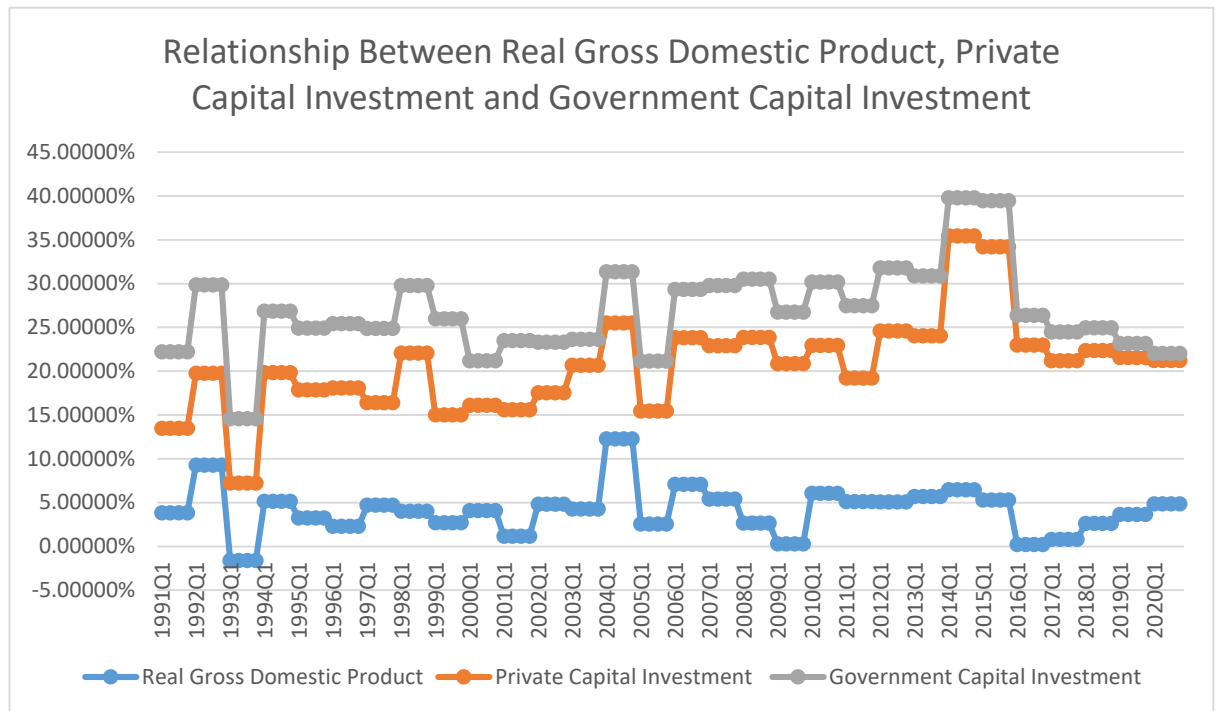
Despite this, the challenges of recent infrastructure development in Namibia has been prioritised, with a specific focus on water infrastructure. Namibia's NDP5 and the Harambee Prosperity Plan (HPP) 2016/17 - 2019/20 both stress the need to increase investment in infrastructure development by the year 2022. The NDP is set to prioritise sustainable investments in infrastructure during the NDP5 period, as it has been noted that the lack of infrastructure results in bottlenecks in economic development. Specific focus areas for the government include energy and water infrastructure development. Additionally, the Namibian Government has also set its commitment towards achieving some of its infrastructure goals by the implementation of the Public-Private Partnership Act 4 of 2017, adopted in 2018 aimed at addressing critical infrastructure needs by incentivising participation from the private sector through leveraging off Public-Private Partnerships (PPPs). Furthermore, the Namibian Government, through the Government Institutions Pension Fund (GIPF) has also established a dedicated infrastructure fund, the Namibian Infrastructure Fund (NIF) set up to address the country's infrastructure backlogs for the following sectors: energy, water and sanitation, ICT, transport and logistics, health and municipal services. Infrastructure development and upgrading is one of the key focus areas in the 2021-2025 Harambee Prosperity PlanII , currently under implementation in Namibia.

2.3 Economic growth nexus infrastructure development in Namibia

Since 1990 Namibia's real GDP has increased almost every year. Remarkably for an economy so dependent on the vagaries of international commodity markets, Namibia has experienced negative growth in the only three (3) years since independence in 1993 (when diamond production was cut dramatically in response to De Beers stockpiling), 2009 (when the collapse of Lehman Brothers helped trigger the world economic recession) (Sherbourne, 2012) and in 2017 due to contraction in the construction sector caused by in investment in mining, high household indebtedness and a disappearing Angolan consumer base and also decline hotels and restaurants sectors (Reuters, 2018).

In terms of government capital expenditure and private investment since 1991 there has been a significant and persistent growth, however (Sherbourne, 2012), argues that this growth has been far too low to sustain the rates of growth required to achieve the growth rates envisaged by Vision 2030. Levels of investment compare unfavourably with fast growing economies such as China (46.8 percent in 2011), Vietnam (35.0 percent) or neighbouring Botswana (30.7 percent). For the period 1991-2017 both private investment and government capital expenditure exceeded GDP.

Figure 1.1: Relationship between Government Capital Expenditure and GDP



Sources: Namibia Statistics Agency 1991 – 2020

Looking at the impact of government spending and private investments on economic growth, Figure 1.1, provides for a somewhat thought-provoking relationship. Since 1991 to 2004 the average growth rate of Namibia was 4.25% with government capital expenditure being 18.93% and private investments 13.08%, showing a positive relationship between the variables stated. Despite this fact, taking the period from 2005 to 2017, the picture is different with the average growth rate of Namibia being 3.99% reflecting a slight decline, on the other hand, government capital expenditure rose to 24.75% while private investments also showed a similar trend with an increase to 19.14%. This clearly shows that despite the relationship being positive from 1991 to 2004, there is a contradictory pattern from 2005 to 2009, picking up again from 2010 and then being consistent till 2016 where it then starts to decline again.

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

The relationship between infrastructure development and economic growth has been investigated substantially in the literature. In this Chapter, the relevant theoretical and empirical literature concerning the study are reviewed. The Chapter is divided into three subsections; theoretical, empirical literature review and a conclusion. Theoretical literature will focus on well-known theories about infrastructure and economic growth whilst empirical literature will focus on the past studies of economic growth and infrastructure to understand the methodologies used in these studies by past researchers and recommendations they made for future researchers on the subject matter.

3.2 Theoretical literature

There is a vast and diverse theoretical literature on infrastructure development and economic investment although most applies to the developed world. This subsection reviews relevant theories pertaining to the relationship between infrastructure and economic growth. The section focusses on the theories guiding the study by specifically discussing the Neo-classical growth theory also known as the Solow-Swab growth model and the endogenous growth theory.

The neoclassical which is also known as the Solow growth model is a modification of the early Harrod-Domar model which recognized capital stock as the only factor of production. The Neoclassical growth theory added labour as another factor of production to develop a model where the total output is a function of capital stock and

augmented labour in a Cobb Douglas function to show constant returns to scale. The model assumes capital is subject to diminishing returns to scale. The model therefore be summarized as follows: $Y(t) = f[K_t^\alpha (A_t L_t)]^\beta \dots \dots \dots$ (3.1)

Where output $Y(t)$ is produced from capital stock $K(t)$ and augmented labour $(A_t L_t)$, $\alpha + \beta = 1$.

According to the Solow growth model, in the short-run, the rate of economic growth in a country is influenced by capital accumulation as resolute by the saving and depreciation rates. The Neoclassical growth theory also assumes that in the long-run, economic growth is exogenously determined by population growth rate and technological progress growth rate.

The model also predicts an international convergence in the total GDP levels where poor countries are assumed to grow at a higher pace as compared to the rich or developed countries. In this kind of a scenario where capital is mobile the rich countries should invest in the poor countries where capital in the form of infrastructure is scarce and there are high returns to the investment. Based on the neoclassical growth model notion that long run growth is inclined by technological progress and labour force growth owing to population transformation, shocks in infrastructure stock can only have temporary effects on income. Thus, shocks to infrastructure can raise the steady-state income per capita in an endogenous growth model.

The endogenous growth theory came as a reaction to omissions and deficiencies in the Solow or Neoclassical growth model. It is a new theory which explains the long run growth rate of an economy on the basis of endogenous factors as against exogenous factors of the neoclassical growth theory. The endogenous growth model developed by Romer (1986) and Lucas (1988) focused on the role of human capital as the main

source of increasing returns and divergence in growth rates between developed and underdeveloped countries. The theory states that investment in human capital, innovation, research and development as well as knowledge are the main drivers of economic growth. Therefore, economic growth is determined by endogenous factors and not exogenous variables.

The incorporation of R&D variables and imperfect competition into the growth framework began in the 19th century. According to the endogenous growth model, technological advances result from research and development activity, and technological progress and knowledge accumulation are treated as endogenous variables, thus it is also termed the endogenous growth theory. According to the model, the long-run growth rate depends on a stable business environment: government policies and actions on taxation, law and order, provision of infrastructure services, protection of intellectual property rights, and regulation of international trade, financial markets, and other aspects of the economy.

The endogenous growth approach argues that there is a role for government institutions that can overcome any market failures associated with the various types of Infrastructural investment. Hence, investment in public infrastructure is crucial to economic development and growth. Further, endogenous growth theory states that the improved infrastructural investment drives growth; thus, investment may contribute to a long- run rate of economic growth.

The endogenous growth model is therefore an extension of the Solow model and can be specified as follows: $Y = Ak^{\alpha}L^{\beta}$ (3.2)

Where, Y is output, K is capital stock and A is a constant on assumption of constant returns to scale in the neoclassical growth model, to ensure that investment matters in the long run growth and growth is endogenous ((Raboloko, 2019).

The new growth model endogenizes the technology factor as follows:

$$A_t = BH^c, \quad 0 < c < 1 \dots \dots \dots (3.3)$$

Where, H , is the level of human capital stock, if H increases by 1 percent, A , is assumed to increase by c percent.

If labour input is allocated between physical output production and human capital production by xL , and $(1 - x)L$, respectively. Then the production function from equation (3.2) can be rewritten as: $Y = B[k^\alpha H^c (xL)^\beta] \dots \dots \dots (3.4)$

Based on this model, endogenous growth is possible in the long run provided there is continuous investment in human capital. According to equation (3.4) there is no diminishing returns in the production of human capital.

Barro (1990) endogenous growth model considered a broad concept of capital by considering both human (education and training as well as having and raising children) and non-human capital (include physical or economic infrastructure such roads, dams and electricity).This framework assumes constant return to scale and increase an in growth if human and physical capital are considered together. The two factors are further assumed to be complements or substitutes in between the production process. Additionally, these models ascertain that the economy is always on steady path growth and all quantities grow at the same rate contrary to the neoclassical model that argues that investment impact growth on transitional period. The Barro (model) further assumes a closed economy and government does any form of capital and therefore

does not produce any goods and services and consume output produced by the private sector. Government responsibility is the direct input into the private into private production and this in turn create opportunities for positive linkages between government investment and growth thereby promoting productivity of private investment. The Cobb-Douglas production can be written as:

$$y = Ak^{1-\alpha}g^\alpha \dots \dots \dots 0 < \alpha < 1 \dots \dots \dots (3.5)$$

Where, y represents output per unit of labour, A refer to the level of technology, k measures producers quantity of capital and g represent productive government expenditure per worker. All these services are assumed to non-rival and non-excludable, output is determined through a combination of k and g in the production process, production exhibit constant return to scale k and g together and diminishing returns in k and g separately. Diminishing returns are because of not increasing government input at the same ration as the increase in private inputs.

If government expenditure is financed through a flat-rate tax, according to Barro (1990), government run a balanced budget because quantity of public services offered to each household-producer equals revenue from tax and aggregate expenditure, $\tau = g/y$. In addition, the theory argues that expanding productive government expenditures relative to output increases the growth rate by increasing the marginal product of capital. The theory concludes by stating that there exists an optimal level of public-sector expenditure on productive services at which the economic growth is optimized, beyond which the negative tax effect dominates the productivity effect and the rate of economic growth declines. However, it is difficult to estimate this optimal level in reality.

The theoretical review show that both the endogenous and exogenous growth theories do not clearly specify the role of infrastructure development in the production process. Infrastructure development features temporary growth effects in the presence of diminishing returns to capital under exogenous theory, while under endogenous theory they improve the efficiency of all other input factors and hence the long run productivity growth.

3.3 Empirical literature

Studies on the nexus between infrastructure development and economic growth are inconclusive. Some research found partial positive relationship between the two variables and others found little or no significantly positive relationship between the two.

(Aschauer, 1989) studied the link between public expenditure and economic growth in the US and concluded that reduced government spending on public infrastructure was one of the primary causes of the economic slowdown in the U.S. Using a production function in which state output is a product of Labour, productivity, utilization, private capital, and public infrastructure. He found core infrastructure (highways, mass transit, airports, electrical and gas facilities, water, and sewers) to have a profoundly positive effect on the productivity of state economies. Using Generalized Methods of Moment (GMM) and Autoregressive Distributed Lag model (ARDL), (Sahoo, et al., 2010) investigated the role of infrastructure development in promoting economic growth in China for the period 1975 - 2007. The findings of the study were that infrastructure

development in China had a positive and significant contribution to Chinese economy than both public and private investment.

(Kruger, 2012) investigated the relationship between infrastructure investments and economic activity in Sweden for the period 1800 to 2000 testing for causality in the Granger sense and constructing a vector autoregressive model separately for each time scale. In order to overcome the problem of endogeneity, independent time scales were used to analyse the relationship. The study showed that there are considerable correlations between economic fluctuations and investments and that infrastructure investments Granger causes growth in the short run and that the reverse is true for longer-time horizons. This implied that the infrastructure investment planning process is reactive and not proactive. The study concluded that payoffs from infrastructure projects are highly positively correlated with overall economic activity; that is, the benefits from these projects for society as a whole are largest in good times but provide no insurance during bad times. This study will borrow heavily from the methodology used by (Kruger, 2012) in order to find the causal relationship between infrastructure and economic growth.

(Mburu, 2013), studied the relationship between government investment in infrastructure and economic growth using a descriptive research design. In this study emphasis was given to secondary data which was obtained from the Government development expenditure in infrastructure obtained from Economic Survey reports published by the Kenya National Bureau of Statistics. The data included the government investments in infrastructure and also economic growth data from CBK covering a period of ten years between 2005 and 2012. In order to test the relationship between the variables the inferential tests including the regression analysis was

applied. The study showed that government investment in infrastructure development had a positive and significant effect on economic growth in Kenya for the period of the study. The study recommended that adequate funding should be directed towards infrastructure projects preparation, implementation and maintenance. The study also suggested that proper reform policy should be complemented with the availability of necessary infrastructures that are important for the economic development in the country.

Nghipangwa (2017) studied water infrastructures in Namibia using a mixture of explorative qualitative and quantitative. The study relied on a survey and a case study of State actors and NSAs involved in water infrastructure in Namibia. Data from both the structured infrastructure questionnaires and secondary data from document review (i.e. water-capital project reports) were extracted, classified, and evaluated using statistical analysis tools. Data pertinent to the research were extrapolated to support the analysis of water infrastructure funding and financing structures. The research examined the State of water-infrastructure development finance in Namibia, by analysing the participation of State and non-State actors in water infrastructure development and finance.

Kidake (2018) empirically analysed the long-run and short-run associations between infrastructural and FDI stocks in Kenya using the principal component analysis (PCA) to generate infrastructure component. This was generated from the three main measure of infrastructure which includes electricity generation in kilowatts, Mobile cellular subscription (per 100 people), and the total expenditure on transport infrastructure (Road, air, water, and Rail). With these annual Time series data for the period 1980-2015, obtained from the World Bank database and the Kenya Bureau of Statistics

(KNBS) publications. The study results showed that FDI and infrastructural development are related in the long run. Further, the study indicated that FDI affected the infrastructure in the short run significantly. Infrastructural development had a positive significant effect on the FDI in the short run. Granger causality results indicated a unidirectional causality running from FDI to infrastructural development. The study recommended that measures to be put in place to facilitate infrastructure development with aim of attracting FDI Inflows.

(Kodongo & Ojah, 2016) investigated the relationship between infrastructure and economic growth in the Sub-Saharan Africa using System GMM to estimate a model of economic growth. Using panel data for 45 Sub-Saharan African countries for the period of 2000 to 2011. The study showed that the spending on infrastructure and increments in the access to infrastructure that influence economic growth and development in Sub-Saharan Africa. In lesser economically developed countries especially those of infrastructure spending, are more important for lesser developed economies of the region than for the relatively more developed economies, which seldomly have better than near-zero access to infrastructure.

(Calderon & Serven, 2010) studied the effects of infrastructure development on economic growth and income distribution for 100 countries using panel data from the year 1960 to 2000. Using simple equations for GDP growth and conventional inequality measures and applying the GMM estimators to cater for endogeneity. The two main results from the study are that economic growth is positively affected by the stock of infrastructure assets and higher infrastructure quantity and quality reduces income disparity in the country. The study concluded that infrastructure development

can be highly effective to combat poverty. The study recommended that infrastructure development should rank at the top of the poverty reduction agenda.

Daido and Tabata (2013), studied the relationship of public infrastructure and economic development in Japan by developing a political economy model of growth to examine economic development led by the interactions between an economic decision concerning a firm's production technology (CRS vs. IRS technology) and a political decision concerning public infrastructure. The study showed that multiple equilibrium growth paths occur due to differences in expectations regarding the quality of public infrastructure. These multiple paths were found to demonstrate why economies with poor initial conditions can catch up to and, furthermore, overtake economies with better initial conditions.

(Palei, 2015) assessed the impact of infrastructure on economic growth and global competitiveness in Czech Republic. With the aim of finding the casual relationship between infrastructure and economic growth, the study results showed that country's competitiveness is influenced basically by the level of institutional development and other seven factors, including infrastructure, in turn infrastructure factor is determined mainly by the quality of roads, railroad infrastructure, air transport and electricity supply. The study concluded that infrastructure can influence economic growth through enabling businesses to generate additional production capacity, having positive impact to education and health and allowing access to poor and undeveloped areas to the core business activities.

Terada-Hagiwara and Straub (2010) assessed the state of infrastructure and Growth in Asia using 2 distinct approaches of growth regressions and growth accounting to analyze the link between infrastructure, growth, and productivity. The study concluded

that a number of countries in developing Asia have significantly improved their basic infrastructure endowments in the recent past, and this appears to correlate significantly with good economic growth performances. Evidence from the study indicate that this is mostly the result of factor accumulation which is considered as a direct effect, while the impact on productivity is inconclusive.

(Datta & Mbarika, 2006) conducted a global investigation about the Granger Causality between information infrastructure investment and service sector growth in the USA. The longitudinal study introduced and explored infrastructure development and service-sector growth as key metrics for IT investment success. The study also traced the notional evidence of IT infrastructure development as mediating the causal relationship between information infrastructure investments and service-sector growth. Using data from all the three income countries groups, the mediating and lagged impact of information infrastructure on service-sector growth reveals that information infrastructure development does play a significant role as a mediator. It points out that information infrastructure investments can be a misleading causal antecedent if countries fail to develop their infrastructure. This also provides evidence of a recursive relationship between infrastructure development and service-sector growth.

Senelwa (2018) conducted a time series study on the Granger Causality between Infrastructure and Foreign Direct Investment in Kenya for the 1980-2015 Study period. Using the Principal Component Analysis (PCA) to generate the infrastructure component. The study results indicated that FDI and infrastructural development are related in the long run. It was also showed that FDI affected the infrastructure in the short run significantly. Infrastructural development had a positive significant effect on

the FDI in the short run. The Granger causality results indicated a unidirectional causality running from FDI to infrastructural development. The study recommended measures to be put in place to facilitate infrastructure development with aim of attracting FDI inflows, and on the other hand, the study proposed policies to be put in place to increase FDI inflows with main aim of facilitating infrastructure development in Kenya.

(Herranz-Loncán, 2007), analyzed the impact of infrastructure investment on Spanish economic growth between 1850 and 1935. Using new infrastructure data and VAR techniques, he shows that the growth impact of local scope infrastructure investment was positive, but returns to investment in large nation-wide networks were not significantly different from zero. He provided two contemporary explanations for the latter results. On the one hand, public intervention and the application of non-efficiency investment criteria were very intense in large network construction while on the other hand, returns to new investment in large networks might have decreased dramatically once the basic links were constructed. Also, a study on the United State of America for period 1980-2007 by Heinz et al. (2009), showed a positive or direct link between infrastructure development and GDP. Similarly, (Perkins, et al., 2005) identified a direct association between infrastructure development and economic growth for South Africa for study using Pesaran, Shin and Smith's F-tests. Younis (2014), analysed the significance of Infrastructure Investment on Economic Growth in Pakistan using Principle Component Analysis and VECM which was applied to estimate the long-run as well as short-run relationship between the variables. Contrary to findings from past studies, the study found that the long-run impact of private investment and social infrastructure investment on economic growth is positive and significant while economic infrastructure investment affects economic growth

negatively. In the short-run, on the other hand, infrastructure investment does not have any significant impact on economic growth. The study recommended that there is need to divert resources from economic infrastructure to social infrastructure which has the potential to increase growth rate since there was inefficiency in infrastructure investment in Pakistan.

Jan *et al.* (2012) used a Cobb-Douglas production function augmented with index of physical infrastructure to study the relationship between GDP and physical infrastructure. The study used transportation, energy and telecommunication infrastructure and constructed an index of physical infrastructure using principle component analysis. The findings of the study showed that a long-run relationship between GDP and Physical Infrastructure.

(Agenor & Moreno-Dodson, 2006) examined various channels through which public infrastructure can affect economic growth. The endogenous growth model was used to develop a link between health infrastructure and growth. It climaxes the effect of developing infrastructure on investment adjustment cost like resilience of private capital and production of health and education services. The study recommends the design of strategies which aim at promoting growth and reducing poverty although it fails to take in to account the fact that different states show different behaviour regarding infrastructure investment and economic growth.

Herranz-Loncán (2017) analysed the impact of infrastructure investment on economic growth for Spain using the secondary data from the year 1850 to 1935. Using new infrastructure data and VAR techniques, the findings show that the growth impact of local-scope infrastructure investment was positive, although the returns to investment in large nation-wide networks were not significantly different from zero. This was due

to public intervention and the application of non-efficiency investment criteria which were very intense in large network construction and also the returns to new investment in large networks might have decreased dramatically once the basic links were constructed.

Regionally, Perkins et al (2005) studied the impact of economic infrastructure on economic growth in South Africa using the F-tests. The study showed that there was a long-run forcing relationships from public-sector economic infrastructure investment and fixed capital stock to gross domestic product (GDP), from roads to GDP and from GDP to a range of other types of infrastructure. They also found that the relationship between economic infrastructure and economic growth was unidirectional.

M'Amanja and Morrissey (2012) analysed the determinants of growth in Kenya using the data from 1964 to 2002 using a multivariate approach on time series. Authors found that shares of private and public investment, and imports in GDP have strong beneficial effects on per capita income in Kenya. The implication for policy makers were that, in order for Kenya to foster and sustain growth, closer attention should be given to factors that promote private investment. Private investment appeared to have a stronger influence on growth than public investment, the results show that a 10% increase in private investment leads to about 0.57% increase in output while a similar increase in government investment leads to a 0.30% increase.

Heintz et al (2009) analysed the statistics for the United States using two different time periods of 1950-1979 and 1980-2007 to detect the link between infrastructure investment and Gross Domestic Product (GDP). The former study period's results showed that growth in public infrastructure contributed almost one- for-one to economic growth. During this period infrastructure investment in core areas such as

transportation, water management and electricity generation grew at an average rate of 4 percent whilst GDP growth 4.1% during the same period. The results from the second study period showed that when growth in public infrastructure investment drastically fell to 2.3%, average annual GDP growth also fell to 2.9 percent over the same period. This shows that there is a very strong positive relationship between GDP and infrastructure investment.

(Srinivasu & Rao, 2013) conducted a study on the relationship between infrastructure development and economic growth. The results showed that there was a positive and statistically significant relationship between infrastructure development and economic growth, as well as infrastructure development and poverty. According to the study, improvement in infrastructure leads to an increase in productivity and ultimately improvement in economic growth.

(Mbulawa, 2017) examined the impact of economic infrastructure on long term economic growth in Botswana in a similar study to the current study. The study used annual time series data for the period 1985 to 2015, aided by a vector error correction model (VECM) and the ordinary least squares (OLS) technique to determine the impact of electricity distribution and maintenance of roads on long term economic growth in Botswana. The study findings show that long term economic growth is explained by both measures of infrastructure (electricity distribution and maintenance of roads). However, electricity distribution was found to have a greater impact on economic growth than road maintenance.

Raboloko (2019) studied the impact of infrastructure on economic growth in Botswana. This study was different from the previous studies in Botswana as it considered additional measures of infrastructure such as healthcare infrastructure and

education infrastructure. The study employed an Autoregressive Distributed Lag (ARDL) estimation technique to determine how infrastructure affects economic growth in Botswana. The empirical results show that healthcare infrastructure has a positive and significant impact on economic growth in Botswana in the long run. The results further reveal that electric power consumption has a positive and significant effect in influencing economic growth in the short run. The results imply that in order to achieve higher economic growth, policymakers should consider accelerating improvement of healthcare infrastructure.

In exploring the impacts of economic and social infrastructure on economic growth in South Africa, (Kularatne, 2006) employed the ARDL and VECM approaching while adapting Barro's (1990) model. The study findings indicate that both economic and social infrastructure has a positive and significant effect on economic growth and private investment is crowded in. Also, (Vukeya, 2015) assessed the impact of government economic and social infrastructure investment on South African economic growth and found that economic infrastructure investment is an important determinant of growth though social infrastructure investment and private investment have negative effect. Opposing to Kularatne findings, the causality study in Vukeya's found that growth tends to cause economic infrastructure investment thus supporting Wagner Law and neutral causality exists between growth and social infrastructure investment.

In analyzing the relationship between infrastructure investment and economic growth Du *et al.* (2022) used the three-dimensional analysis framework of economic growth conditions, process, and results. This empirical examination was based on provincial

panel data for China from 2004 to 2019 and findings demonstrate that infrastructure investment can significantly improve economic growth.

(Stungwa & Daw, 2021) found a positive relationship between infrastructure development and economic growth in South Africa. The study employed Cross-section Seemingly Unrelated regression using an annual panel data collected from nine provinces for the period 2006-2019. The results showed that infrastructure is an effective instrument to stimulate economic growth.

The empirical literature reviewed above shows that there is scant evidence of the linkages between Government infrastructure development and economic growth in Namibia. Additionally, empirical studies mostly focused on the broad relationship between public and private investment. However, to avoid aggregation bias this study will separate Government infrastructure development from private investment. Empirical investigation suggest the Granger-Causality test have not received adequate priority in the few country specific studies Therefore, this study contributes to literature by filling the gap in terms of variable choice and estimation technique.

3.4 Conclusion

The chapter made a valuable attempt to review theoretical and empirical literature relevant to the study. The theory behind the relationship between infrastructure development and economic growth vary between bidirectional, non and unidirectional. Empirical literature on the other hand show mixed results differing from country to country, depending on country specific macroeconomic environment, research period, methodology and choice of variables, thus suggesting the link between infrastructure development and economic growth is heterogeneous. The next Chapter presents the theoretical and empirical methodology employed in the study.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

The previous chapter attempted to review several theoretical and empirical literature relevant to the study. This chapter will present the methodology used to investigate the relationship between infrastructure investment and economic growth in Namibia. The study will borrow heavily from previous scholars regionally and internationally to formulate the best model which best explains the relationship between infrastructure investment and economic growth.

4.2 Theoretical Framework

The theoretical framework for this study augments (Barro's, 1990) simple endogenous growth model. The model introduces the real-world feature of congestion in the consumption of publicly provided goods which are rivalries but not excludable. In this model of congested public goods, every producer benefits from the provision of public capital. However, for a given stock of public capital g the benefits to producers decline as they raise their individual k , and hence their output. This is the nature of the congestion existing in the consumption of public capital represent, for example, the miles of highways provided, the number and size of airports, and law and order, and k can represent highway traffic, air traffic, and the number of legal disputes. Barro and Sala-i-Martin (1992) argue that national defense and domestic security services (police and prisons), which are often deemed to be prototypical nonrival and nonexcludable

public goods, can also be considered to be subject to a form of congestion. The state of national and local security depends on expenditures on defense and police services, g , in relation to the level of the perceived external threat, where that threat is a function of the “prize” potentially attainable by aggression, which is proportional to the private domestic capital stock, k . Hence, it can be argued that g / k represents the effective level of national and domestic security.

The Barro model assumed that government does not own any capital nor produce any goods and services and therefore government consume output from the private sector. The productive services that the government provides correspond with inputs the private sector needs. Therefore, the role of the public sector is a direct input into private production. This role provides an avenue for positive linkages between public investment and growth, thereby implying government investment play a contributory role in the productivity of private investment. The Cobb-Douglas production function can be presented as:

$$y = Ak^{1-\alpha}g^\alpha \quad 0 < \alpha < 1 \dots\dots\dots(4.1)$$

From equation (1), y refers to output, A measures the level of technology, k represents the representative producer’s quantity of capital and g refers the productive government expenditure. These services are assumed to be non-rival and non-excludable, to support these assumptions. From the model, output is determined by parallel combinations of k and g in the production process of the economy. Production exhibits constant returns to scale in k and g together; however, it exhibits diminishing returns in k and g separately. Diminishing returns are a consequence of not increasing government inputs by an equivalent ratio as private inputs.

When government expenditure is financed by a flat-rate income tax, according to (Barro, 1990) then government runs a balanced budget because the amount of public services provided to each household-producer equates revenue from tax and aggregate expenditure, $\tau = g/y$. Furthermore, the theory argues that expanding productive government expenditures relative to output raises the growth rate by raising the marginal product of capital. The theory concludes by stating that there is an optimal level of public sector expenditure on productive services at which the rate of economic growth is optimized, beyond which the negative tax effect dominates the productivity effect and the rate of economic growth declines. However, it is difficult to estimate this optimal level (Njiru, Simiyu and Bunde, 2020).

The theoretical framework employed in this study is similar to the one adopted by (Barro, 1990) and include labour as an additional input. The theoretical model can be specified as:

$$Y = A(G, PI, L, e) \dots \dots \dots (4.2)$$

Where: Y represent output as a function of Government capital expenditure, G represents Government capital expenditure used as measure of government infrastructure investment due a lack of data, Private Investment, PI , Labour force, L and e represents other factors influencing economic growth not included in the model.

4.3 Empirical model

The empirical model utilized in this study is similar to the work of (Njiru, Simiyu and Bunde, 2020) and (Kandenge, 2011) given as:

$$Y_{it} = \alpha_1 + \beta X_{it} + \mu_i + \varepsilon_{it} \dots \dots \dots (4.3)$$

Where: Y_{it} is the Real GDP growth rate at time t . The X variable represent other growth determinant variables used in the study.

The empirical model can then be specified as follows:

$$RGDP_{it} = \beta_0 + \beta_1 GCFG_{it} + \beta_2 GCFP_{it} + \varepsilon_{it} \dots \dots \dots (4.4)$$

Where:

RGDP = Real Gross Domestic Product growth rate;

GCFG = Government Capital Expenditure as a % of GDP; as a proxy of government infrastructure investment.

GCFP_{it} = Private Capital Expenditure as a % of GDP;

and ε_t = the error term.

4.4 Econometric framework

4.4.1 Unit Root Test

Unit root tests is used to determine if trending data should be first differenced or regressed on deterministic function of time to render the data stationary. A time series data is considered stationary if the mean and variance are constant over time and value of the covariance between the two time periods depends only on the distance or lag between the two time periods and not the actual time at which the covariance is computed (Gujarati, 2013) However, if the mean and variance change in samples for different time spans then, this type of variable is non-stationary.

There are several ways of testing for unit roots such as the Dickey-Fuller (DF) test, Augmented Dickey-Fuller (ADF) test, co-integration regression Durbin-Watson (CRDW) test, Phillips-Perron (PP) test, Kahn and Ogaki test, Leyborne-McCabetest test, as well as, the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests. The DF, ADF, KPSS and PP tests are the most popular types of unit root tests applied in empirical work. This is mainly due to their simplicity and general nature (Johansen, 1988). However, this study employed both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) to test the stationarity or non-stationarity of the variables and their order of integration.

The aim of unit root test is to examine the data generating process specifically:

1. Pure random walk: There is no intercept and no time trend as specified by equation (4.5) below.

$$\Delta y_t = \delta y_{t-1} + \sum_{t-1}^p \alpha_t \Delta y_{t-1} + \varepsilon_t \dots \dots \dots (4.5)$$

2. Random walk with drift and no time trend

$$\Delta y_t = \vartheta + \delta y_{t-1} + \sum_{t-1}^p \alpha_t \Delta y_{t-1} + \varepsilon_t \dots \dots \dots (4.6)$$

The significance of random walk model is that economic time series follow a pattern that resembles a trend model. Additionally, if two time series are independent random processes then the relationship between the two does not have an economic meaning.

3. Random walk with drift and trend

$$y_t = \vartheta + \gamma t + \delta y_{t-1} + \sum_t^p \alpha_t \Delta y_{t-1} + \varepsilon_t \dots \dots \dots (4.7)$$

The number of lagged difference terms to include is often determined empirically and usually is suggested to include enough terms to ensure that the error term is serially uncorrelated (Gujarati, 2013).

4.4.2 Lag Length Selection

Prior to conducting both the ARDL and VECM analysis, it is important to determine the appropriate optimal lag length of the VECM model because model is sensitive to the lags and choosing too few lags can result in misspecifications while too many lags might result in unnecessary loss of the degree of freedom. Therefore, according to Nkoro and Uko (2016), appropriate lag length should be selected using statistical tests.

The selection of the optimal lag length is usually dictated by the criteria's; such as the Akaike Information Criterion (AIC), Schwarz (Bayesian) Criterion (SC), or Hannan-Quinn Criterion (HQC). These tests show the convergence in the lag length.

4.4.3 Autoregressive Distributed Lag Model or Bound Cointegration Test

The autoregressive distributed lag (ARDL) or bound testing approach proposed by Pesaran et al (2001) was used to investigate the short and long run relationship between the dependent and the explanatory variables. The ARDL tool was adopted based on three rationale: firstly, Pesaran et al (2001) advocated the use of the ARDL model for the estimation of level relationship because the model suggests that once the order of

ARDL has been identified, the relationship can be estimated by OLS. Compared to the popular multivariate cointegration techniques such as Johansen and Juselius methods, bound test allows the cointegration relationship to be estimated by OLS once the lag order of the model is identified. Secondly, the ARDL model (bounds test) allows a mixture of $I(1)$, $I(0)$ or mutually cointegrated variable as regressors, that is, the order of integration of relevant variables may not be necessarily the same. Therefore, the ARDL model has the advantage of not requiring precise identification of the order of the underlying data. Thirdly, this technique is appropriate for small of finite sample size (Pesaran et al, 2001). Additionally, where sample size is small, test for the order of integration has little power. Therefore, the application of unit root test may not provide a conclusive result regarding the order of integration of the variables of interest. However, the major limitation of the bound test procedure is that it crashes in the presence of $I(2)$ series (Kumo, 2012).

To examine the short and long run nexus between economic growth and infrastructure development, following Pesaran et al (2001), we constructed vector autoregressive (VAR) of order p , denoted by VAR(p) for the infrastructure led economic growth function:

$$\pi_t = \mu + \sum_{i=1}^p \beta_i \pi_{t-i} + \varepsilon_t \dots \dots \dots (4.8)$$

Where, π_t is the vector of both explanatory variables x_t and dependent variable y_t defined as the GDP growth rate [RGDP]. The vector matrix representing a set of explanatory variables is defined as $x_t = [GCFG_t, GCFP_t]$, $\mu = [\mu_y, \mu_x]$, t it time or trend variable, while β_i is matrix of VAR parameters for lag i . In this model, we consider the actual values or trend variables instead of their growth rates to enable us to examine both the short-run and long-term causal relationships between the

independent and the explanatory variables. Furthermore, according to Pesaran et al (2001), in the ARDL model, y_t must be an $I(1)$ while regressor x_t can either be $I(0)$ or $I(1)$.

From equation (4.8) the Vector Error Correction Model (VECM) can be specified as follows:

$$\Delta\pi_t = \mu + \alpha t + \delta\pi_{t-1} + \sum_{i=1}^{p-1} \psi \Delta y_{t-1} + \sum_{i=0}^{p-1} \psi_i \Delta y_{t-i} + \varepsilon_t \dots \dots \dots (4.9)$$

Where Δ is the first difference operator capturing the short-term component of the model; the long multiplier matrix, δ can be partitioned as follows:

$$\delta = \begin{bmatrix} \delta_{yy} & \delta_{yx} \\ \delta_{xy} & \delta_{xx} \end{bmatrix} \dots \dots \dots (4.10)$$

The diagonal elements of the matrix are unrestricted, therefore the selected series are can either be $I(0)$ or $I(1)$. Therefore, if $\delta_{yy}=0$, then y is $I(1)$. On the other hand, if $\delta_{yy} < 0$, then y is $I(0)$. In this case it is possible to test the presence of at most one cointegrated vector between the dependent variable and the set of explanatory variables. According to Pesaran et al (2001), in case of unrestricted intercepts and no trends, we impose the restriction $\delta_{xy} = 0, \mu \neq 0, \text{ and } \alpha = 0$, in order to derive the preferred ARDL model. The preferred infrastructure led growth model can be stated as follow:

$$\begin{aligned} \Delta RGDP_t = & \beta_0 + \beta_1 RGDP_{t-1} + \beta_2 GCFG_{t-1} + \beta_3 GCFP_{t-1} \\ & + \beta_2 POP_{t-1} + \sum_{i=0}^{p-1} \alpha_1 RGDP_{t-1} + \sum_{i=0}^{p-1} \alpha_2 GCFG_{t-1} + \sum_{i=0}^{p-1} \alpha_3 GCFP_{t-1} \\ & + v_t \dots \dots \dots (4.11) \end{aligned}$$

Where, $(\alpha_1, \alpha_2, \alpha_3)$ represent the short run parameters while $(\beta_1, \beta_2, \beta_3)$ represent the long run parameters and v_t denote the white noise disturbance term.

The lag length for equation (4.11) is determined using the minimum of both Schwarz, Akaike information and Hannan-Quinn information criterion.

According to Kumo (2012), the long run elasticities are the coefficients of one lagged explanatory variable (multiplied by negative sign) divided by the coefficient of the one lagged dependent variable. For instance, based on equation (4.11), the long run elasticity of government infrastructure investment is $\left(\frac{\beta_2}{\beta_1}\right)$. The short run effects are captured by the coefficients of the first-difference variables in equation (4.11).

A Wald test (F-statistic) is estimated from equation (4.11) to determine the long run relationship between the variables. The Wald test is conducted by imposing restrictions on the estimated long-run coefficients of RGDP, GCFG and GCFP. The null and alternative hypothesis tested in the model are:

$$H_0: \beta_1 = \beta_2 = \beta_3 = 0 \quad (\text{Variables are not cointegrated})$$

$$H_0: \beta_1 \neq \beta_2 \neq \beta_3 \quad (\text{Variables are cointegrated})$$

The computed F-statistic is compared to the critical values tabulated by Pesaran et al. (2001). According to Pesaran et al. (2001) lower bound critical values assume that explanatory variables x_t are integrated of order zero, while upper bound critical values assume that the variables x_t are integrated of the order one. If the computed F-statistics

value is smaller than the lower bound critical value, then the null hypothesis of no cointegration between the variables is not rejected and we conclude that government infrastructure investment and other explanatory variables do not exhibit a long-run relationship with economic growth. On the other hand, if the computed F-statistic is greater than the upper bound value then economic growth and its determinant are cointegrated and we conclude that government infrastructure investment and other explanatory variables exhibit a long-run relationship with economic growth.

4.4.5 Vector Error Correction Model

Given that the Bound test results revealed a long-run relationship among the variables under review, a vector error correction methodology (VECM) was adopted to analyze the research objectives by estimating and generating the regression results and all the investigations required for the study. The VECM model is regarded as a reliable procedure for examining the effects among variables under study for based on three motives, firstly it is an effective method for forecasting economic time series. Secondly, it is a useful model in designing and evaluating economic models. Finally, VECM models is an effective tool for evaluating the impact of alternative economic policy actions (Sims, 1980). Furthermore this model is rich in dynamic structure and can estimates dynamic interactions between variables under study by using the impulse response analysis or forecast error variance decompositions. Moreover, the VECM treat treats all observed variables as prior endogenous which avoid simultaneity problem among variables associated with the simultaneous equation's models (Mills & Patterson, 2007). Additionally, the VECM model, is flexible and easy for

application. The model can also be extended to encompass moving average errors, which can be transformed into a multivariate version of an ARMA model, known as a VARMA. Another advantage is that, instead of having only two variables, the system can be expanded to include more variables, of which each variable has an equation. The additional useful facet of the VECM model is the compactness with which the notation can be expressed. The VECM model equation is described above and listed as equation (4.11).

The cointegration of the variables warrants an estimation of an Error Correction Model (ECM) on the ARDL form in order to determine the speed of adjustment of the variables concerned to their equilibrium values. That is, the rate or speed at which deviations of the previous period from longrun equilibrium are corrected in the next period. The error correction model can be specified on the ARDL form as follows:

$$\Delta RGDP_t = \beta_0 + \sum_{i=0}^{p-1} \beta_1 RGDP_{t-1} + \sum_{i=0}^{p-1} \beta_2 GCFG_{t-1} + \sum_{i=0}^{p-1} \beta_3 GCFP_{t-1} + \gamma ECM_{t-1} + v_t \dots \dots \dots (4.12)$$

ECM is residual acquired from the estimation of equation (4.11) for cointegration γ refer to the speed of adjustment of the variables concerned to their long-run equilibrium values v_t is the White noise error-term.

The Vector Error Correction Model is very appropriate in examining the long run and short run effect of government infrastructure investment on economic growth in

Namibia. The study applies different diagnostic tests to confirm the unbiased and overall significance of generated results as well as the stability of the estimated models. To test for model misspecification and for the stability of the model, cumulative sum (CUSUM) test is used and the null hypothesis of this test state that the regression equation is correctly specified and when plotted CUSUM line graph should remain inside the 5 percent level of significance. level then it's concluded that the model is correctly specified otherwise the model is miss specified.

4.4.6 Variance Decomposition and Impulse Response

Variance decomposition is a complement method to the impulse response functions for examining the effects of shocks to the dependent variables. According to Stock and Watson (2001), this technique determines how much of the forecast error variance for any variable in a system, is explained by innovations to each explanatory variable, over a series of time horizons. Normally, own series shocks explain most of the error variance, although the shock will also affect other variables in the system. It is also important to consider the ordering of the variables when conducting these tests, as in practise the error terms of the equations in the VECM will be correlated, so the result will be dependent on the order in which the equations are estimated in the model to provide a brief report on impulse responses and forecast error variance decompositions.

4.4.7 Diagnostics

The study conducted different diagnostic tests to confirm the unbiasedness and overall significance of the generated results as the stability of the estimated models.

4.4.7.1 Serial Correlation

Serial correlation or autocorrelation occurs when the error term observations in a regression are correlated. This error term represents a random “shock” to the model, or something that is missing from the model. If the error term observations follow a pattern, this pattern will be evidence of autocorrelation. For each observation, the error term represents the distance between the actual value of the dependent variable and the predicted value. In the presence of serial correlation, then there will most likely be room to improve the model so that the regression does a better job of predicting the dependent variable. Engle’s Lagrange Multiplier test was used to test for the presence of autocorrelation, with Ordinary Least Squares (OLS) methodology requiring that the error terms in a time series need to be uncorrelated (Gujarati, & Porter, 2009). An uncorrelated time series can still be serially dependent due to a dynamic conditional variance process. The null hypothesis of the LM test is that there is no serial correlation in the residuals. Serial correlation is present when residuals are shown to have correlations with past values. The null hypothesis may not be rejected if the probability value exceeds the 5% level of significance, meaning that there will be no autocorrelation in the series.

4.4.7.2 Heteroscedasticity

The classical linear regression assumes that the variance of the error term is constant over time, that is, the error term is homoskedastic. If the variance of the error term is changing over time then the assumption of homoskedastic is violated leading to heteroskedasticity. Ordinary least squares estimates are consistent in the presence of heteroskedasticity, but the conventional computed standard errors are no longer valid (Green, 2000). In this study heteroskedasticity test is conducted using the Breusch-Pagan test method where the null hypothesis is that the variance of the error term is constant. If existence of heteroskedasticity is found, ARDL model using the robust standard errors is used to account for the problem of heteroskedasticity.

4.4.7.3 Normality tests

As a starting point, all the data series are tested for normality to know the nature of data distribution. The Jarque-Bera test is the most used normality test and hence this study will also adopt that test. The Jarque-Bera test uses the sum of the skewness and kurtosis statistics based on the skewness and coefficients. The Jarque-Bera statistic can be specified as follows:

$$JB = \left[\left(\frac{S^2}{6/n} \right) + \left(\frac{(K - 3)^2}{24/n} \right) \right] \dots \dots \dots (4.13)$$

Whereby:

n is the sample size, S refer Skewness coefficient, and K is a measure of Kurtosis coefficient. The Jarque-Bera test statistic follows the chi-squares distribution with two degrees of freedom. Under this test the null hypothesis of normality is $= 0$ and Kurtosis is equal to 3 and the expected value of the statistic is 2.

4.4.6 Data measurement and data sources

The study employed time series annual data converted into quarter for the period 1991Q₁ - 2020Q₄. The quarterly data consist of three variable and the data was sourced from the World Bank's world Development indicators, COMSTAT and Namibia Statistics Agency.

CHAPTER 5: EMPIRICAL RESULT AND FINDINGS

5.1 Introduction

The purpose of this chapter is to examine the link between variables empirically, based on the models specified in Chapter four, using Vector Error Correction Model (VECM). Section 5.2 present the empirical analysis while section 5.3 provides a summary of the chapter.

5.2 Empirical analysis

5.2.1 Descriptive Statistic

It is important to report descriptive statistics before analysing data series to study the distribution and variability of the variables. Table 5.1 summarises the descriptive statistics, it shows the measures of central tendency, measures of dispersion and measures of normality.

Table 5.1: Descriptive statistics

	RGDP	GCFG	GCFP
Mean	4.124650	6.126772	16.59105
Median	4.167403	6.733115	16.39315
Maximum	12.26695	10.98117	28.98630
Minimum	-1.619904	0.790031	8.839754
Std. Dev.	2.698201	2.339350	4.810837
Skewness	0.588921	-0.358489	0.841632

Kurtosis	4.478122	2.878009	3.688792
Jarque-Bera	17.86079	2.644698	16.53907
Probability	0.000132	0.266509	0.000256
Sum	494.9580	735.2127	1990.926
Sum Sq. Dev.	866.3543	651.2342	2754.154
Observations	120	120	120

5.2.2 Unit Root Test

The initial step in applying the VECM technique is to establish the order of integration of the series by conducting unit root test to determine the existence, or not, of unit roots in the series.

Table 5.2: Unit root tests

	Model specification	ADF	PP	ADF	PP	Integration order
Variables	Intercept and Trends	Levels	Levels	1 difference	1 difference	
RGDP	Intercept	- 2.886732**	- 2.885863**	- 2.886732**	- 2.886074**	<i>I</i> (0)

	Intercept and trend	-3.449365	-3.448021	-	-	$I(1)$
GCFG	Intercept			-	-	$I(1)$
		-2.886732	-2.885863	2.886732**	2.886074**	
GCFG	Intercept and trend	-3.449365	-3.448021	-	-	$I(1)$
				3.449365**	3.448348**	
GCFP	Intercept	-2.885863	-2.885863	-	-	$I(1)$
				2.886074**	2.886074**	
GCFP	Intercept and trend			-	-	$I(1)$
		-3.448021	-3.448021	3.448348**	3.448348**	

Source: Researchers own computations. Note: ***, ** and * denotes 1%, 5% and 10% significance level respectively.

The study conducted a stationarity tests using two commonly used time series unit root tests, the Augmented Dicker-Fuller (ADF) and Philips Peron (PP). Both trend and intercept were included in the test equations for all the variables using the two test types. Table 5.2 presents unit root tests results. Evidence from table 5.2, show that using ADF unit root techniques at levels $I(0)$, the RGDP is stationary while GCFG and GCFP show constant variability (not stationary) and after differencing, they are integrated of order $I(1)$ at 5% significance. The concept of being stationary or not containing unit root implies that the variables has zero mean, constant variance and the residuals uncorrelated over time. Variables are only differenced if they are not cointegrated so that they can be deemed fit to enter the VAR. Since all the variables in

this study are not integrated of the same order they cannot enter the unrestricted VAR and therefore we proceed to perform an ARDL bound test. Variables are integrated of the orders 1 and 0 which supports the use the ARDL model.

5.2.3 Determination of the Lag Length

The first step in estimating a VAR model is to determine the optimal lag length of the VAR. Therefore, for this process this study determined the optimal lag length using the, LR test statistics, final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQIC). The results displayed in table 5.3, show the lag convergence is 5.

Table 5.3: Lag-Length Criteria

Lag	LogL	LR	FPE	AIC	SC
0	-835.6063	NA	640.0090	14.97511	15.04793
1	-599.9645	454.4520	11.18303	10.92794	11.21920*
2	-597.6901	4.264471	12.61511	11.04804	11.55776
3	-594.4231	5.950679	13.98815	11.15041	11.87858
4	-589.2678	9.113803	15.00809	11.21907	12.16569
5	-543.2548	78.87945*	7.770953*	10.55812*	11.72319
6	-541.7900	2.432516	8.926140	10.69268	12.07620

7	-539.8315	3.147584	10.17881	10.81842	12.42039
8	-537.0554	4.312895	11.46000	10.92956	12.74998

5.2.4 ARDL Bound test

Upon confirming the order of integration offered in Table 5.2 and selecting the optimal lag structure displayed in Table 5.3 to be used in ARDL modelling, the next step is to examine the existence of a long run relationship between the explanatory variables and GDP growth rate, we applied the ARDL bound test for co-integration as proposed by Pesaran et al. (2001). Under the bounds test one can either use the F-test or the Wald test. The test was conducted using the critical values of the bound test for both upper and lower bounds. The null hypothesis; $H_0: \beta_1 = \beta_2 = \beta_3 = 0$ is tested against the alternative hypothesis $H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq 0$. The results of the bound test for the bound test as selected by the AIC is provided in Table 5.4.

Table 5.4: Bound Test for co-integration

Equations	K	F-statistics	Decision
(1)	2	5.190301	Co-integration
Critical values for (F-statistics)	Lower bound at 5%		Upper bound at 5% = 3.87

	= 3.1		
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Source: Researchers own computations. Note: If F-statistics is less than lower bound critical value - No Co-integration. Fail to reject Null hypothesis. If F-statistics is higher than upper bound critical value – Co-integration. Reject Null hypothesis.

Bound test results in Table 5.4, show that the calculated F-statistic is greater than the upper bound critical value and such conclusion was drawn that there was co-integration between the variables under study. The results also confirm the use of an ECM to represent the relationship between economic growth and factors contributing to it. Therefore, the study continued to estimate the regression output, and speed of adjustment to balance given the existence of a long-run relationship and the results are presented below.

5.2.5 Estimated Long-Run and Short-Run

After establishing the presence of the long run relationship between the variables the next would be to estimate the long and short run relationship between the variables. Regression of variables at level and first difference is done for the period 1991 to 2020. The aim for running the regression of the data is to generate the residuals to be used in formulating an error correction term to be used to construct short run ECM.

Table 5.5: Estimated ARDL Model for the Infrastructure Investment led Growth Equation (8): 1991 - 2020

Variable	Coefficient	T-Statistic	Prob
RGDP(-1)	0.716304	11.21386	0.0000**
GCFG	0.496958	2.586022	0.0110**
GCFG(-1)	-0.533056	-2.702130	0.0080**
GCFP	0.161428	1.636260	0.1046
GCFP(-1)	-0.185503	-1.879000	0.0628*
C	1.823317	1.692227	0.0934
Model criteria/Goodness of fit			
R-squared	0.546429	Akaike info criterion	4.133180
Adjusted R-squared	0.526360	Schwarz criterion	4.273304
Sum squared resid	392.9121	Durbin-Watson stat	1.800071
F-statistic	27.22682	Prob(F-statistic)	0.000000

Source: Researchers own computations. Note: ***, ** and * denotes 1%, 5% and 10% significance level respectively.

The estimated coefficients of GDP growth (RGDP) and government capital expenditure (GCFG) are statistically significant at 5% level while GDP growth (RGDP) and private capital expenditure (GCFP) are found to be significant at 10% level. Negative relationship can be observed between GDP growth and government capital expenditure as well between GDP growth and private capital expenditure. The adjusted R-squared is 0.55 implying that the model fits well with the data, this value suggest that when the real GDP growth adjust by 55%, this could be explained by the changes in all explanatory variables. Furthermore, there is a 1% significance of the entire model as suggested by the F-statistic probability value of 0.00000, which does not exceed 0.01. the Durbin-Watson statistic value of 1.800 suggests that there is no decision on autocorrelation given that it lies between 1.166 and 1.808. The prospect of spurious regression is ruled out by the circumstance of Durbin-Watson statistic being greater than the coefficient of determination.

Table: 5.6: Long-run estimated coefficients

Variable	Coefficient	T-Statistic	Prob
GCFP	-0.127242	0.310917	0.6831
GCFP	-0.084863	0.147640	0.5666
C	6.426999	3.833261	0.0964

Source: Researchers own computations. Note: ***, ** and * denotes 1%, 5% and 10% significance level respectively.

From Table 5.6, Government capital expenditure and private capital expenditure are found to be statistically insignificant and exhibit a negative relationship with economic

growth. The coefficient of Government capital expenditure recorded a negative of 0.127242 which statistically insignificant and suggest that if government capital expenditure increase to 100% the economic will decline by 12.7242%. Thereby suggesting a cut in government capital expenditure to promote growth.

The coefficient of Private capital investment is negative 0.08486, meaning a 100% increase in private capital expenditure will result in 8.486% decrease in growth. These findings are consistent with a study by Younis (2014), who analysed the significance of Infrastructure Investment on Economic Growth in Pakistan and the study found that the long-run impact of economic infrastructure investment on economic growth is negative. Furthermore, according to Stungwa and Daw (2021), infrastructure was found not be an effective instrument to stimulate economic growth in South Africa.

Table: 5.7: Short-run estimated coefficients

Variable	Coefficient	T-Statistic	Prob
D(GCFP)	0.496958	2.662675	0.0089**
(GCFP)	0.161428	1.697911	0.0923*
CointEq(-1)	-0.283696	-4.616534	0.0000***

Source: Researchers own computations. Note: ***, ** and * denotes 1%, 5% and 10% significance level respectively.

Table 5.7, show the results of the short-run model, the error correction model shows the changes in the variables in the short-run while adjusting to their long-run

equilibrium. In this model all the regressors, namely government capital expenditure and private capital investment have a positive relationship with economic growth. They are also statistically significant, meaning that they play a major role in explaining changes in economic growth. However, Table 5.5 and 5.6 show a conflicting view in that there is no significant long relationship established.

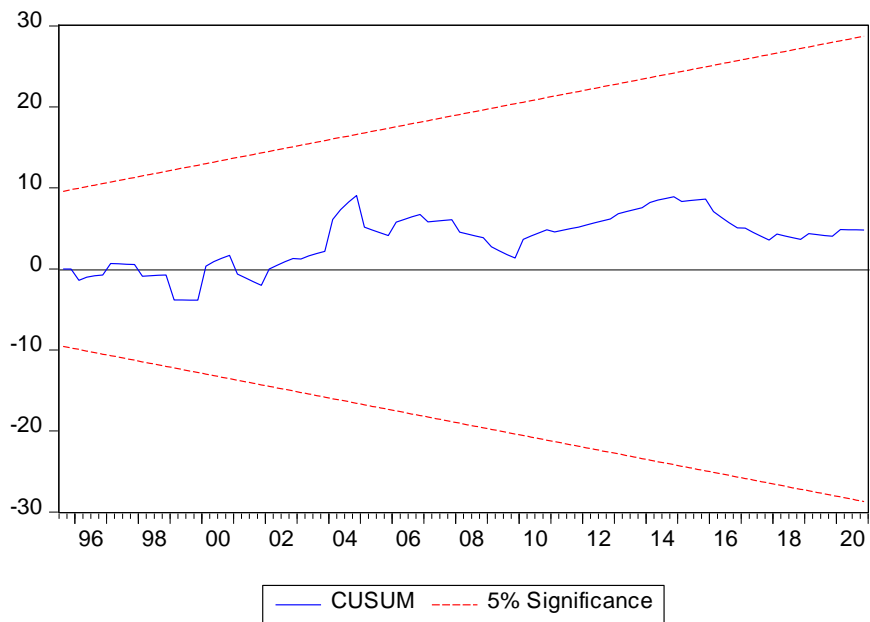
5.2.6 Diagnostics

Before we present our estimated VECM results, it is necessary to begin by analysing the residuals to determine whether the results presented in the next section are efficient and reliable. We undertake the following tests: CUSUM stability, serial correlation test, normality test based on the Jarque-Bera test and heteroscedasticity based on the White heteroscedasticity test. The null hypothesis for these diagnostic tests is that there is no serial correlation, no normality and no heteroscedasticity.

5.2.6.1 Stability Test

The stability test of the ARDL long-run combined with the short run dynamics for the equation was estimated to their stability. In this regard the CUSUM test was performed. The results gave sufficient evidence to reject the null hypothesis of the model not being stable at 5% significance level. The results therefore support the claim that the model is stable since the residuals lie within the dual standard range. The CUSUM test result are presented in Figure 5.1.

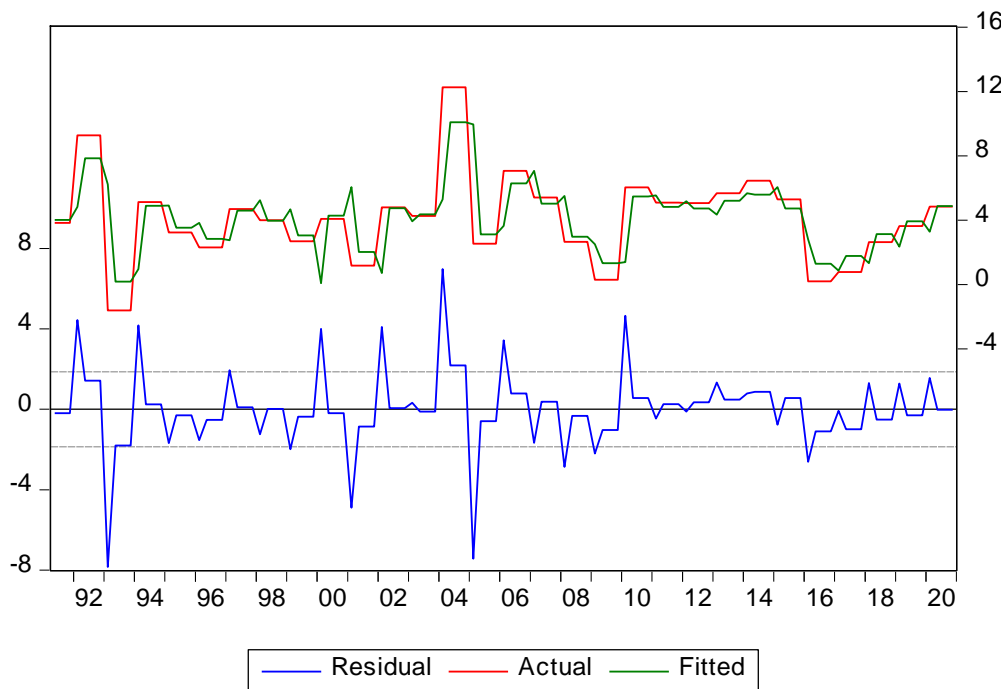
Figure 5.1: Plots of CUSUM



Source: Researchers own computations.

In addition to the stability test of the dynamic model, it is also advisable to examine the fit of the error correction model. This is done by visualising the residual, actual and fitted. The results are displayed in Figure 5.2.

Figure 5.2: Fitter verse Actual graph



Source: Researchers own computations.

5.2.6.2 Serial Correlation Test

Table 5.8, results from correlation test. Correlation of a variable with itself over successive time period is a normal problem face in time series analysis. Serial correlation can lead to the underestimation of standard errors, thereby making the t-values to be overestimated. Based on results results from the correlation test we cannot reject the null hypothesis of no serial correlation in our model. Therefore, there's no omission of an important variable in the model (p-value >0.005).

Table 5.8: Breusch-Godfrey Serial Correlation LM Test:

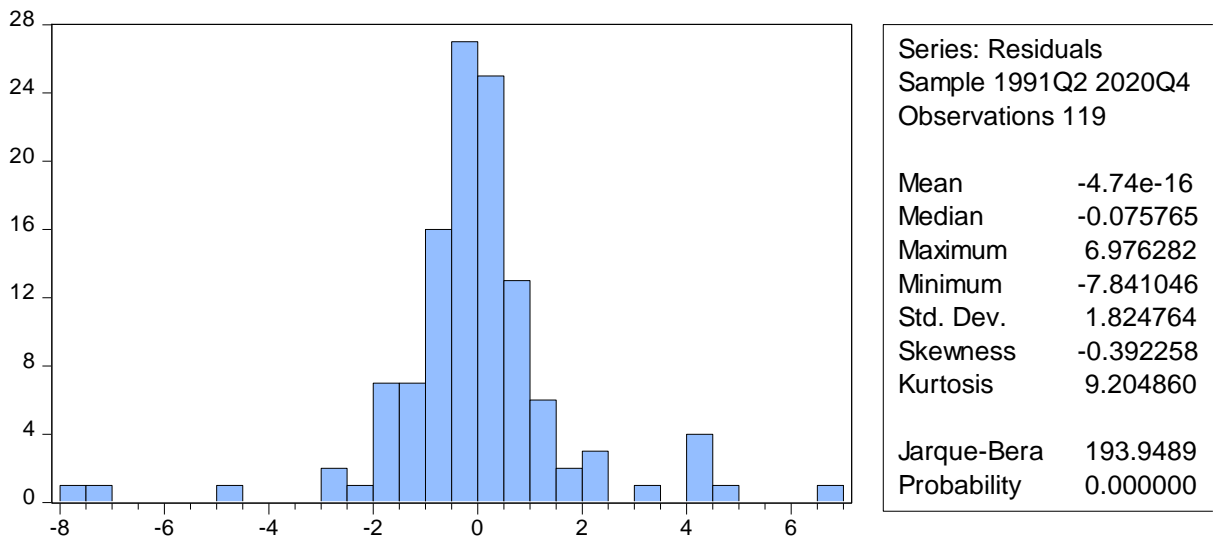
F-statistic	2.076508	Prob. F(2,111)	0.1302	F-statistic
Obs*R-squared	4.291758	Prob.Chi-Square(2)	0.1170	Obs*R-squared

Source: Researchers own computations.

5.2.6.3 Stability Test

The normality test is performed to make sure that the estimated residuals are normal. Models with residuals that are not normally distributed cannot produce efficient estimates. Figure 5.4 based on the Jarque-Bera test show that model is statistically insignificant at 5% level.

Figure 5.3: Normality Test



Source: Researchers own computations.

5.2.7 Vector Error Correction Model

Since there is cointegration as shown in Table 5.4, the direction of causality is tested by using the VECM presented in Table 5.8. The error correction term is negative and statistically significant at 10% significant level, which implies that the measure of government infrastructure development and economic growth are adjusted to their long run equilibrium relationship at an adjustment speed of 41.48%. A percentage change in government capital expenditure is associated with a 0.156083% increase economic growth on average ceteris paribus in the short run while a percentage change in private capital expenditure is associated with a 0.071405% increase in economic growth. The results shows that there is a long run causal relationship between government capital expenditure and economic growth.

Table 5.9: VECM Results

Error			
Correction:	D(RGDP)	D(GCFP)	D(GCFG)
CointEq1	-0.414792	-0.003193	-0.010199
	(0.07534)	(0.07709)	(0.03918)
	[-5.50592]	[-0.04142]	[-0.26032]

D(RGDP(-1))	0.186785	0.000943	0.005180
	(0.09369)	(0.09587)	(0.04872)
	[1.99360]	[0.00983]	[0.10632]
D(RGDP(-2))	0.186785	0.000943	0.005180
	(0.09369)	(0.09587)	(0.04872)
	[1.99360]	[0.00983]	[0.10632]
D(GCFP(-1))	0.071405	0.000253	0.002108
	(0.09919)	(0.10149)	(0.05158)
	[0.71990]	[0.00249]	[0.04088]
D(GCFP(-2))	0.071405	0.000253	0.002108
	(0.09919)	(0.10149)	(0.05158)
	[0.71990]	[0.00249]	[0.04088]
D(GCFG(-1))	0.156083	0.005624	-0.001414
	(0.19855)	(0.20317)	(0.10326)
	[0.78610]	[0.02768]	[-0.01370]
D(GCFG(-2))	0.156083	0.005624	-0.001414
	(0.19855)	(0.20317)	(0.10326)
	[0.78610]	[0.02768]	[-0.01370]
C	0.018458	0.058082	-0.068351

	(0.17507)	(0.17914)	(0.09105)
	[0.10543]	[0.32422]	[-0.75073]

Source: Researchers own computations.

The result are in consistent with empirical findings from Kidake (2018), Herranz-Loncán (2017), Pulei (2015), Younis (2014), Mburu (2013), Kruger (2012), Sohoo et al. (2010) and Seven (2010) suggesting a positive long run relationship between infrastructure development and economic growth.

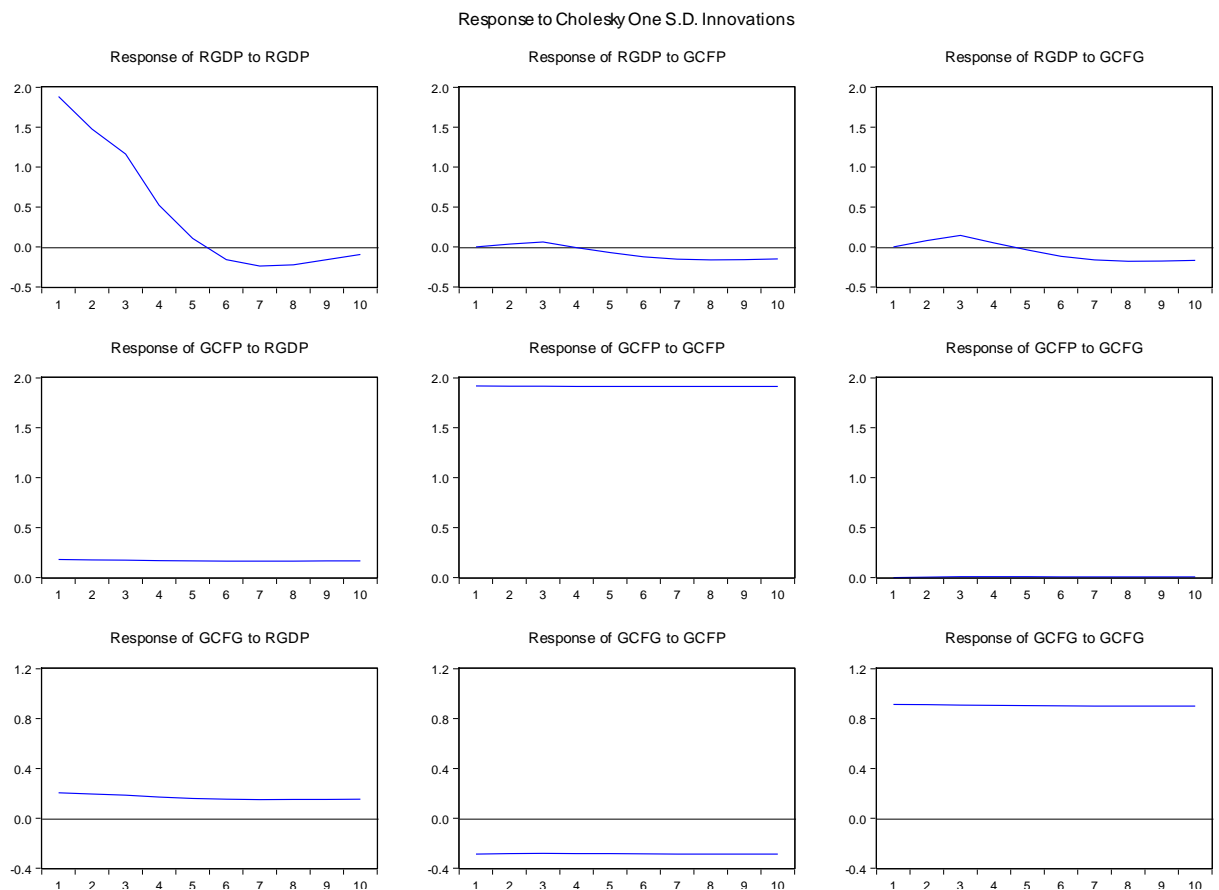
This finding further supports Keynesian hypothesis that states that an increase in government expenditure causes GDP to increase. The possible explanation could be that when government capital expenditure increases, this indicates high spending or an increase investment, improved infrastructure thereby contributing positively to the economy. According to Kumo (2012), increase in investment create more productive capacity, more opportunities for jobs and higher wages resulting in higher income boosting aggregate demand and economic growth.

5.2.8 Impulse response function

The purpose of the impulse responses was to determine the quantitative responsiveness of both current and future values of each of the variables as a result of a one-unit increase in the current value of one of the VAR errors, assuming that this error returns to zero in subsequent periods, and also that all other errors are equal to zero. In other

words, the impulse response function relates to how economic growth reacts to government capital expenditure and private capital expenditure over a given time period. The results of impulse response estimations are presented in Figure 5.4.

Figure 5.4: Impulse response



The interpretation of the generalised impulse response functions provide evidence of what happens to the one variable if you cause a short-run shock to the other. The X-axis shows the percentage change of how much the variable respond while Y-axis shows the time horizon. The generalised impulse response of economic growth to structural innovations in private capital investment shows that economic growth is positive and keeps increasing until 3 quarters. Afterwards it becomes negative and

continue with the downwards trend and does not return to the initial steady state, instead it finds a new equilibrium level. With regard to government capital expenditure, the impulse response function of economic growth to structural innovations in government capital expenditure shows that economic growth continues on a positive upwards for about 4 quarters and then declines.

The generalised impulse response of private capital investment to structural innovation in economic growth shows stability, constant movement and exhibit a positive relationship as presented in Figure 5.4. This also confirms that private capital investment endogenously does not respond to economic growth shocks. On the other hand, government capital expenditure also responded positively though declined until 5 quarters, but on the positive grid, and afterwards finds a new equilibrium level. This also confirms that government capital expenditure responds endogenously to shocks in economic growth.

5.2.9 Structural analyses

Table 5.10: Variance Decomposition of RGDP:

Period	S.E.	RGDP	GCFP	GCFG
1	1.883086	100.0000	0.000000	0.000000
2	2.395159	99.86408	0.021204	0.114714
3	2.667351	99.54632	0.071165	0.382518
4	2.718745	99.52953	0.069594	0.400873

5	2.722010	99.44229	0.137193	0.420517
6	2.731986	99.05038	0.342779	0.606838
7	2.751476	98.40958	0.642679	0.947740
8	2.771047	97.67170	0.973416	1.354885
9	2.785852	96.96500	1.287998	1.747002
10	2.796609	96.33601	1.571090	2.092898

Source: Researchers own computations.

Based on table 5.10, in the short run 100% of forecast error variance in real GDP is explained by real GDP itself and contribution of GCFP and GCFG is strongly exogenous. In the long run the influence of real GDP on itself is dwindling while the influence of GCFP and GCFG are increasing moving into the future exhibiting strong endogenous influence on RGDP.

From table 5.10, RGDP is explaining 0.8712% of the forecast error variance in GCFP and GCFG is explaining 0% of the forecast error in GCFP exhibiting strong exogeneity in the short run. In the long run the influence of GCFP on itself is increasing indicating a strong endogenous influence on itself while the influence of RGDP and GCFG is decreasing.

Table 5.11: Variance Decomposition of GCFP

Period	S.E.	RGDP	GCFP	GCFG
1	1.926853	0.871206	99.12879	0.000000
2	2.723670	0.856642	99.14306	0.000293
3	3.334212	0.844922	99.15413	0.000946
4	3.848615	0.828481	99.17034	0.001176
5	4.301630	0.813546	99.18520	0.001255
6	4.711081	0.801224	99.19750	0.001272
7	5.087610	0.791969	99.20676	0.001270
8	5.438124	0.785312	99.21342	0.001264
9	5.767400	0.780632	99.21811	0.001261
10	6.078898	0.777296	99.22144	0.001262

Source: Researchers own computations.

From Table 5.11, the influence of RGDP on GCFG is 4.34% in short run and this influence is decreasing moving into the long run to 3.056% . The influence of GCFP on GCFG is increasing from short to long run while the influence of GCFG on itself is also increasing.

Table 5.12: Variance Decomposition of GCFG:

Period	S.E.	RGDP	GCFP	GCFG
1	0.979282	4.335719	8.597189	87.06709
2	1.381015	4.154226	8.554680	87.29109
3	1.686716	4.003833	8.514869	87.48130
4	1.942700	3.785451	8.540503	87.67405
5	2.167164	3.583270	8.586720	87.83001
6	2.369395	3.411902	8.639509	87.94859
7	2.555211	3.279106	8.687042	88.03385
8	2.728288	3.180239	8.725727	88.09403
9	2.891104	3.108354	8.755102	88.13654
10	3.045362	3.055743	8.776790	88.16747

Source: Researchers own computations.

5.3 CONCLUSION

The aim of the chapter was to establish the relationship between economic growth and infrastructure development using a proxy of government capital expenditure. The results show that there is a positive short run and long run relationship between the two variables. The next chapter conclude the study and provides policy recommendations.

CHAPTER 6: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 INTRODCUTION

This chapter is organized into five parts: the summary of findings, conclusions of the study, recommendations for policy and areas for future research.

6.2 SUMMARY OF FINDINGS

This study set out to investigate the long run relationship between infrastructure development and economic growth in Namibia using quarterly data from the year 1991 to 2020 in a Vector Error Correction Model (VECM). The study employed secondary obtained from the World Bank development indicators, Namibia Statistics Agency and COMSTAT. The data included the government capital expenditure as a percentage of GDP used as a proxy for infrastructure development, economic growth (Real GDP growth rate) and private capital expenditure as a percentage of GDP. Data analysis techniques tend to give complex results and as such to avoid incidence of spurious regression results, the basic steps involved in analyzing time series data in E-views is implemented. The study applied a ARDL bound test on the different variables employed to examine a long run and short run relationships. VECM test was the last test to establish the direction of the relationship between the variables used.

From regression analysis the results indicate that a stable long-run relationship exists between infrastructure development and economic growth in Namibia. The result

further indicates that there is a positive relationship between government capital expenditure and economic growth. Such findings are supported by both theoretical and practical analysis indicating that government infrastructure investment exerts positive impact on growth.

Empirical work by Du *et al.* (2022), Ziolo (2022), (Vicente, et al., 2022), (Perez-Montiel & Manera, 2021), (Ayub, 2021) (2021), Njiru, Simiyu and Bunde (2020), (Seidu, et al., 2020), (Horvat, 2020), (Unnikrishnan & Kattookaran, 2020), (Mubila & Yepes, 2017) and Palei (2015) all confirm a positive relationship between government infrastructure development and economic growth.

The study concluded that government investment in infrastructure promotes economic growth in Namibia. On the other hand, private capital investment was also found to cause growth in both the short run and long run. Therefore, the conclusion made was that private investment does cause economic growth and this was as a result of crowding in effect arising from government expenditure on infrastructure.

6.3 CONCLUSION

The relationship between the economy and infrastructure is important to promoting inclusive growth and sustainable development. From the study findings and discussion, the study concludes that government investment in infrastructure development affect the level of economic growth in Namibia for the period of this study. Infrastructure development supports different kinds of economic activity as an input into production and advances the marginal product of other capital used in the production process. The study concludes that infrastructure development promotes

economic growth while infrastructure development crowd's in private investment. Therefore, such finding bear strong argument to encourage the governments to spend more of their annual budgets on the infrastructure development.

6.4 RECOMMENDATIONS

The study recommends the following:

1. There is more potential for infrastructure (economic and social) to be an enabler for the economic growth rate in Namibia. Therefore, the government needs to increase infrastructure funding to at least between 7 and 9% of GDP as recommended by World Bank (Njiru, Simiyu, and Bunde., 2020). This will enhance productivity as a result of increased physical and human capital thereby leading to high economic growth.
2. Embezzlement of government funds allocated to infrastructure development needs to be restrained by close up any loopholes identified and conducting regular monitoring and evaluation on their use.
3. The government should ensure that its infrastructure spending is complementary to the private sector investment as this will raise marginal capital of private sector and also increase investment in form of direct productive activities as private investors will be motivated to invest thus raising economic growth.
4. Given government budget constraint emphasis should also be given on developing public-private partnerships (PPPs) and encourage joint-venture

project development between international firms to attract FDI inflow and local enterprises for infrastructure development.

5. There should be established Initiative focusing on the political championing and sponsoring of specific infrastructure projects with potential impact on economic integration. This high level initiative should focus on sponsoring infrastructure projects, through political leadership and championing. Government leaders should be motivated by the common interest to promote a Namibian led and owned development agenda, pursue a value-driven partnership premised on selected sector priorities with infrastructure as a core target.
6. The government should establish a clear strategy for the reform of the sector, based on structuring profitable investments opportunities. Regulations should be refocused on providing an enabling environment that serves to contain risk.

6.5 AREAS FOR FURTHER RESEARCH

The study proposes that future research be conducted, to separately investigate the effect of private sector investment in infrastructure development on the level of economic growth in Namibia due to the fact that private sector investment operate from different strategic and financial foothold from the public sector. Another study will be required to understand the effect of government capital/infrastructure investment on private capital expenditure in understanding the role of public investment on private capital investment. This study focused on the secondary data only. Economic growth is also affected by non-empirical factors found in the country

where the investment is taking place and therefore there is need to support the conclusions of this research using a qualitative approach to study current behavioural issues affecting infrastructural investment and economic growth such as governance and leadership. Another research should be conducted to understand the effect of social infrastructure development such as human resource on economic development because physical infrastructure can only enhance the economic growth given that there is a sustainable social infrastructure.

References

- Abur, W., 2019. *A New Life with Opportunities and Challenges: The settlement experiences of South Sudanese-Australians*, s.l.: Africa World Books Pty Ltd .
- Agenor, P.-R. & Moreno-Dodson, B., 2006. *Public Infrastructure and Growth: New Channels and Policy Implications*, Washington DC: SSRN Electronic Journal .
- Ahmad, N. & Du, L., 2017. Effects of energy production and CO 2 emissions on economic growth in Iran: ARDL approach. *Energy*, 123, Volume 123, pp. 521-537.
- Anon., n.d. Younis, F. (2016). Significance of Infrastructure Investment on Economic Growth. Munich Personal RePEc Archive (MPRA), 72659..
- Aschauer, D. A., 1989. *Why is Infrastructure Important?* , Chicago : Federal Reserve Bank of Chicago .
- Ayub, M., 2021. Infrastructural Investments and economic growth: Evidence from Pakistan. *Journal of Business and Social Review in Emerging Economies*, 7(3).
- Baporika, N., 2016. Infrastructure Development as a Catalyst for Social-Economic Advancement. 5 (4),. *International Journal of System Dynamics Applications*., 5(4), pp. 101 -113.
- Barro, R., 1990. Government Spending in a Simple Model of Endogenous Growth. *The Journal of Political Economy*, 98(5), p. 103–125.
- Bobek, V. V., Moritz, J. J. & Horvat, T. T., 2019. *Namibia's Triple Challenge and Its Economic Development*. 2nd ed. s.l.:IntechOpen.

- Calderon, C. & Serven, L., 2010. Infrastructure and Economic Development in Sub Saharan Africa.. *Journal of African Economies*, 1(19), pp. i13-i87.
- Comission, N. P., 2012. *Namibia's Fourth National Development Plan*, Windhoek: National Planning Comission.
- Comission, N. P., 2017. Windhoek: National Planning Comission.
- Cooke, B. & Kothari, U., 2001. *Participation: The New Tyranny*, London : Zed Books .
- Daido, K. & Tabata, K., 2013. *Public infrastructure, production organization, and economic development* , Hyogo: Journal of Macroeconomics .
- Datta, P. & Mbarika, V., 2006. A Global Investigation of Granger Causality between Information Infrastructure Investment and Service-Sector Growth. *The Information Society*, 22(3), pp. 149-163..
- Du, X., Zhang, H. & Han, Y., 2022. “How does new infrastructure investment affect economic growth quality? empirical evidence from China,”. [Online] Available at: <https://doi.org/10.3390/su14063511>. [Accessed 25 September 2021].
- Emecheta, B. & Ibe, R., 2014. Impact of bank credit on economic growth in Nigeria. *European Journal of Accounting Auditing and Finance Research*, 2(9), pp. 11-21.
- Estache, A. & Limi, A., 2010. Bidder Asymmetry In Infrastructure Procurement: Are There Any Fringe Bidders?. *Review of Industrial Organization*, 36(2), pp. 163-187.
- Foresti, P., 2007. *Testing for Granger Causality between stock prices and economic growth*, s.l.: MRPA Paper, 2962.

Fossati, A., 2004. Morals and Public Economics: The Case for Justice and Equality. *SSRN Electronic Journal* .

Government of the Republic of Namibia, 2021. *Harambee Prosperity Plan II 2021-2025. Action Plan of the Namibian Government Towards Economic Recovery and Inclusive Growth*, Windhoek: s.n.

Granger, C., 1969. Investigating Causal Relations by Econometric Models and Cross Spectral Methods. *Econometrica* , 37(3), pp. 424-438.

Granger, C., 1980. Testing for Causality: A Personal Viewpoint. *Journal of Economic Dynamics and Control* , 2(4), pp. 329-352.

Gujarati, D. N., 2013. *Basic econometrics*. New York: McGraw-Hill Inc. New York: McGraw-Hill Inc.

Harris, R. & Sollis, R., 2003. Applied Time Series Modelling and Forecasting, 2nd Edition. In: *Applied Time Series Modelling and Forecasting, 2nd Edition*. West Sussex : John Wileys and Sons Ltd, pp. 34-37.

Herranz-Loncán, A., 2007. Infrastructure investment and Spanish economic growth, 1850-1935. *Explorations in Economic History*, 44(3), pp. 452-468.

Horvat, T. e. a., 2020. Impacts of investments in infrastructure projects on emerging markets' growth: The case of East African countries. 34(1).. *Economic Research-Ekonomska Istraživanja*,, 34(1).

Johansen, S., 1988. Statistical analysis of cointegration vectors.. *Journal of Economic Dynamics and Control*, Volume 12, p. 231–254.

- Kandenge, F., 2011. Public and Private Investment and Economic Growth in Namibia (1970-2005).. *Botswana Journal of Economics*, 7(11).
- Kandenge, F., 2011. Public and Private Investment and Economic Growth in Namibia (1970-2005).. *Botswana Journal of Economics*, 7(11).
- Kodongo, O. & Ojah, K., 2016. Does infrastructure really explain economic growth in Sub Saharan Africa?.. *Review of Development Finance*, 6(2), pp. 105-125.
- Kruger, N. A., 2012. *Does Infrastructure Really Cause Growth?* , Stockholm : Centre for Transport Studies .
- Kularatne, C., 2006. *Social and Economic Infrastructure Impacts on Economic Growth in South Africa*.. Cape Town, University of Cape Town School of Economics.
- Kumo, W., 2012. *Infrastructure Investment And Economic Growth In South Africa: A Granger Causality Analysis*, Pretoria: Africa Development Bank.
- Mbulawa, S., 2017. The Impact Of Economic Infrastructure On Long Term Economic Growth In Botswana.. *Journal of Smart Economic Growth*., 2(1), pp. 15-33.
- Mburu, J. M., 2013. *Relationship between Government Investment in Infrastructure and Economic Growth in Kenya*., Nairobi: University of Nairobi,.
- Mubila, M. & Yepes, T., 2017. *Infrastructure and rural productivity in Africa*., Bristol : Bristol University Press .
- Namibia, B. o., 2014. *Financing of Infrastructure for Sustainable Development in Namibia*. Windhoek, The Research Department of the Bank of Namibia.

- Njiru, E., Simiyu, J. & Bunde, A., 2020. Effect of Government Infrastructure Investment on Economic Growth in Kenya.. *Journal of Economics and Sustainable Development*, 11(4), pp. 77-86.
- O'Fallon, C., 2003. *Linkages between infrastructure and economic growth*, Wellington : Ministry of Economic Development, Pinnacle Research .
- O'Fallon, C. D., 2003. *LINKAGES BETWEEN INFRASTRUCTURE AND ECONOMIC GROWTH*, Wellington : Pinnacle Research .
- Oriakhi, D. & Arodove, L., 2013. The Government Size – Economic Growth Relationship: Nigerian Econometric Evidence Using a Vector Autoregression Model. *International Journal of Business and Management*, 8(10).
- Palei, T., 2015. Assessing the Impact of Infrastructure on Economic Growth and Global Competitiveness.. *Procedia Economics and Finance*, Volume 23, pp. 168-175.
- Perez-Montiel, J. & Manera, C., 2021. *Government Public Infrastructure Investment and Economic Performance in Spain (1980–2016)*. *Applied Economic Analysis*, 30(90). [Online]
Available at: <https://doi.org/10.1108/aea-03-2021-0077>.
[Accessed 18 June 2021].
- Perkins, P., Fedderke, J. & Luiz, J., 2005. An analysis of economic infrastructure investment in South Africa. *The South African Journal of Economics*, 73(2), pp. 211-228.
- Raboloko, M., 2019. The Impact of Infrastructure on Economic Growth in Botswana. *Botswana Institute for Development Policy Analysis*, Volume 66, p. 23.

Reuters, 2018. *Namibia drops into recession as construction, retail slump*. [Online]

Available at: <https://www.reuters.com/article/namibia-gdp-idUSL8N1RB2FO>

[Accessed 13 July 2018].

Sahoo, P., Dash , R. & Nataraj, G., 2010. Infrastructure Development and Economic Growth in China. *IDE Discussion Paper*, Volume 261, pp. 1-16.

Schade, K., 2000. *Namibia: A Decade of Independence*, Windhoek : NEPRU .

Seidu, R. D., Young, B. & Robinson, H. M. R., 2020. The impact of infrastructure investment on economic growth in the United Kingdom. *Journal of Infrastructure, Policy and Development*, 4(2), p. 217.

Sheehama, J. K., 2022. *Infrastructure Connects People to People, People to Commerce and Commerce to Markets*, Windhoek : The Economist .

Sherbourne, R., 2012. *Guide to the Namibian Economy 2013/14*, Windhoek : John Meinert Printing .

Srinivasu, B. & Rao, P., 2013. Infrastructure Development and Economic Growth: Prospects and Perspective. *Journal of Business Management and Social Sciences Research (JBM & SSR)*, 2(1), pp. 2319-5614.

Straub, S. & Terada-Hagiwara, 2010. *Infrastructure and Growth in Developing Asia*, Manila : Asian Development Bank .

Stungwa, S. & Daw, O., 2021. *Infrastructure development and population growth on economic growth in South Africa*, Potchefstroom : North West University .

Sunde, T., 2018. The interaction of energy consumption and economic growth in South Africa: assessment from the bounds testing approach. *International Journal of Sustainable Economy*, 10(2), p. 170.

The World Bank, 2022. *The World Bank in Namibia*. [Online]

Available at:

[https://www.worldbank.org/en/country/namibia/overview#:~:text=Real%20gross%20omestic%20product%20\(GDP,and%202.4%20percent%20in%202022.](https://www.worldbank.org/en/country/namibia/overview#:~:text=Real%20gross%20omestic%20product%20(GDP,and%202.4%20percent%20in%202022.)

[Accessed 12 July 2022].

UNDP, 2008. *International Human Development Indicators: Namibia*. [Online]

Available at: <http://hdrstats.undp.org/en/countries/profile/NAM.html>

[Accessed 22 November 2021].

UNDP, 2021. *SDG investor map report for Namibia*, Windhoek : UNDP.

Unnikrishnan, N. & Kattookaran, T., 2020. Impact of public and private infrastructure investment on economic growth: Evidence from India. *Journal of Infrastructure Development*, 2(12).

Vicente, C. J., Savard, L. & Ataides de Freitas, C., 2022. Economic impacts of infrastructure investment with different funding mechanisms: Evidence from Guinea-Bissau. *Cogent Economics & Finance*, 10(1).

Vukeya, V., 2015. *The impact of Infrastructure Investment on Economic Growth in South Africa*, Richards Bay : University of Zululand .