UNIVERSITY OF KWAZULU-NATAL

Transport systems' preparedness towards a regional logistics hub in Namibia

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DECLARATION

I, **Gloria Tshoopara** declare that:

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ABSTRACT

Ports are vital to the Southern African Development Community's regional supply chain and Namibia's economic development. Deficiencies in the country's transportation systems have impeded the realisation of its vision of becoming a regional logistics hub. Integrating smart mobility frameworks is crucial to enhance Namibian transport systems' preparedness for a regional logistics hub. These hubs are centralised structures where service providers collaborate and share assets to offer value-added services. Transport systems' preparedness evaluates existing infrastructure, capabilities, and resources for efficient regional logistics operations. This study aimed to ascertain the challenges inhibiting regional logistics hubs and transport systems' key performance indicators in facilitating such a hub. Its objectives were to identify the challenges inhibiting the regional logistics hub in Namibia; analyse the extent of transport systems' connectivity, accessibility, and centrality in facilitating a regional logistics hub; evaluate the transport systems' key performance indicators in facilitating a regional logistics hub in Namibia; and develop a transport demand management framework for a regional logistics hub.

A star-like network analysis with hub-and-spoke was employed to conceptualise a framework that suggested network links radiating from a central node to connect transportation networks. A combination of qualitative methods (interviews), quantitative data (a questionnaire), and document analysis was used to gather and analyse data. Drawing on Cochran's formula, the sample size was 384 for the quantitative approach, while saturation was reached after interviews with 12 participants in the qualitative leg. Inferential statistics assisted in determining correlations between the study variables and thematic analysis was used to uncover key themes in the qualitative data. The researcher developed a freight transport demand management framework (LOC TRUCK) by combining primary data and input from the reviewed documents. The study's key finding was that the Namibian transport system is under-prepared to facilitate a regional logistics hub, demonstrated by inadequate railway infrastructure, low levels of inter-modality, funding and investment, extensive long-distance travel, and incompatible transport systems within the region to promote a well-connected and accessible transport system. The results have financial and managerial implications for decision-makers regarding the strategic direction of the regional logistics hub, especially in terms of transport systems' infrastructural development.

Keywords: Logistics hubs, Transport systems, Demand Management, Key Performance Indicators, Accessibility, Centrality, Connectivity

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Hebrews 11:1 "Now faith is the assurance of things hoped for, the conviction of things not seen."

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DEDICATION

I dedicate this dissertation work to my late mother, Ms Metha Uushona, who succumbed to COVID-19 on 10 July 2021. This achievement is for you, my dearest queen, my pillar of strength; your constant love and support are appreciated.

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LIST OF ABBREVIATIONS

AfCFTA	African Continental Free Trade Area
AfDB	African Development Bank
ArcMap	Aeronautical Reconnaissance Coverage MAP
ATT	Average Travel Time
CEO	Chief Executive Officer
CFA	Confirmatory factor analysis
CMA	Common Monetary Area
COMESA	Common Market for Eastern and Southern Africa
COVID	Corona Virus Disease
CPS	Cyber-Physical System
CSV	Comma-Separated Values
DRC	Democratic Republic of the Congo
ERP	Enterprise Resource Planning
EU-EPA	European Union - Economic Partnership Agreements
FTMDS	Freight Transport Demand Management
GDP	Gross Domestic Product
GOB	Gobabis
GPS	Global Positioning System
GRO	Grootfontein
HGVs	Heavy Goods Vehicles
HKA	Hosea Kutako Airport
Hr	Hour
HR	Human Resources
IATA	International Air Transport Association
ICT	Information and Communication Technology
IFC	International Financial Cooperation
IT	Information Technology

IMO	International Maritime Organization
IoT	Internet of Things
JICA	Japan International Cooperation Agency
KAR	Karibib
KEET	Keetmans
KET	Keetmanshoop
Km/Hr	Kilometres per Hour
KMO	Kaiser-Meyer-Olkin
KPIs	Key Performance Indicators
LIV	Livingston
LOC	Leevi Ogwandje Cordel
LOS	Level of Service
LPI	Logistics Performance Index
LSD	Least Significant Difference test
LUD	Luderitz
MAR	Mariental
MPH	Miles per Hour
MSTEAMS	Microsoft Teams
NAD	Namibian Dollar
Namport	Namibian Ports Authority
NOOR	Noordoewer
OECD	Organization for Economic Cooperation and Development
OKA	Okahandja
ONG	Ongwediva
OPU	Opuwo
OSH	Oshakati
OTA	Otavi
OTJ	Otjiwarongo

PPP	Public Private Partnership
RA	Roads Authority
RFID	Radio Frequency Identification
RMA	Rand Monetary Area
RUC	Road User Charges
RUN	Rundu
SACU	Southern African Customs Union
SADC	Southern African Development Community
SHE	Shesheke
SMEs	Small and Medium Enterprises
SWA	Swakopmund
TEU	Twenty-foot Equivalent Unit
TDM	Transport Demand Management
TransNamib	Rail Transport of Namibia
TWB	The World Bank
UAE	United Arab Emirates
UN	United Nations
USA	United States of America
WB	Walvis Bay
WBNLDC	Walvis Bay-Ndola-Lubumbashi Development Corridor
WCO	World Customs Council
WHO	World Health Organisation
WHK	Windhoek
Wi-Fi	Wireless Fiber
WTO	World Trade Organization

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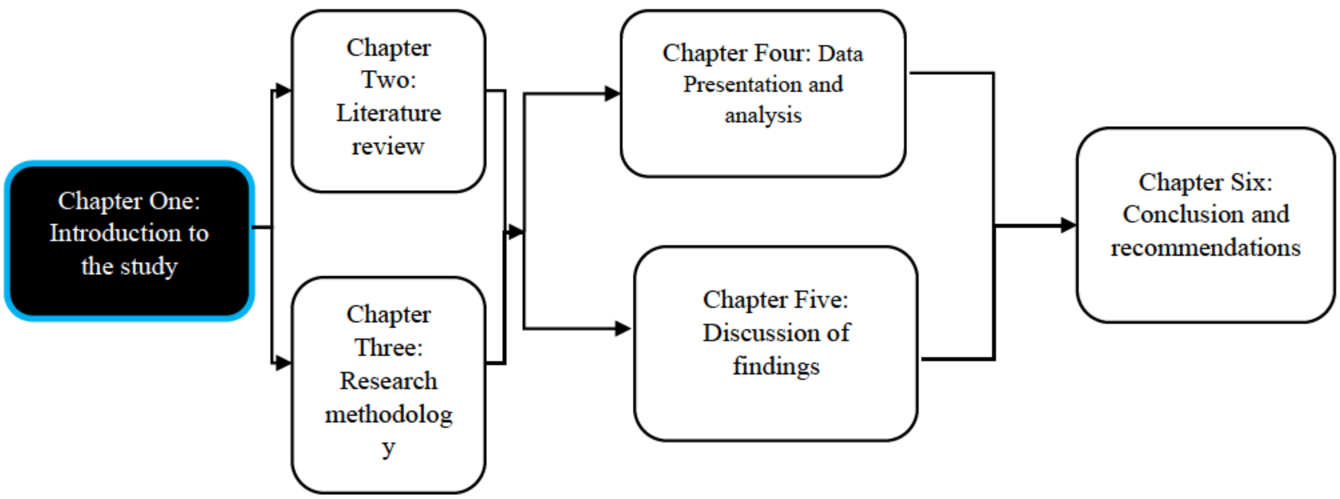
CHAPTER ONE:

INTRODUCTION TO THE STUDY

"There can be no doubt that the transportation sector is the most critical sector of our economy." ~ Robert Brady

1.1 Introduction

Chapter one covers the background of the study, the problem statement, research objectives and the research questions, which provide the thrust of the study. The theoretical and conceptual framework employed is also presented to identify the study variables. Lastly, the chapter discusses the study's significance, justification, limitations, and structure.



The world has become one big village, and no country is an island; thus, global markets are intertwined (Chen & Wu, 2017). Consequently, global markets significantly influence port operations. Ports are a crucial part of the global supply chain, with each port serving a broad hinterland that connects to several nations as a vital tool for trade facilitation (Yang, He, Zhu, & Notteboom, 2020). They also serve as a conduit for international trade and a vital link between sea and land transport. In general, nodes and infrastructural facilities that link places in logistics networks are referred to as logistics hubs (Akhavan, Ghiara, Mariotti, & Sillig, 2020). Logistics hubs that are resourceful and well-connected, with regular, dependable shipping services, are critical to lower trade costs, including transportation costs, connect supply chains, and enable global trade (Humphreys, Stokenberga, Dappe, & Hartmann, 2019). Therefore, manufacturers, retailers, and distributors involved in the export and import of containerised products rely on efficient seaport operations and transport systems (Cariou & Notteboom, 2022). The significance of transportation networks and hubs lies in the need to facilitate the flow of products from the point of production to the point of final consumption (Topolšek, Čižiūnienė, & Ojsteršek, 2018). Hence, transport systems link the manufacturing and consumer markets (Chen & Wu, 2017). Accordingly, the success of the manufacturing and consumption markets is highly reliant on the transportation system. Rodrigue and Notteboom (2020) posit that when transportation systems are inadequate in relation to availability, connectedness, capacity or dependability, this increases economic opportunity costs or missed opportunities. The African transport system is criticised for being inadequate, compromising its competitiveness (Kett, Cole & Turner, 2020; Mouhamed, & Qiu, 2020; Brussel, Zuidgeest, Pfeffer, & van Maarseveen 2019). Furthermore, Zimmermann and Haase (2017) state that most African countries do not cooperate to develop transportation infrastructure; hence, Mozambique, Namibia, Angola and South Africa are positioning themselves as Southern African Development Community (SADC) regional hubs (AfDB, 2019) with no evidence of synergy in their efforts. Furthermore, the poor level of intra-Africa trade, which stands at 12% (Hollington, 2021, pp. 47-59), points to the inadequacy of African transportation systems.

This study examined transport systems' preparedness for a regional logistics hub from a Namibian perspective. It investigated transport systems' connectedness, centrality, and accessibility from an integrated regional perspective, as opposed to a silo standpoint. Liu, Wang, Xie, Mu, and Lim (2021) note that seaports linked to road and rail infrastructure facilitate 80% of global trade. However, due to the fact that significant investment is required for railway networks and rolling stock, most African countries prioritise capital investment in roads over rail transport (Oumarou, 2015). Namibia is no exception. Although the quality of its road infrastructure has been rated the best in Africa for the past five consecutive years, surpassing economic giants such as China, India, Italy and South Africa (WEF, 2019), its transport system still relies heavily on road infrastructure. While there has been recent investment in the development of port and road infrastructure, there is no parallel growth in the other components of the transport system. It is against this background that this study aimed to determine the interdependencies of the components of this system to render them connected, accessible and central to critical markets.

1.2 Background of the Study

This study focused on demonstrating the need for Namibia to boost its transport systems towards becoming a logistics hub that meets regional and global standards. Africa is home to more than a billion people living in 54 countries, and is bigger than the United States of America (USA), Europe, China, and India combined (Achour, Bader, Shelleman, Thomas, Unnikrishnan, & Wilburn, 2015). Thus, African logistics has great potential to build tomorrow's markets (Ruske & Kauschke, 2013) and become an active player in global supply chains (Nicita, Ognivtsev, Shirotori, & Miho, 2013). However, while the continent offers tremendous opportunities, it is challenged by the lack of access to affordable and reliable transport systems that are crucial for global trade (Selko, 2015). An efficient transportation network is vital for global supply chains and economic growth (Closs & Bolumole 2015). Global competition has created geographical fragmentation of supply chain activities, resulting in a flow-concentration of trade at regional logistics hubs (Bolumole, Closs, & Rodammer, 2015). Dos Santos, Vieira and Luna (2016, p. 11) define logistics hubs as "large-scale structures within which different logistics service providers collaborate to offer value-added services by sharing assets." Developing effective logistics hubs requires the integration of all supply chain network partners, including ports. Through its west coast route, Namibia is strategically located to provide a gateway to Southern Africa (Angola, Botswana, Lesotho, Mozambique, Namibia, South Africa, Swaziland, Zambia, and Zimbabwe) (Savage, 2014). Optimal location of its logistics hub could thus reduce transportation costs, promoting supply chain synchronisation (Savage, 2014).

Namibia envisages becoming the international logistics hub for SADC (Savage, 2014); however, such hubs require the balanced development of transportation systems to achieve significant overall benefits (dos Santos Vieira & Luna, 2016). Namibia's Vision 2030 outlined in National Development Plan Four (NDP4), combined with extensive port expansion (Republic of Namibia, 2017), calls for a re-evaluation of the impact of transportation systems. In the past 20 years, the Namibian government has invested in developing transport infrastructure (roads, rail, maritime and ports, and aviation) to meet national and regional demands and position the country as a logistics hub for SADC (Republic of Namibia, 2017). Accordingly, the government expanded the Walvis Bay Port, connecting global markets and linking its corridors to Angola, the Democratic Republic of the Congo (DRC), Zambia, Zimbabwe, Botswana, Malawi, and South Africa (Walvis

Bay Corridor Group (WBCG), 2019). Walvis Bay's port is strategically located to accelerate the SADC region's economic growth, offering a gateway to Southern Africa. Namibia launched the port expansion project in 2008 in line with Vision 2030 (Namport, 2019) and its container handling capacity has trebled to 1 005 000 Twenty-Foot Equivalent Units (TEUs) per annum (Namport, 2019). This enabled it to accommodate the largest ship ever to anchor in Namibian waters, the 335-meter Maersk Sheerness, with a loading capacity of 9 000 TEUs, in 2020 (Hartman, 2020).

However, expansion of the port infrastructure and increased volumes were not accompanied by the growth of other supporting transportation systems. The Namibian transport system is challenged by under-investment in core infrastructure and it utilises an old, dilapidated rail network and suffers from a deferred road maintenance plan (Zietsman, Ramani, & Kenney, 2014). The transportation industry is also highly reliant on imported electricity and has inadequate Information and Communication Technology (ICT) infrastructure (Zietsman et al., 2014). Namibia's low population density (World Bank, 2019) also presents challenges in achieving transport economies of scale. This research study aimed to determine the transport systems' preparedness to facilitate a regional logistics hub. In developing the conceptual framework, three variables, namely, connectivity, accessibility, and centrality were identified. To achieve the research objectives, a theoretical framework was adopted for each identified factor. The network analysis theory was employed to examine the connectivity variable, while accessibility was investigated using stakeholder theory, and the Hub and Spoke theory was used for the centrality variable. The relationship between the variables points to the transport systems' preparedness towards a regional logistics hub in Namibia.

As Dubai's success demonstrates, Namibia's aspiration to become the logistics hub of the SADC region is not implausible. Dubai's greatest strength is its strategic location at the crossroads of major shipping routes connecting the Indian Ocean to the Atlantic Ocean on one side and the Pacific Ocean on the other, while Namibia has the advantage of being geographically located on the south-western coast of Africa, with proximity to major international markets, making it the region's best candidate for a logistics hub, with access to the rest of the world. Like Namibia, Dubai has an exceptional seaport and road network. To become a logistics hub, Namibia may need to enhance the efficacy of its telecommunications network, provide extensive ICT capabilities, and produce a better trained and disciplined workforce. Dubai invested in the same areas. The UAE aspires to become a world-class logistics hub that not only serves the region, but also the Indian subcontinent and acts as a transit point for commodities destined for Europe from China and East Asia (Akhavan, 2017). As a logistics hub for the landlocked nations of the SADC region, Namibia envisages gaining a stronger competitive advantage. Furthermore, in 2005, the transport and communication sector played a pivotal role in the UAE's economy, making a substantial contribution to gross domestic product (GDP) and providing employment opportunities to a significant proportion of the workforce (Economic Planning Division, 2019). Namibia also needs to establish the envisioned logistics hub in order to stimulate economic growth and create new jobs. Similar to Dubai, it may experience the growth of physical infrastructure, expansion of financial markets, and the upgrading of its corporate governance system. In addition, increased emphasis on logistics-related education and research will alter the logistics landscape and expedite the development and eventual viability of the envisioned logistics hub. Similar to Dubai, efforts should be directed to human resources and maintaining a regulatory regime that is business-friendly.

1.3 Research Problem Statement

The Walvis Bay port is strategically located, with deep water and stable weather conditions, to stimulate the SADC region's economic growth by being a gateway to Southern Africa. The gateway will provide the shortest regional route on the west coast, resulting in cost and time savings along the Walvis Bay corridors (Japan International Cooperation Agency (JICA), 2015). Through its Vision 2030, Namibia envisages becoming the SADC regional logistics hub. In line with this vision, it launched a port expansion project in 2008 on 40 hectares of reclaimed offshore land (Namport, 2019). The Walvis Bay port expansion was completed in 2019, tripling the port's container handling capacity from 355 000 TEUs to 1 005 000 TEUs per annum (Namport, 2019).

In April 2020, the Namibian Ports Authority received the largest vessel to ever dock in Namibian waters, the 335-meter Maersk Sheerness, with a loading capacity of 9 000 TEUs (Hartman, 2020). Shipping industry trends have resulted in increased demand for larger vessels (Prokopowicz & Berg-Andreassen, 2016). However, Namibia's vision of becoming the regional logistics hub requires more than increased port capacity and a strategic location; such hubs need logistics infrastructure coupled with interconnectivity and accessibility of transport systems (Gonen, 2019).

This study is justified by observing a discrepancy between the expansion of port infrastructure and the insufficient investment in supporting transportation systems, such as rail and road infrastructure, in Namibia's vision of becoming a regional logistics hub. The study aims to address this gap by examining the transport systems' preparedness to facilitate the efficient functioning of the logistics hub. Additionally, there is a lack of research on the implications of increased port capacity on transportation systems within the SADC region, making this study unique in its focus on the broader context. By analysing key variables such as connectivity, accessibility, and centrality, the study seeks to contribute valuable insights into developing a fully functional and integrated transport system for the regional logistics hub. The Namibian transport system is challenged by under-investment in core infrastructure and it uses an old, dilapidated rail network, with the road maintenance plan having been deferred (Zietsman, Ramani, & Kenney, 2014). The transportation industry also relies heavily on imported electricity and its ICT infrastructure is inadequate (Zietsman et al., 2014). Namibia's low population density of three people per km^2 (The World Bank, 2019) also presents challenges in achieving transport economies of scale for freight distribution and infrastructure sustainability.

The incompatibility of infrastructure, regulations, and policies within the SADC region hampers regional integration, as there is a lack of harmonised regional strategies to sustain a safe, secure, and reliable transport system (SADC, 2012). Thus, for SADC to attain robust regional integration, the envisaged logistics hub needs an efficient transport system to facilitate trade and socio-economic interconnections (Chigombe, 2014). The Walvis Bay logistics hub calls for an integrated and sustainable multimodal transport system throughout Southern Africa.

Researchers have focused on the logistics hub's development and its benefits for the economy (Savage, Fransman, Jenkins, & Bamford, 2014; Savage, 2014; Savage & Fransman, 2014). However, few (dos Santos Vieira & Luna, 2016; Oonk, 2016) have considered the implications of the port's increased capacity for the region's transportation systems, excluding the SADC context. This research study investigated the transport systems' preparedness to facilitate a regional logistics hub in Namibia. The envisaged hub calls for an integrated and fully functional transport system. Hence, three key integrated transport system variables were identified to map the transport flow, namely, connectivity, accessibility, and centrality.

1.4 Research Objectives

Main research objective:

To assess the preparedness of transport systems in Namibia for facilitating the establishment of a regional logistics hub.

The research objectives were to:

1. Identify the challenges inhibiting the establishment of a regional logistics hub in Namibia;
2. Analyse the extent of the connectivity, accessibility, and centrality of transport networks in facilitating a regional logistics hub;
3. Evaluate the Key Performance Indicators (KPIs) of the transport system in facilitating a regional logistics hub in Namibia; and
4. Develop a transport demand management (TDM) framework for a regional logistics hub.

1.5 Research Questions

Main research question:

What is the current level of preparedness of transport systems in Namibia to support the development and operation of a regional logistics hub?

The study's objectives were met by addressing the following research questions:

1. What are the challenges inhibiting the Namibian regional logistics hub?
2. To what extent do transport networks' connectivity, accessibility, and centrality facilitate the Namibian regional logistics hub?
3. What are the Key Performance Indicators (KPIs) of the transport system in facilitating a regional logistics hub in Namibia?
4. What TDM variables need to be considered when developing a framework that supports a regional logistics hub?

1.6 Theoretical Framework

The network analysis theory was the main theoretical framework that underpinned this study. It was used to analyse the degree of transport infrastructural connectivity, accessibility, and centrality within the international logistics discourse.

Network analysis refers to the "interconnectivity or linkage of a set of components of a system into a complete whole to produce a spatial and structured pattern. The network may be either a static feature at a point in time or a dynamic phenomenon which is subjected to change through time" (Abbas & Hashidu, 2019, p.61). This theory is widely used to analyse social structures that emerge from the recurrence of multiple actors' relations. It has been applied in the Information Technology (IT) field (Giuditta De & Nepelski, 2013; Simiraglia, 2015) and the transport industry to study transport system geography (Cats, Koppenol, & Warnier, 2017; Madigan, et al., 2019; Rodrigue, 2020). For the purposes of this research, the network analysis theory was used to examine connectivity variables within the context of transport systems in a logistics hub.

The Hub-and-Spoke theory was employed as a subsidiary theory to support the network analysis theory. "Hub-and-spoke, as a network structure, allows for greater flexibility within the transport system through a concentration of flows" (Rodrigue, 2020, p. 263). It is not intended to be used through one supply chain, but across a broader distribution network. As a result, hub-and-spoke topologies have been adopted in various industries (dos Santos Vieira & Luna, 2016).

The stakeholder theory defines a stakeholder as any individual or community that may influence a business enterprise or is influenced by it (Bhasin, 2018). This theory was applied to understand how businesses and individuals build shared interests in exchange for goods and services.

The systems theory regards an organisation as an organism made up of sub-systems that must work in synergy for its success (Rodrigue, 2020). This research study employed all these theories as they are used in various modes of transport, playing a complementary role rather than being used as substitutes for one another.

1.7 Conceptual Framework

Maxwell (2012, p. 222) defines a conceptual framework as a "visual or written product, one that explains, either graphically or in narrative form, the main things to be studied—the key factors, concepts, or variables—and the presumed relationships among them." This study's three main variables were connectivity, accessibility, and centrality. The conceptual framework is presented in Figure 1.1 below to indicate the linkages between the study's constructs.

1.7.1 An international logistics hub: conceptual overview

The Logistics Hub Master Plan of Namibia (2018, p. 7) conceptualises an international logistics hub as a site where a complete package of international logistics services is readily available to serve market demand for international logistics. It represents the highest degree of organisational and functional development to serve vast international distribution networks with a global range. Integrated services include the major functions required for international trade, *inter alia*, the following:

- Efficient port,
- Storage (operations base for logistics),
- Efficient transport network,
- Collection and distribution of goods (international logistics companies), and
- Cross-border arrangements.

The Master Plan emphasises that, in the absence of any of these elements, it ceases to be a logistics hub. Thus, as shown in Figure 1.1, an international logistics hub offers a complete package with five essential components. Another critical aspect emphasised by the Master Plan is that the five functions alone do not guarantee an international logistics hub's success; a level of market demand is also a prerequisite.

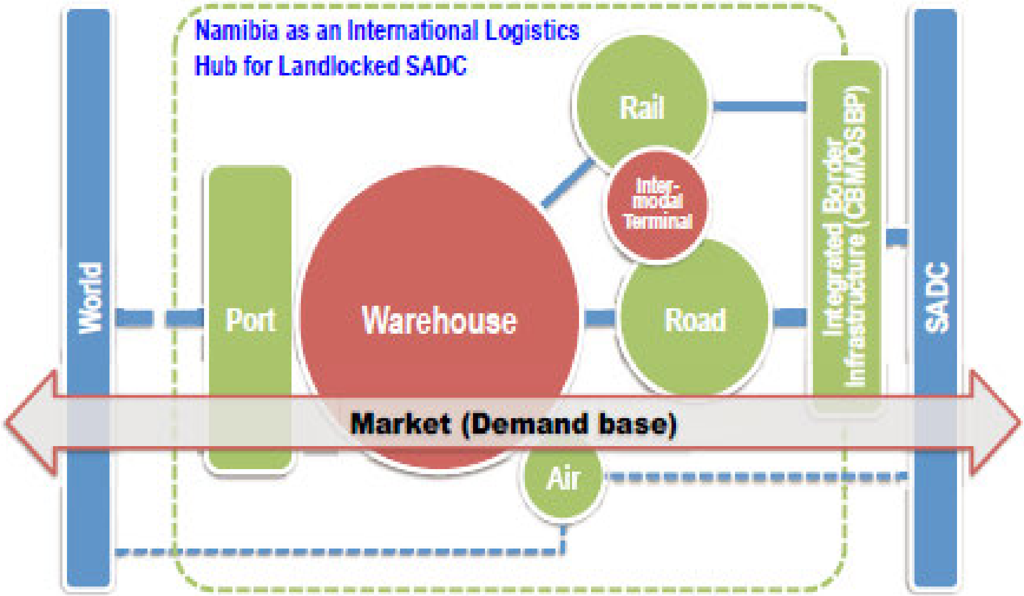


Figure 1- 1: Market plus five essential components of an international logistics hub

Source: The Logistics Hub Master Plan of Namibia (2018)

1.7.2 Conceptual framework for "Namibia as an International Logistics Hub"

The overview on the concept of an international logistics hub offered a broad definition. This section zeroes in on the international logistics hub as it relates to the Namibian context (see Figure 1.2 below).

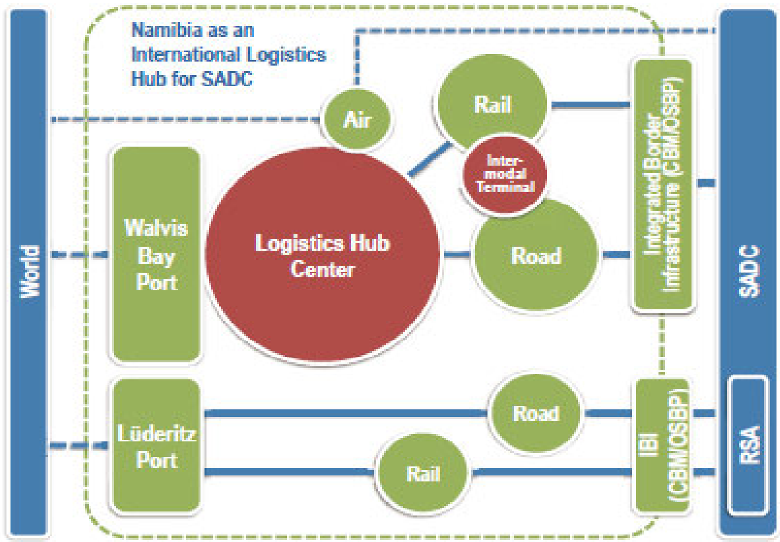


Figure 1-2: A Conceptual Framework of Namibia's International Logistics Hub

Source: The Logistics Hub Master Plan of Namibia (2018)

The above transport infrastructural components were analysed based on three main variables: connectivity, accessibility, and centrality, illustrated in Figure 1.3.

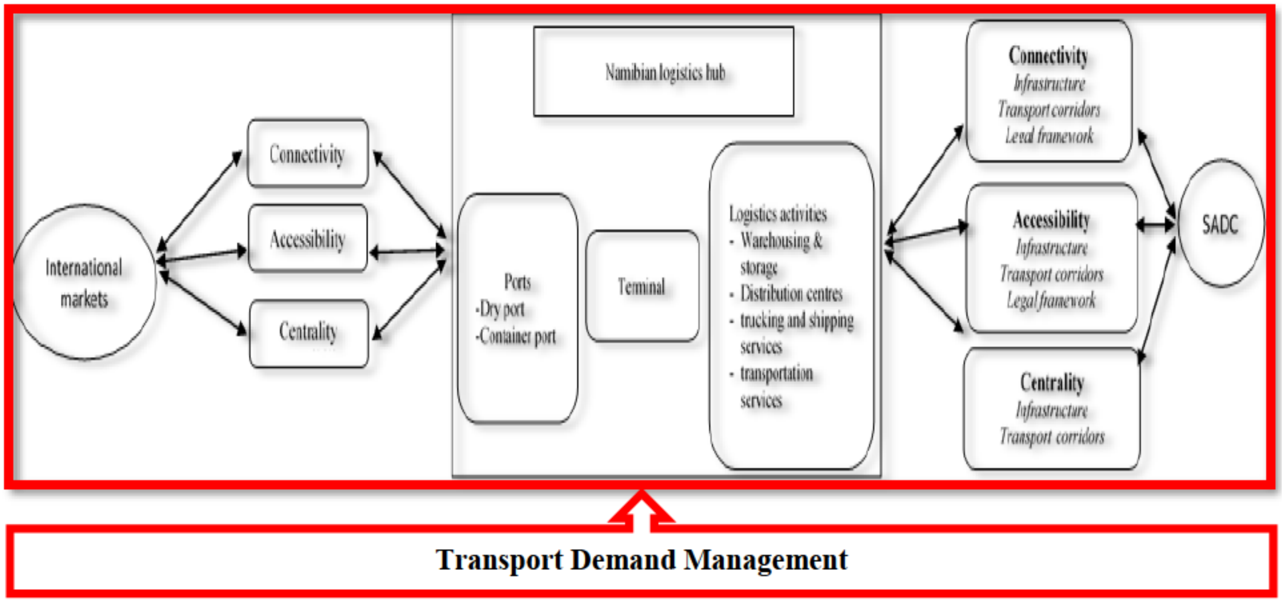


Figure 1-3: Study Conceptual Framework

Source: Developing a Conceptual Framework for International Logistics Hubs (2010)

Figure 1.3 depicts the network analysis for the Namibian logistics hub using star-like network analysis with Hub-and-Spoke. This conceptual framework suggests that the network links should radiate from a central node, in this case, the Namibian logistics hub.

Rodrigue (2020) asserts that *connectivity* defines a network's relevance. It refers to the comparative degree of connectedness within a transportation network irrespective of distance (Sasidharan, Usman, Ngezahayo, & Burrow, 2019). Adequate transport infrastructure enhances connectivity; consequently, it is an output of well-developed and maintained regional transport infrastructure to facilitate a regional logistics hub (OECD, 2018). The conceptual framework suggests that transport systems' preparedness requires SADC and international markets' connectivity to the logistics hub; hence, operational efficiency requires an integrated systems approach by all member states. These connections should be resilient and reliable to accomplish the KPIs (Rodrigue, 2020). The researcher employed the network analysis theory to explore the performance of the transport network system based on frequency, speed, volume, distance, safety and security, and degree of centrality.

Accessibility within this conceptual framework refers to the degree to which the transport network systems are available to both SADC and international markets. Rodrigue (2020) states that a logistics hub's network system varies from centripetal to centrifugal based on its accessibility to its various suppliers and customers. Centripetal transport networks are characterised by a high degree of centrality, and several nodes can be connected to each other, while centrifugal ones have no specific centrality due to the fact that no node can be significantly connected to the other. Thus, the more countries within a transport network with higher accessibility (centripetal), the higher the logistics hub's success rate (Rodrigue, 2020). The study employed the stakeholder theory to identify stakeholders' interests. This theory suggests that the logistics hub can only create value if all stakeholders' interests are catered for.

Centrality measurements refer to the sum of direct networks between nodes, meaning the sum of direct network connections by shipping lines between two ports (Hong, Tamakloe, Lee & Park, 2019). Centrality indicates the congruence of the transport systems with central areas and geographical structure (Scheurer & Porta, 2016) and reflects strategic positioning in the transport networks (Hong et al., 2019). This suggests that network centrality measures should be integrated to enhance spatial connectivity and accessibility to and from the SADC region (Hong et al., 2019). Namibia is competing with several ports (e.g., Durban and Luanda) to become the most strategic port in the SADC region; substantial effort is thus required to achieve this status (Vissagie, 2013). The study employed the Hub-and-Spoke theory to measure centrality and determine Namibia's level of competitiveness (Hyung-Sik & Dong-Wook, 2011).

Based on the above three key variables, the proposed conceptual framework below was inspired by Knaak et al. (2006). It aimed to study the regional logistics hub's performance in terms of the key variables in order to establish transport systems' preparedness and integration to support the Walvis Bay Port becoming the preferred SADC regional logistics hub. The conceptual framework was also employed to identify the implications for TDM to support a regional logistics hub.

In evaluating the preparedness of transport systems for Namibia to become the envisioned regional logistics hub, the study focused on selected customs regulations and border control measures, direct stakeholders, freight forwarders, freight transporters, trucking companies and vessel agents in the country.

1.8 Significance of the study

The study contributes to the body of knowledge by:

- Assessing Namibia's transport systems' preparedness to support the SADC landlocked countries and SADC region at large,
- Making recommendations to policy-makers, transport and urban planners in Namibia and SADC, transport and regional economists and the World Bank to address the shortcomings identified that will lay the foundation for planning for the development of the country, region and ultimately the continent, and
- Informing non-governmental organisations in Namibia and the SADC region of policies and strategies that will enable Namibia's logistics hub to serve all SADC countries and increase stakeholders' trade and revenue. The study will also assist the Namibian government to identify policies and the infrastructural development needs required for the country to become a logistics hub.

1.9 Justification for the study

Very few studies have investigated the transport system and its impact at the regional level. Hence, this study examined the transport systems' preparedness for a regional logistics hub in Namibia following the expansion of the port. While there is ample evidence that the port is growing due to its geographic location and thus its ability to serve landlocked countries, few studies have examined railway infrastructure. The available literature focuses on the drivers of port expansion, container handling, congestion, and how these factors affect Namibia's transport efficiency. Furthermore, the African Continental Free Trade Area (AfCFTA) offers a major opportunity for African countries to craft trade facilitation measures that cut red tape and simplify customs procedures to enhance long-term growth. The study's findings on network transportation systems' preparedness, accessibility and centrality, as well as intramodality in Africa and globally, will assist in this regard.

1.10 Delimitations of the study

The study was confined to participants and respondents from Walvis Bay and Windhoek as major geographic areas or zones. The main reason was that Windhoek is Namibia's primary business centre and the port is located in Walvis Bay; focusing on these areas thus provided access to the main stakeholders. Furthermore, only three variables, accessibility, connectivity, and centrality, were selected to measure transport systems' preparedness. This was due to the fact that they are the most critical factors in ensuring that a transport system is ready for the envisioned logistics hub.

Lastly, the researcher developed software that could be used for forecasting and alleviating transport challenges, although the programme requires online renewal every three months. A pilot project is required to determine the efficacy of this prototype programme.

1.11 Thesis Structure

This study investigated four significant themes in relation to transport systems' preparedness for a logistics hub for SADC: obstacles impeding the vision of becoming a logistics hub, the level of connectivity, accessibility, and centrality of transport networks, evaluation of the transport KPIs and the development of a framework for TDM. The dissertation is presented in six chapters as follows:

Chapter 1: Introductory chapter

This chapter serves as a preface to the study. It introduces the topic, background, problem statement, rationale for the study, and its objectives and questions and presents a summary of key concepts such as a logistics hub and transport systems, as well as their impact on national, regional, and global economic development. The chapter also provides an overview of Namibia's logistics hub and transport systems.

Chapter 2: Literature review

This chapter presents a literature review that shows how logistics hubs depend on transport systems from an empirical point of view. It includes definitions, concepts, and theories in order to understand previous research. The review is linked to the research goals and the dimensions of the logistics hub and transport systems.

Chapter 3: Research Methodology

The study employed a mixed method approach. This chapter describes the study population, sample size, and sampling and the data collection methods. The research design, as well as the research techniques and methodology are explained. The development of the measurement tools to address the research problem and questions is set out, including the approach adopted to investigate the implications of the findings. Finally, the chapter discusses the procedures employed to validate the study and increase the credibility of the results.

Chapter 4: Data Analysis and Presentation of Results

The researcher analysed the data collected by means of a questionnaire and interviews using SPSS software and NVivo. Multivariate and ANOVA analyses were used to examine the differences, correlations, and interrelationships between the study's variables. The qualitative data were analysed using thematic analysis and presented using NVivo. This chapter presents and analyses the research findings and relates them to the literature.

Chapter 5: Discussion of Results

This chapter interprets and discusses the study's results. The research aimed to examine the extent of transport systems' preparedness towards the attainment of a logistics hub in Namibia that will enable it to become a trade gateway for the Southern African region. The discussion is categorised into four sections based on the study's objectives and broken down into documentary analysis (content, frequency and time-series), the quantitative results (frequency distribution, descriptive statistics, inferential statistics, and factor analysis) and the qualitative analysis (thematic analysis) to measure the extent to which the identified challenges inhibit a regional logistics hub in Namibia.

Chapter 6: Recommendations and Conclusion

This chapter provides a summary, conclusion, recommendations based on the findings, and suggestions for further research on Namibia's transport systems' preparedness towards the envisioned logistics hub.

1.12 Conclusion

Chapter one served as the preface to the study. It began by presenting the background to the study, the problem statement, and the rationale for conducting the research. The chapter also outlined the objectives and research questions that guided the empirical investigation. It discussed important concepts such as logistics hubs and transport systems, highlighting their significance in driving national, regional, and global economic development. It also emphasised the crucial role played by efficient transport systems in facilitating the movement of goods, services, and information within and beyond the hub and presented an overview of Namibia's logistics hub and transport systems.

Lastly, the chapter highlighted Namibia’s strategic location at the crossroads of major regional trade routes in Southern Africa that presents an opportunity for it to become a key logistics hub and a gateway to the SADC market. This study assessed Namibia's transport systems' preparedness towards establishing a regional logistics hub. It undertook an in-depth analysis of the current state of Namibia's transport infrastructure, regulatory framework, and associated challenges. The research drew on best practices from successful logistics hubs worldwide to inform recommendations to improve Namibia's transport systems' preparedness.

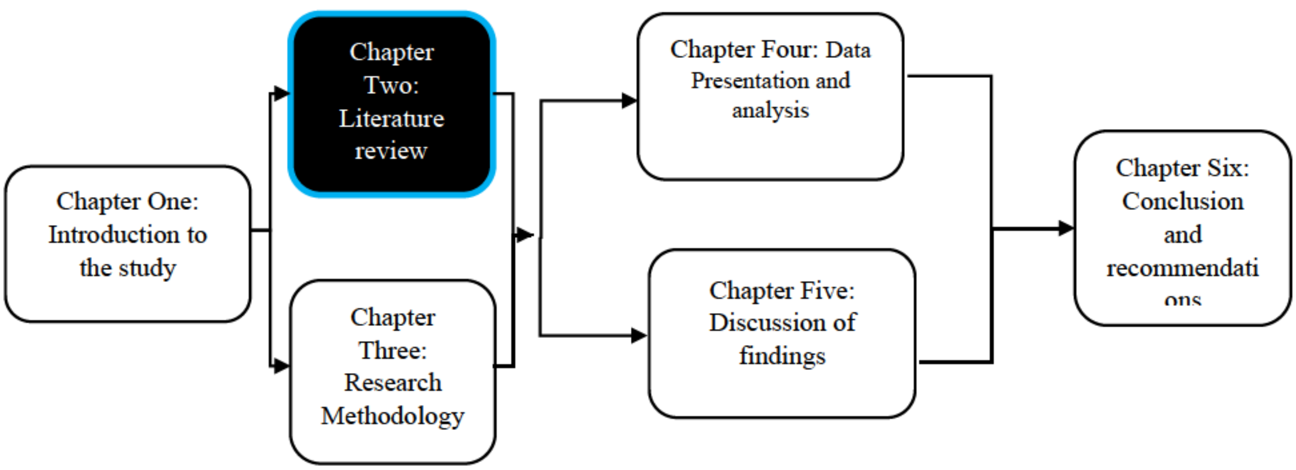
CHAPTER TWO:

LITERATURE REVIEW

"Globalization is a fact, because of technology, because of an integrated global supply chain, because of changes in transportation. And we're not going to be able to build a wall around that." *~ Barack Obama*

2.1 Introduction

This chapter reviews relevant published material on the study topic in order to understand previous research and trends. It also sets out the theories that underpinned the study and the dimensions of transport systems and discusses Namibia's vision to serve as a regional logistics hub against the current transport systems' preparedness.



Other issues covered in this chapter include the challenges that are inhibiting this vision from becoming a reality, the regional transport systems' preparedness, the role played by transport systems in the supply chain, and operational challenges faced by transport systems, specifically railway transport. The chapter also presents a review of strategies to increase operational efficiency and briefly examines case studies of regional and European railway systems. It concludes with a summary of the anticipated roles of TransNamib in the Walvis Bay Corridor Group (WBCG) and the operational challenges it is facing in carrying out those roles.

Transportation connects the several steps that result in the conversion of resources into useful goods in the hands of the ultimate consumer. It involves planning all these functions and sub-functions in order to minimise costs and maximise service to customers. Once in place, the system must be effectively managed (Fair et al., 1981).

2.2 Background of the study

The Bretton Woods multilateral world trading system that emerged out of World War II introduced an integrated global environment that has continued to shape international trade and global transportation systems (World Bank, 2019; Chow, 2018; Mattoo & Subramanian, 2009). Worldwide, countries rely on trade to foster their development and trade ties foster greater global interdependence. Global transport systems are critical in facilitating global trade and economic growth, including in small developing countries like Namibia (Ismail & Mahyideen, 2015). This calls for integrated transport systems, policy frameworks and rule-based arbitration systems facilitated by independent intergovernmental bodies such as the World Customs Council (WCO), World Trade Organization (WTO), International Maritime Organization (IMO), and International Air Transport Association (IATA), to which Namibia is a signatory. Namibia is also a member of various regional trading bodies (including the Common Market for East and Southern Africa (COMESA), Southern African Customs Union (SACU), Southern African Development Community (SADC), European Union Economic Partnership Agreement (EU-EPA), and Common Monetary Area (CMA)), enabling her to trade with a vast number of countries on a competitive basis (Amos, 2010).

In the early 1990s, global trade witnessed dramatic changes in the provision and management of trade logistics services that stimulated the development of global transport systems (Tien, 2019). The shared objective was to enhance integration, political stability, and security, as well as international and regional socio-economic cooperation. However, evidence remains of discord in global transport systems, policy frameworks and trade regulations.

The increased geographical fragmentation of global production, manufacturing and distribution processes led to the advancement of global transport systems, which resulted in the exploration of regional logistics hubs. To facilitate successful regional logistics hubs, African governments need to implement policy reforms and strengthen institutions to enable their national and regional transport systems to sustain efficient global trade links (AfDB, 2019; Kingombe, 2014). Regional integration seeks to create more competitive markets, connect landlocked countries to international markets, and promote intra-African trade (AfDB, 2019). Most African governments focus their investment on “hard” physical infrastructure for their transport systems for regional integration. Indeed, in the recent past, 25% of funding by the African Development Bank Group (NAD 1.5 billion) has been dedicated to transport infrastructure projects (AfDB, 2019, p. 22). However, more careful attention should be paid to the “soft” areas of international and regional integration, such as policy frameworks, regulations, and institutional design. In light of these developments, Africa faces critical challenges such as trade supply capacity, harmonisation of policy and legal frameworks, and the incompatibility of transportation systems to leverage global transportation systems (Olayiwola, 2020). Facilitating trade and transportation in Africa calls for an adequate, high-quality, efficient, and effective transportation system. The inadequacies of the continent’s transport system explain current high transportation costs, with landlocked countries particularly vulnerable. According to Kingombe (2014, p. 2), average transport costs constitute 14% of the export value, and the proportion is even higher in countries like Malawi (56%), Chad (52%), and Rwanda (48%). To address this challenge, Namibia invested in a new container terminal on reclaimed land and increased logistics capacity to facilitate a logistics hub that will benefit neighbouring landlocked countries (AfDB, 2019).

As organisations become more complicated and expand globally, the logistics sector is continually formulating innovative strategies to meet the expectations of these expanding firms. The logistics hub is one such approach. A logistics hub is a location dedicated to all activities associated with the transportation, sorting, coordination, and distribution of commodities for national and international transit. JICA (2015, p. 1) offers the following definition: “An international logistics hub is a place where a complete package of international logistics services is readily available in order to serve market demand for international logistics.” “The envisaged picture of a complete logistics hub encompasses logistics services that provide efficient, effective and affordable transportation of goods and services from the harbour to a specified final destination and vice versa”. The Council of Supply Chain Management notes that supply chain management includes planning and managing all activities related to sourcing and procurement, conversion, and logistics management (Brewer & Speh, 2000). Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. Essentially, supply chain management combines supply and demand management internally and externally across companies. Logistics management, as defined by the Council of Logistics Management, encompasses the planning, implementation, and control of efficient and effective forward and reverse flow and storage of goods, services, and associated information from the point of origin to the point of consumption in order to fulfil customers' needs (Brewer & Speh, 2000). Thus, logistics is a subset of supply chain management.

In line with the above definitions and the Master Plan for the Development of an International Logistics Hub for SADC Countries, the Port of Walvis Bay is strategically positioned to become one of the region's as well as the world's most recognised logistics hubs. New developments at the harbour have offered opportunities such as job creation as a result of increased traffic, new support services and an increase in existing products and services rendered to the port through feeder services, shipping lines and freight forwarders, etc. The new developments will include modernised ICT infrastructure that could lead to operational efficiency. If properly established, it will open up opportunities for new routes, economic growth and international recognition. Savage, Fransman and Jenkins's (2013) research concluded that the logistics hub would greatly benefit Namibia and the region. It will be a lucrative transit point for landlocked SADC countries and will create jobs and alleviate some of the socio-economic challenges currently experienced in Namibia. It is thus clear that the establishment of a logistics hub in Namibia will create spinoffs such as job creation, an inflow of new skills from experts from international markets, and infrastructure development.

Maharaj (2013) notes that, in 2012, the Port of Durban's capacity was 2.9 million TEUs and that with adjustments and configurations, it could increase to 4 million TEUs. Statistics show that, over the years, this South African port has become the most favoured and the biggest port in the region, as it is strategically situated to receive goods from all over the world, including the economic powerhouse of Asia. However, it experiences high volumes of traffic, leading to delays in transshipments because of congestion, resulting in revenue losses, e.g., through demurrage charges among some businesses. Hence, the expanded Port of Walvis Bay could function as a secondary port to alleviate the congestion at the Port of Durban. It will facilitate the transit of cargo destined for Namibia and landlocked countries, serving as a convenient alternative port of call.

The upgraded Port of Walvis Bay was launched towards the end of 2019 and, to the best of the researcher's knowledge, no studies have been conducted on the real impact of the increase in cargo volumes and logistical activities at this port; this was the focus of the current study.

The Bretton Woods multilateral world trading system introduced after World War II has critically impacted international trade and global transportation systems, which are essential for fostering greater global interdependence. The efficient functioning of global transport systems is critical in facilitating trade and economic growth, particularly for small developing countries such as Namibia. However, despite efforts to establish a regional logistics hub, critical challenges such as trade supply capacity, policy harmonisation, and transportation system incompatibility persist in Africa. Therefore, the investment in the Port of Walvis Bay and the assessment of its impact on increased cargo volumes and logistical activities are critical in uncovering the real implications of the port expansion and providing valuable insights for future development and improvement.

Transport System and Infrastructure

According to Ran and Boyce (2012, p. 1), a

> "transportation system or mode is a system for moving persons or goods consisting of three components: (a) The vehicle (equipment) is what moves objects or traffic (people, goods). The vehicle consists of a container and some type of motive power, either onboard or elsewhere. (b) The guideway is what the vehicles move along. The guideway consists of links and nodes that together form a network. A sequence of links is called a route. A terminal is a node where traffic is transferred from one vehicle to another. (c) The operations plan is the set of procedures by which traffic and vehicles are moved over the guideway, including schedules or timetables, crew assignments, and control systems."

Kock and Lannquist (2022) assert that, in developing a transport system, its nature and the context in which its occurs need to be taken into account, ranging from national, regional and international, to cultural, historical, environmental, economic, political, and technological perspectives. Rodrigue and Notteboom (2012) note that an efficient transport system could create socio-economic development opportunities, and have beneficial multiplier effects that could improve market access and create job opportunities, while an inefficient transport system could have a serious negative impact on a nation’s economy. Bugarčić, Skvarciany, and Stanišić (2020) concur that transportation and/or transportation systems are the backbone of any economy; however, they could also negatively impact economic development and the environment. It is against this background that the current study investigated the inefficiencies of transport systems as well as negative externalities derived from increased demand for transport due to the increase in volumes at the Port of Walvis Bay.

Namibia’s National Development Plan (NDP) calls for a sustainable transport system to serve the country, the region, and global markets by 2022. However, NDP 5 notes that achievement of this vision is hampered by significant challenges in the logistics industry, including a lack of funding for development of the transport sector and the need for qualified personnel with technical expertise in the various transport subsectors (National Planning Commission, 2017). Furthermore, a lack of infrastructural improvements in one system/sector creates a burden on the next sector, as traffic that is better suited for rail transportation is forced to use the road network. Such constraints create operational inefficiencies, undermining sustainability. While the literature identifies gaps within transportation systems and offers recommendations to improve the industry; these have not always been successfully implemented (Cichosz, Wallenburg, & Knemeyer, 2020). The current study therefore investigated implementation challenges and offers recommendations for improvement.

According to the Motor Vehicle Accident Fund of Namibia (MVA), Namibia ranked first in Africa with regard to road accidents in 2018, with 19 000 accidents, leading to the death of 700 persons and 7 000 suffering disabilities (Motor Vehicle Accident Fund of Namibia, 2018). It recommends an increase in the number of dual carriage highways as well as a change in drivers’ behaviours. Jones et al. (2019) also highlight the burden placed on roads and infrastructure in Namibia that have negative socioeconomic impacts. They note that human behaviour and the increased number of commercial and private vehicles on the roads lead to high accident and fatality rates. Thus, this research study investigated whether the corridors developed recently have had a positive impact and reduced the number of fatalities on Namibian roads.

Efficient and well-functioning transport systems and infrastructure are crucial for socio-economic development, market access, and job opportunities. However, the transportation sector faces challenges such as inefficiencies and negative externalities resulting from increased transport demand. The lack of funding, qualified personnel, and infrastructural improvements hinder sustainability in the industry, leading to operational inefficiencies. Additionally, Namibia's high rate of road accidents and fatalities underscores the need for improved infrastructure and changes in drivers' behaviour. Addressing these challenges and implementing effective recommendations are critical for enhancing the modalities and achieving a sustainable, safer, and more efficient transport system.

Corridors

The SADC Protocol on Trade of 2008 established the SADC Free Trade Area. Aimed at promoting regional integration, its implementation saw a reduction in tariffs and an increase in intra-SADC regional trade (Shayanowako, 2011). This has been a driving force in Namibia's vision to become an international logistics hub, and for the Port of Walvis Bay to act as the gateway for the SADC region. The 2015 Namibian Master Plan for the Development of an International Logistics Hub for the SADC Region advocates for strategic corridors to carry out economic activities within the region, extending to global trade routes. This gave birth to corridors such as the Walvis Bay Corridor Group, Trans-Kalahari, Trans-Caprivi, Trans-Orange and Trans-Kunene. The report further highlights that, ideally, corridors should primarily be supported by a rail network to and from the Port of Walvis Bay. However, the researcher identified gaps in the implementation of these recommendations, motivating the current study. In line with the desire for regional economic empowerment, expressed in the notion of one African economy, Namibia is part of various regional governance bodies such as Southern African Railway Association (SARA), SADC Transport, and Southern African Maritime, supported by members such as the Walvis Bay Corridor Group, that aim to develop strategic objectives for the logistics industry within the region to boost domestic and international trade. However, Saurombe (2009) notes that there is a gap between SADC initiatives and the national objectives of different countries. This study thus examined the challenges experienced by member states that hinder the synchronisation of policies and efforts.

Chibira and Mdlankomo (2015) note that the SADC region confronts a number of challenges such as high operating costs, insufficient facilities, inefficient regulatory and corridor management systems, accidents and delays, and environmental pollution. Reducing delays at corridor borders during customs clearing by integrating regional policies and procedures could lead to increased trade volumes and per-corridor profit, as well as enhanced trade facilitation, national integration, and economic growth. Rodrigue (2016) notes that equal numbers of passenger and cargo vehicles use Namibia's road system. Increased trade volumes and/or cargo traffic increase congestion, especially by commercial vehicles such as trucks, creating the need to separate trucks or commercial vehicles from passenger vehicles. Namibian roads have two traffic lanes, one in each direction, and no shoulders. All types of vehicles, including buses, trucks, bicycles, private vehicles, and motorbikes use the same lane. With a growing population and rated as one of the countries with the highest number of road accidents, as well as limited networks, and limited transportation planning, Namibia faces serious challenges if no solution is found. Rodrigue (2016) adds that, in the air transport mode, freight and passengers are largely integrated because they share the same terminal facilities. The Yamoussoukro Decision of 1999 encourages the privatisation of the airline industry, but little progress has been made at the national level because regional members are worried that competition will undermine the dominance of their national carriers (UNECA, 1999).

As noted by Rodrigue (2016), heavy industries are linked to rail transport networks due to their capacity to carry large volumes and heavy freight, while containerisation has improved the flexibility of rail transport by linking it to the road and maritime modes. Rail integration is not possible in the SADC region because of the different gauges used by member states.

2.3 Theoretical framework

The network analysis theory was the main theoretical framework underpinning this study. The theory analyses the degree of transport infrastructural connectivity, accessibility, and centrality within the international logistics discourse. Network analysis refers to the "interconnectivity or linkage of a set of system components into a complete whole to produce a spatial and structured pattern. The network may be either a static feature at a time or a dynamic phenomenon subjected to change through time" (Abbas & Hashidu, 2019, p. 61). This theory has been widely used in various studies to analyse the social structures that emerge from the recurrence of multiple actors' relations. It is applied in the field of information technology (IT) (Simiraglia, 2015; Giuditta De & Nepelski, 2013) and within the transport industry to study transport system geography (Rodrigue, 2020; Cats, Koppenol & Warnier, 2017). This research study employed the network analysis theory to examine connectivity variables within transport systems in a logistics hub. The weakness of the theory is that the outcomes are greatly dependent on the actors involved and their engagement, which can lead to skewed results or high levels of subjectivity (Dahesh, Tabarsa, Zandieh & Hamidizadeh, 2020).

The study utilised the network analysis theory to examine and explore diverse facets of transportation systems in the regional logistics hub, with a specific focus on the constructs of transport infrastructural connectivity, accessibility and centrality. The analysis of transport infrastructural connectivity involved an assessment of the links between various transportation networks, including road, rail, and port systems. The concept of accessibility pertains to assessment of the level of ease with which transportation facilities and provisions can be reached, while considering variables such as proximity and effectiveness. The concept of centrality was used to analyse the comparative importance and status of transportation nodes and hubs within the wider logistics network. Through the application of these constructs, the study sought to assess the transportation systems' level of preparedness, and strengthen knowledge of the connectivity, accessibility and centrality required to promote an efficient logistics environment in Namibia.

The Hub and Spoke theory was used as a subsidiary theory to support the network analysis theory. Hub-and-spoke, as a network structure, "allows for greater flexibility within the transport system through a concentration of flows" (Rodrigue, 2020, p. 263). It is not intended to be used through one supply chain, but across a broader distribution network. As a result, hub-and-spoke topologies have been adopted in various industries (dos Santos Vieira & Luna, 2016). The overall topology is comparable to a wheel, with a central hub connecting to points around the wheel's circumference via numerous spokes. The study used connectivity, node degree, entropy, and concentration indicators to analyse the topological characteristics of a hub-and-spoke transportation network. It made a significant contribution to formulating the appropriate KPIs in this study. With regard to the hub-and-spoke network's reliability, the study used a structure reliability indicator that takes sub-network numbers, the shortest path, and network dimensions into account (Huang, Liu, Fu & Blythe, 2018; Deng & Hu, 2013). The lack of decentralisation in the model may make day-to-day operations less adaptable, especially if any changes made at the hub, even to a single route, have unintended effects on the entire system. Periods of high demand between two spokes may be difficult, if not impossible, to manage.

The Hub and Spoke theory was applied in the study to examine the network structure within the regional logistics hub. This theory emphasises a distinct configuration featuring a central node with numerous links connecting outlying sites. The central hub functions as a pivotal point for transportation operations, consolidating the movement of commodities and amenities. In contrast, the peripheral locations mainly serve as distribution nodes within the network. The hub-and-spoke network is a highly flexible transportation system that can effectively coordinate operations between the central hub and peripheral locations, while also adapting to changes in demand. The study employed diverse topological characteristics such as connectivity, node degree and concentration indicators to evaluate the structure, efficiency, and effectiveness of the network. Furthermore, the construct of reliability was utilised to assess the robustness and resilience of the network, considering variables such as the number of sub-networks, shortest pathways, and network size. By integrating these concepts, the researcher aimed to acquire significant insights into the effectiveness, productivity, and reliability of the hub-and-spoke transportation system, thereby enhancing understanding of its applicability and implications within the regional logistics hub in Namibia.

Bhasin (2018, p. 15) broadly defined a stakeholder as any individual or community that may influence a business enterprise or is influenced by it. The ***stakeholder theory*** is applied to understand how governments, businesses and individuals build shared interests in exchange for goods and services and further entrenches the necessity of a regional logistics hub. It was used in this study to cross-examine the dynamics and interactions between the various stakeholders engaged in the hub's development and operation. The focus was on stakeholder identification, with the goal of identifying individuals and groups with an interest in the logistics hub. Stakeholders' importance and influence were determined by assessing their significance. Efforts were made to include various stakeholders who are decision-makers, ensuring that their viewpoints and concerns were considered. The implementation of effective strategies to manage stakeholders was examined in order to address their needs and foster a favourable environment for collaboration and cooperation. The researcher acknowledged the importance of stakeholders in determining the results and efficacy of the logistics hub. The study focused on creating value for stakeholders, with the aim of producing favourable outcomes and advantages for all parties involved. This approach was intended to enhance the preparedness of the transportation system for the regional logistics hub in Namibia.

Broadly, the network analysis theory proposes a degree of transport infrastructural connectivity, accessibility, and centrality within the international logistics discourse amongst stakeholders. In contrast, the Hub-and-Spoke theory allows for greater flexibility within the transport system through a concentration of flows and extensive mitigation of higher costs in a broader distribution network. These theories were selected as the theoretical framework this study in order to obtain a systematic perspective of an organism made up of sub-systems that must work in synergy for its success (Rodrigue, 2020). The theories were employed as they are used in various modes of transport, playing a complementary role instead of one of substitution.

2.4 Dimensions of a transport system [centrality, accessibility and connectivity]

Developing centrality, accessibility and connectivity indicators for transportation systems provides a tool to measure the systems' compatibility with the geographical layout of central areas and transportation operations within a region (Jayasinghe, Kasemsri, Abenayake & Mahanama, 2019; Sarlas, Páez, & Axhausen, 2020). Batterink (2020) hypothesises that a greater number of convenient transfer points and routes should be made available to users (network connectivity), as well as a high degree of spatial overlap and integration between transport infrastructure and regional logistics hubs and corridors (facility centrality), which will result in increased transport system mobility in the region.

2.4.1 Accessibility in transportation networks

The literature defines accessibility as the degree to which transport networks and land use enable individuals to reach a particular destination or economic activity, including services or opportunities from a location in the network, using a mode of transport or combination of modes (Albacete, 2017; Rodrigue, 2020). Infrastructure development interlinkages determine accessibility. As Abbas and Hashidu (2019) point out, the notion of accessibility therefore, rests on two core concepts. Firstly, location, estimating the relativity of space in relation to transportation infrastructure, provides the means to support movement. Secondly, the distance is extrapolated from the connectivity between locations. The role of transportation networks in enabling economic growth and development is underpinned by accessibility, especially cross-border trade and enhancement of regional corridors. A vital characterisation of accessibility lies in the term "reach", as it implies the movement of people or freight using the transport network to reach a destination complying with international laws while simultaneously formulating nearshore and off-shore policy frameworks.

As a result, access is cited as the primary goal of transport activity (Muhammad et al., 2018; Litman, 2021) in the policies and regulations governing the mobility of vehicles, carriers, and people. The benefits of improved accessibility for transport users and operators can be viewed from various perspectives. Studies by Rothfeld, Straubinger, Paul, and Antoniou (2019) and Pukhova, Llorca, Moreno, Staves, Zhang, and Moeckel (2021) show that transport users benefit in terms of savings in travel time derived from "faster access/egress time to/from buses, train stations, airports and so on", while non-users' benefits include more comprehensive economic benefits associated with transport investment to improve accessibility; and an increase in the number of passengers translates to increased revenue with decreased costs for operators. Improved accessibility has also been linked to better health among the general populace (Brown, Ma, Miranda, Eng, Castille, Brockie, & Trinh-Shevrin, 2019), especially during the COVID-19 pandemic that disrupted the tourism industry and restricted the movement of goods.

Given accessibility's importance as a measure of efficiency, evaluation of transportation networks is increasing. Studies by Zhang, Northridge, Jin, and Metcalf (2018); Chen, Ni, Xi, Li, and Wang (2017) and Castanho, Vulevic, Fernández, Fernández-Pozo, Gómez, and Loures (2017) highlight different approaches to the measurement of accessibility in transportation networks. Albacete (2017) argued that all measures of accessibility investigate the symbiotic relationship between transport and land use to some extent. Thus, these measures have been influential in understanding the correlation effects on the usage of different travel modes. Litman (2021) highlights that current evaluation approaches tend to measure mobility as opposed to accessibility since mobility is less complex to define and quantify; however, improved models of accessibility impacts include multimodal level-of-service indicators and measure the travel distance, time and related costs of users of different transport modes in accessing various services and activities.

2.4.2 Connectivity in transportation networks

According to Rodrigue (2020), connectivity refers to the degree to which passenger or freight flows from one node can reach another node through a direct or indirect link. Abbas et al. (2019, p. 1033) also define connectivity as the interlinkages within a transport system. Both definitions are underpinned by the graph theory, which explores how nodes and linkages are arranged in networks, including direction (Rodrique, 2020). As a result, connectivity is a relative concept, as each node has varying degrees of connectedness to other nodes (Sigler, Martinus & Matous, 2021).

As interconnectivity strengthens, travel distances decrease and route possibilities expand, enabling more direct travel between locations and enhancing the system's accessibility and resilience (Litman & Steele, 2017). For the purposes of this study, a node represents a transportation and trade link between port terminals, transit feeders, and stations. Connectivity can only exist when transport systems connect two or more places (Sharifi & Khavarian-Garmsir, 2020). Integrated transportation systems profoundly transform transportation operations and urban and regional development patterns enabled through transport connectedness (Nahiduzzaman, Holland, Sikder, Shaw, Hewage, & Sadiq, 2021).

Overcrowded transportation corridors in shifting transportation flows are becoming a significant connectivity concern, indirectly affecting cross-border collaboration (Castanho et al., 2017). Thus, Gulyas and Covacs (2016) suggest that improving transport networks is a significant factor in enhancing mobility and economic progression in the region. The importance of cross-border transport system collaboration is now indisputable in the geo-political sphere (Castanho, Vulevic, Fernández, Fernández-Pozo, Gómez, & Loures, 2017). It promotes long-term economic and social development and cohesion for transboundary zones, including administrative and territorial units from neighbouring countries (Vulevic, Castanho, Naranjo Gomez, Loures, Cabezas, Fernández-Pozo, & Martin Gallardo, 2020). Therefore, increasing inter-and intra-operational connectivity within a transportation system is important to minimise future disruptions and silos.

Furthermore, Industry 4.0 primarily focuses on digitalisation, visibility, connectivity, and interoperability (Yuan, 2020). Transport systems are being optimised more efficiently due to the fast expansion of Industry 4.0 technologies, impacting economic growth, competitiveness, and the quality of life through connected transportation networks. Industry 4.0 has transformed transport connectivity between vehicles, infrastructure, drivers and nomadic devices while improving communication (Young-Yun, 2017). By integrating Internet-of-Things (IoT) devices and other linked technologies, the transportation system becomes more interconnected, thereby enhancing its overall functionality and efficiency (Hoey, 2018).

2.4.3 Centrality in transportation networks

Centrality is based on the Social Network Analysis (SNA) concept, which examines essential links in social networks (Cheng, Lee, Lim, & Zhu, 2015; Kurmanalieva, 2020). The concept is applied to transportation networks to identify centralities where the reliability of critical nodes that greatly impact network efficiency is measured through indicators including closeness centrality, “betweenness” centrality and degree centrality (Durón, 2020; Scheurer, 2006).

Studies by Hong, Tamakloe, Lee, and Park; Cao, Feng, and Zhang (2019) and Sciarra, Chiarotti, Laio, and Ridolfi (2018) have shown that each centrality measure produces a different viewpoint on which nodes are significant in the transportation network. The degree of centrality is measured to illustrate the importance of a direct link between nodes in the transport network (Napitupulu et al., 2021). It also enables assessment of the impact of a breakdown of the identified essential links on the efficiency of the network. Kui and Xiufen (2017) found that a high degree of centrality is an indicator of high connectivity for a node and, in turn, leads to improved spatial layout in traffic planning.

Conversely, the betweenness centrality measure measures the number of shortest paths passing through an identified node in the transport network (Kui & Xiufen, 2017; Kurmanalieva, 2020). The larger the betweenness centrality index, the higher the number of paths passing between nodes through a particular node in the network (Kui & Xiufen, 2017). The third significant measure of centrality, closeness centrality, reflects the degree of difficulty with which one node in the transport network connects with another (Kui & Xiufen, 2017). The degree of centrality in a transport network is thus characterised by these three major indexes, which enable an in-depth analysis of the critical nodes of the network.

Other measures of centrality used in transportation network analysis include the reached gravity index and straightness, which are used to determine the ease of travelling from one location to another in the transport network (Cheng, Lee, Lim, & Zhu, 2015). Hong, Tamakloe, Lee, and Park (2019) and Scheurer (2006) argue that the development of centrality through a high degree of spatial overlap between transport infrastructure and urban centres as well as corridors is vital to increase network efficiency through increased mobility. Soh et al. (2010) applied centrality in a study of Singapore's bus and rail transport systems using a complex weighted network analysis of the travel routes. Consideration of centrality as a measure to evaluate the efficiency of transportation systems is increasingly applied in transport network analysis.

The literature (Kui & Xiufen, 2017) shows that the three central measures of centrality in transport characterise the importance of different nodes in the transport network based on the number of connections on one particular node and the impact of that node on others in the network; a node's degree of difficulty in connecting to another node and the shortest path of a particular node, which reflects the load capacity. A more centralised transport network with a high degree of centrality covering the three measures ensures the efficiency of the network through improved flow of traffic on the network and seamless access to transfer locations, which increases the network's connectivity and capacity (Arvis, Vesin, Carruthers, & Ducruet, 2018).

To the best of the researcher's knowledge, no studies have analysed the centrality of the transportation system in Namibia. An effective assessment of transport systems' preparedness towards a regional logistics hub in Namibia calls for an assessment of current infrastructure, such as transport and facility connectivity as well as centrality to determine if the country is well-prepared to be a Southern African logistics hub. To strengthen the connection between the hub and the region, Yu, Chen, and Yan (2019) suggest that more subway lines should be gradually be built to improve the network system and the topological distance between the region and the hub.

The development of centrality, accessibility, and connectivity indicators critically influences the evaluation of transportation systems' compatibility and efficiency in a region. Assessing these aspects is vital for determining the preparedness of Namibia's transport systems to become a regional logistics hub and identifying areas for improvement. The integration of Industry 4.0 technologies and IoT devices plays a crucial role in enhancing connectivity and interoperability, fostering economic growth and improving quality of life. However, the lack of empirical evidence regarding centrality analysis in Namibia's transportation system emphasises the criticality of conducting an assessment to evaluate its readiness as a regional logistics hub.

2.5 The vision of Namibia as the regional logistics hub

As part of Namibia's roadmap towards Vision 2030, the country's fourth NDP (NDP4) developed a regional logistics hub positioning the country as the preferred trade route for Southern Africa. JICA (2015, p. 7) defined a logistics hub as "a place where a complete package of international logistics services is readily available to serve market demand for international logistics". This definition was adopted for this study as it contextualises the Namibian vision of becoming a logistics hub. The Walvis Bay port is strategically located to accelerate the growth of the SADC region by providing a gateway to Southern Africa (WBCG, 2019). Cost and time savings are achieved along the Walvis Bay corridors by offering the shortest possible regional route on the west coast (Petrus, 2020). In alignment with the NDP 4's objectives, the Namibian government expanded the commercial harbour, Walvis Bay Port, and increased its capacity to a potential 750 000 TEUs per year (Savage, Fransman, Jenkins, & Bamford, 2014; JICA, 2015, p. 2) at a cost of N$3 billion / (R 3 billion) (Amakali, 2017, p. 25). These developments have transformed the region's trade potential, connecting world economic centres with close to 300 million consumers in the SADC region that has a GDP of more than N$500 billion / (R500 billion) (Amakali, 2017, p. 25), ultimately enhancing economic growth, offering new routes, and promoting international recognition (Savage, Fransman, Jenkins, & Bamford, 2014).

Figure 2.1 shows Namibia's geographical position in the SADC region. The blue lines depict the trade corridors that run from Walvis Bay Port to neighbouring nations. Through its four major transport corridors, namely the Trans-Kalahari, Trans-Caprivi, Trans-Cunene, and the Trans-Orange Corridor, Namibia provides landlocked SADC countries with much-needed access to global markets (Petrus, 2020). The port is strategically linked to major inland routes such as the Trans-Kalahari Highway, the B2 Road (Windhoek-Gobabis), and the B1 Road (Windhoek-Otjiwarongo). These routes enable efficient transportation of goods and provide seamless access to neighbouring countries, including Botswana, Zambia, and Zimbabwe. Furthermore, the port is a vital link to regional ports like Cape Town, Durban, and Dar es Salaam, strengthening regional integration and facilitating international trade (Konstantinus, 2021).

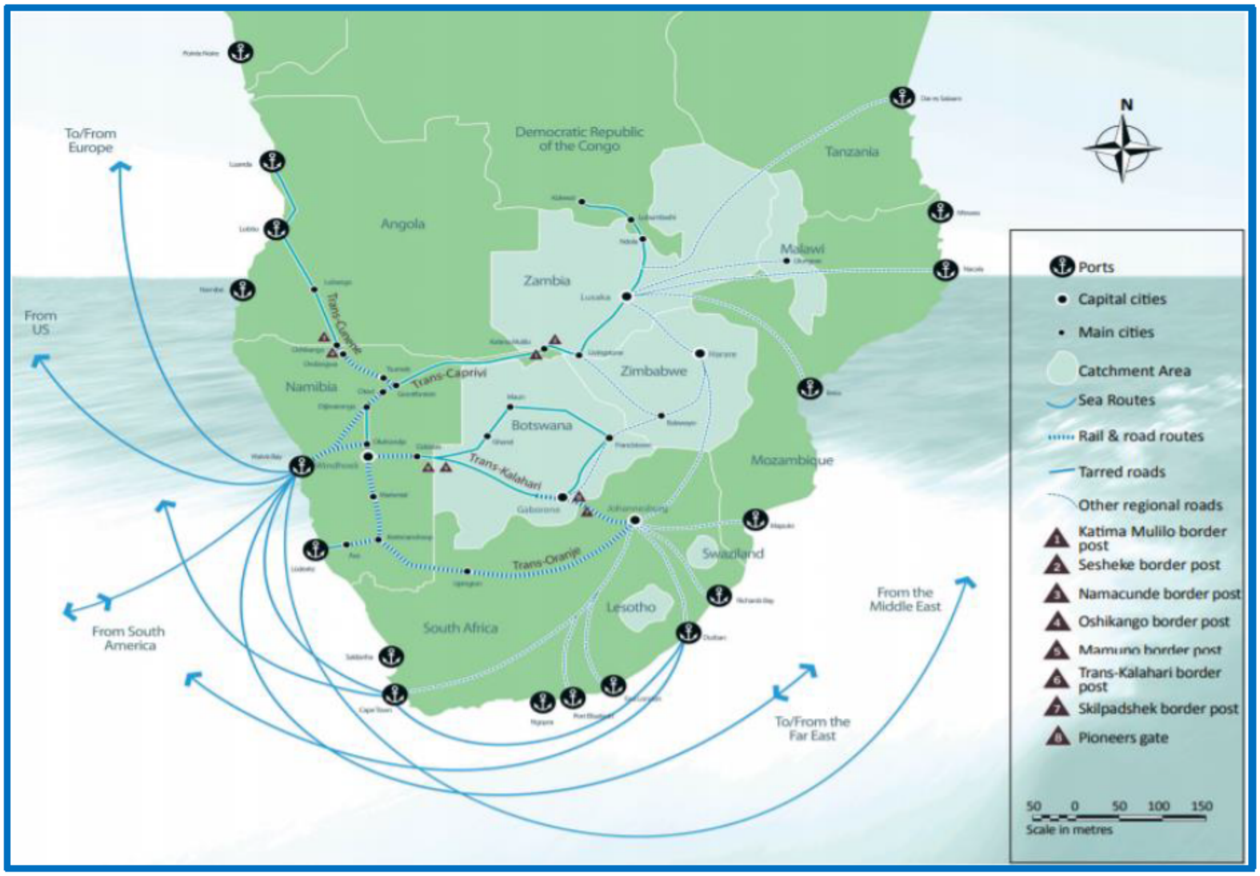


Figure 2-1: Walvis Bay Corridors

Source: Walvis Bay Corridor Group (2015)

Although a good geographical location is essential, it should be the least of Namibia's concerns. As Savage, Fransman, Jenkins and Bamford (2014) argued, regional logistics hubs are known to be either a curse or a blessing to the host country's economy, depending on harmonised regional strategies, transport systems and policies' legal compatibility. This raises the issue of whether or not the infrastructure to transport people and goods is ready to support the regional logistics nodes. In Europe, ports have been successful pioneers in integrating various modes of transportation. Therefore, to boost sustainable regional growth in transport, the transport interchanges must connect maritime to rail, road, and inland waterways (European Commission, 2013). Port infrastructure expansion and increased volumes must be accompanied by growth in other supporting transport infrastructure, such as railways and roads. The transport modes' usage imbalances are of serious concern in relation to becoming a regional logistics leader (Saruchera, 2017). In tandem with efficient synchronised regional strategies for transport systems, policies and legal structures, the landlocked countries benefit from integrating various modes of transportation. Huo, Zhang and Chen (2018) suggest that the region should formulate harmonised regional strategies at national and regional levels for a successful regional logistics hub.

2.6 Regional transport systems' preparedness

While well-developed infrastructure is crucial for the economic growth of a region, inadequate infrastructure is a significant barrier to Africa reaching its full economic potential. Supply chain nodes and spatial link design are inextricably linked to transportation planning and land use management (Somuyiwa, Oduwole, & Babatunde, 2020). The nodes are typically connected via road, rail, inland waterways, or air (Li, Ma, Zheng, & Xiao, 2022). Nodes and links comprise the transportation network that is crucial for freight logistics routes connecting seaports to the hinterland (Aritua, 2019; Carboni & Dalla Chiara, 2018; Saparovna Mukhtarova, Sarsengalievich Ospanov, Antoni, & Duzbaievna Sharapiyeva, 2018). Africa is characterised by many landlocked countries that rely on regional transportation networks to promote economic progress. As such, these countries are constantly confronted by congestion, insufficient transportation capacity, inoperable transportation systems, and increasing demand for reliable and effective transportation systems (Mouratidis, 2021).

Moreover, transit times in African transport corridors are absurdly long due to various issues, including ambiguous and even contradictory rules and regulations, inefficient service providers, bottlenecks, and time-consuming administrative and customs procedures. This view is supported by studies indicating that, while average transportation costs as a percentage of export value are estimated at 14%, for landlocked countries like Malawi, Chad, and Rwanda, they reach 56%, 52%, and 48%, respectively. In contrast, the average for all developing countries is 8.6% (Bofinger, 2011). The high transit costs in some landlocked countries are due to the lack of linked transportation networks. It is due to this fact that developing nations have struggled to modernise and renew existing transportation infrastructure and systems. This is particularly true in a regional setting as collaborative efforts by all member states are required to develop and sustain accessibility and connectivity within the regional transportation system.

Figure 2.2 (Charalambides, 2005) depicts the SADC region's transport system's disconnect and illustrates the potential to enhance transportation infrastructure. According to Smith (2020), regional cooperation in transport networks and infrastructure can be achieved by common trade policy and deregulation to overcome the effects of silo transport systems, such as cabotage regulations. However, the impact would be significantly greater if such laws and trade policies could be liberalised at the regional level. Rodrigue (2020) suggests that decarbonisation of transportation influences the transport system's economics, infrastructure, regulatory environment and innovative practices for sustainability.

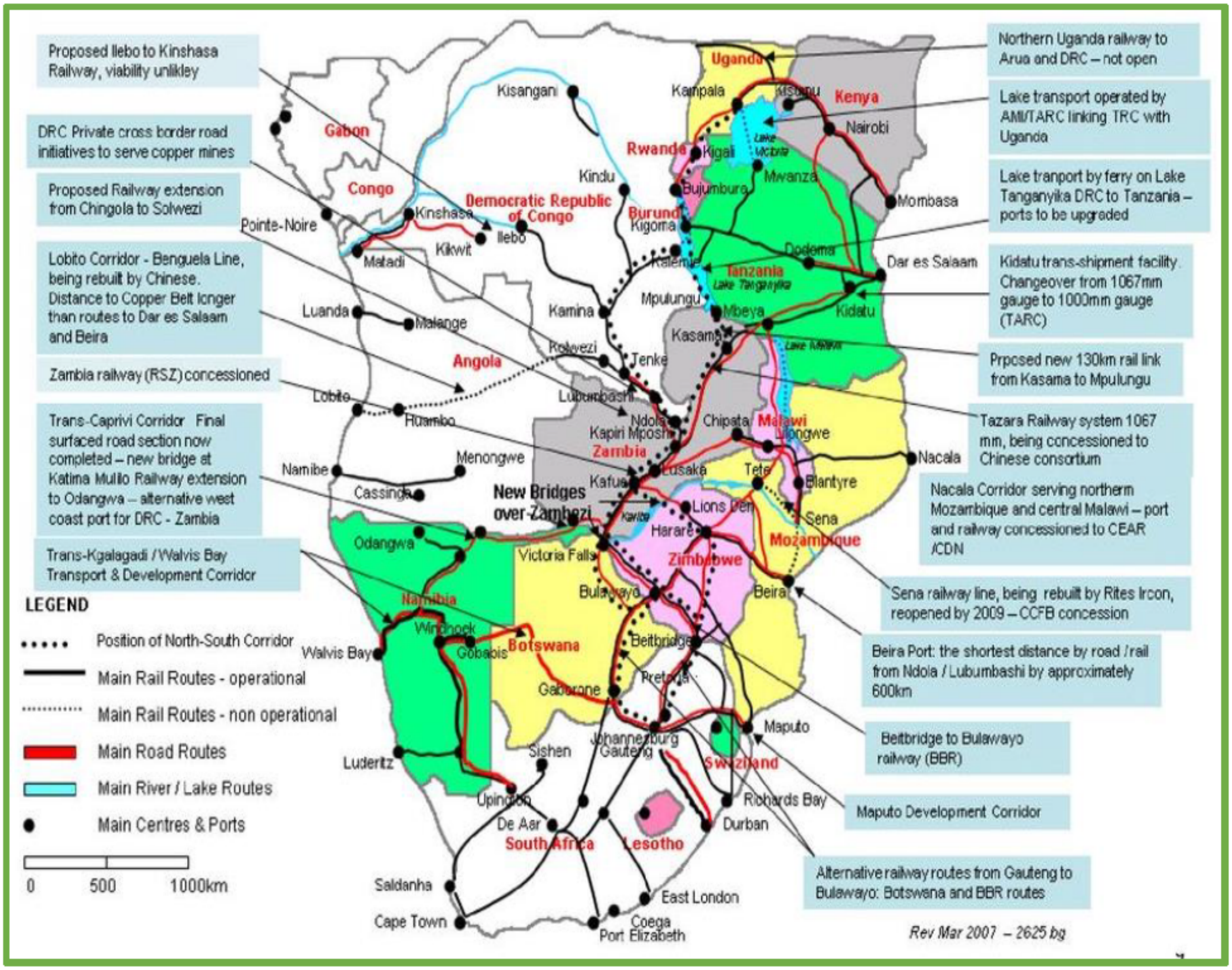


Figure 2-2: SADC Regional Transport Corridors and Ports

Source: Charalambides (2005)

2.6.1 Maritime transportation system

According to the United Nations Conference on Trade and Development (UNCTAD) (2018), sea transport is the pillar of global trade and economics. Around 80% of global trade by volume and more than 70% by value is handled by sea and managed by ports globally (Kang, Wu, Yu, & Su, 2022, p. 1). The percentage is even higher in the majority of developed countries. The European region benefits from huge volumes and proximity to vital ports. This contrasts with most emerging regions, such as Africa, where a third of the countries are landlocked and not close to ports (Konstantinus, Zuidgeest, Christodoulou, Raza, & Woxenius, 2019). Consequently, international trade in such countries relies on efficient regional transport systems via logistics hubs. As a result, most ports in developing countries are leveraging their inherent marine edge and repositioning themselves as preferred logistics and distribution hubs for landlocked countries. Furthermore, the rise of mega-ships and the formation of mega-strategic partnerships generate increasing economies of scale, necessitating a centralised logistical approach that incentivises ports to increase capacity and enhance efficient cargo throughput to handle increased volumes (Chinemerem & Ogochukwu, 2018). The transport system’s preparedness includes ensuring that port operations have the capacity required to facilitate global trade. Although several studies have shown that investment in port infrastructure led to economic growth, most research on seaborne commerce's economic impact have only focused on one seaport or region.

A complete picture of how seaborne trade affects the global economy is still lacking (Munim & Schram, 2018). Kinsey (1981) stated that, in the context of the Port of Liverpool, the port’s impact on the local economy was diminishing. This claim was substantiated in more recent studies, one in South Korea (Jung, 2011) and another in China (Deng, Lu, & Xiao, 2013), indicating that port investment is declining. Although Deng et al. (2013) concluded that seaborne trade had no discernible effect on economic growth, they found evidence of a significant positive correlation between regional economic activities and value-added activities at ports, including services such as warehousing and storage (e.g., inventory management), customs clearance and documentation (e.g., import/export procedures), value-added processing (e.g., assembly, packaging), and distribution and logistics services (e.g., transport coordination). This reflects the changing functions of ports, which have evolved from being primarily focused on services to being viewed as a critical component of the supply chain and a natural focal point for regional development by providing value-added logistical services. The latter presents a research gap. Nevertheless, this study investigated how transport systems add value for the logistics hub.

The Namibian Ports Authority (Namport) is mandated to develop and operate all seaports within the borders of the country. It currently only operates two ports, namely, Luderitz and Walvis Bay. Namport’s medium- to long-term policy objective is to make Walvis Bay Port the preferred port in Southern Africa and to develop strategic partnerships with operators in the region to attract increased freight volumes and contribute to the country’s economic development. Key strategic projects planned by Namport include expansion of the port of Luderitz to accommodate the development of the Southern Corridor Development Initiative (SCDI), which aims to produce and export green hydrogen from Namibia. In addition, Namport plans to conduct a feasibility study for a third port at Agra Fria in northern Namibia (Namport, 2019).

2.6.2 Rail transportation system

A railway system is comprised of a vast network capable of providing safe, efficient, and environmentally-friendly transit across a region, connecting cities and centres of economic activity with developing rural areas. According to Rodrigue (2020), rail networks are characterised by fixed lines structured in a linear nodal hierarchy with nodes connected to intermodal yards, railway stations, and transit stations, making them more resilient. However, railways in the Southern African region were built to transport natural resources rather than facilitate regional or continental connectivity and economic integration. This historical association persists and limits countries from capitalising on the railway's competitive edge. According to Avogadro, Cattaneo, Paleari and Redondi (2021), railways are widely recognised as a rapid, ecologically beneficial mode of transport that is exceptionally competitive across medium-to-long distances due to economies of scale. Rodrigue (2020) adds that when a single rail line is compared to a standard four-lane highway, rail is much more efficient in terms of capacity and land use. Pyrgidis (2021) agrees that the railway is intrinsically competitive in heavy haul, high-speed intercity and heavy intermodal transport. However, trucks account for up to 98% of freight transportation in Africa, while railroads account for less than 2% (Lesmin, Hidayat, Firdaus, & Liew, 2017).

According to Saruchera (2017), despite substantial infrastructure investment in Africa's rail systems, businesses and travellers have abandoned train transportation and opted for road transportation. This creates challenges such as congestion, safety and security issues, environmental concerns, high fuel inefficiency, higher logistical costs, and load constraints. Logistics hubs integrated with freight railways systems have emerged as one option to circumvent the limits imposed by other inland transportation modes by integrating trains with ports and roadways (Zeng, Lu, Lin, Yuen, & Li, 2020).

The existing African railway system is unattractive to freight users and passengers in terms of speed, transit time, reliability, availability, accessibility, safety, and railway system interoperability among neighbouring nations (Oumarou, 2015). African railway authorities thus need to prioritise railway investment to strengthen the transportation system and enable the development of regional logistics hubs to maximise railway usage. The historical inadequacies are entrenched and need to be addressed by a comprehensive strategy to form new structures that will enable organisations to operate in an effective and efficient manner. Government and political realities are also contributing to rail transporting company TransNamib's current reality.

This suggests that, while Government's role in a parastatal's affairs is inevitable, it must be redefined to ensure strategic effectiveness and efficiency. For example, South Africa's Spoornet has included government spending in its planning to manage future risk and has made the smoothening of the regulatory environment a key goal for government involvement in its affairs as a parastatal. This might suggest that, in the case of TransNamib, the government could (strategically) play a more constructive role than simply providing bailouts and subsidies and may, in future, be a more positive contributor to TransNamib's efficiency and effectiveness. These observations suggest that superficial interventions at TransNamib will prove ineffective. Addressing the underlying causes of prevailing issues and implementing strategic change are essential for substantial and enduring transformation in the long term.

Government needs to embrace innovation, with the emphasis on the provision of comfort elements like subsidies and bailouts replaced by a more strategic emphasis on government as the driver of a more expedient regulatory environment and an investor in the future independence of the rail service provider. The intermodal approach to the management of supply chain dynamics is key to the future of the supply chain. An intermodal supply chain delivers more effectively in the logistical process and may yield economic benefits at institutions such as TransNamib. Rail transportation should be repositioned as the preferred means of land transport and the backbone with which all other modes of transportation merge. Strategic interventions will be required to revitalise the rail industry.

Pipeline transportation for piped gas or liquid fuels is another method of moving bulk materials. These pipelines should be discussed in the context of shifting freight from road to rail and pipelines. Intermodal networks' operations are enhanced by the railway system through the compatibility of standardised containers for the transportation of freight. Ports receive consignments from shipping lines that are destined for a delivery point inland. They are then delivered to the end customer using the most cost-efficient, reliable and safe mode of transportation. In most cases, due to the large volume of carrying capacity, railways offer the best alternative to road transport. However, they are limited in terms of network accessibility and their seamless intermodality with road transport plays a key role in last-mile delivery.

The functionality of inbound and outbound port operations can be strengthened by linkages to railway systems. Port-rail connectivity is a vital aspect of port development, both in terms of economic benefits and competitiveness, and in order to reduce the effects of negative externalities on people and the environment. Not only does proper rail connectivity expand the port hinterland and thus increase the capture of new value-added goods and services for the port, but it also promotes capacity growth without affecting the port-city relationship by connecting "spatially" fragmented processes without congesting the urban environment surrounding the port. As the national railway operator, TransNamib is responsible for all railway operations in Namibia. However, the development of the railway infrastructure still lies within the mandate of the Ministry of Works and Transport.

TransNamib's current major strategic objective is the implementation of the "Road to Rail strategy". Its objective is to attract and divert freight traffic from the road network to rail transportation, as road transport accounts for 98% of the freight market share (TransNamib, 2022). Key initiatives in TransNamib's medium- to long-term strategic plans include the acquisition of new rolling stock to improve operations, auctioning non-core properties to increase capital liquidity, and support for government efforts to expand railway infrastructure. TransNamib's inability to sustain its own operations and borrow on its own balance sheet to support the government in expanding the railway network has limited the development of the railway sector in Namibia. Furthermore, the legal and institutional framework limits TransNamib's capacity to fully implement its mandate, as the government still retains direct ownership of the railway network.

2.6.3 Road transportation system

Roads play a critical role in passenger and freight transportation systems as they are more flexible in terms of spatial reach. Road transportation serves a multitude of purposes in terms of freight and several modern technologies have been introduced to improve its efficiency. It is used for small shipments over short distances, provides first- and last-mile logistics in a multimodal transport chain, and is one of the few modes capable of providing door-to-door distribution (Rodrigue, 2020; Engström, 2016). Optimising the transportation road network reduces transportation costs in terms of money and time and contributes to regional integration and the cooperation of neighbouring countries (Habiyaremye, 2020). Even though the region recognises that respective policy regimes represent admirable national objectives and strive to assist Government's programme of action, more frequently than not, national planning takes place in silos, and non-integrated approaches become barriers to service delivery.

Furthermore, governments have historically been inadequate custodians of road infrastructure, as it is easier to postpone road maintenance and development due to high costs and budgetary constraints. As a result, numerous countries have privatised the infrastructure and management of road transportation. However, privatisation may overlook social factors. Thus, Rodrigue (2020) proposes that the most economically profitable roadways be privatised, for instance, by handing over road responsibility to a private company which can charge tolls, while the government subsidises the least profitable routes. The SADC Protocol on Transport, Communications and Meteorology advocates for member states to restructure road sector institutions, notably through the separation of responsibility for road sector finance, implementation, and commercialisation to promote a sustainable integrated, multimodal transport system throughout Southern Africa (Monyepao, 2015).

According to a SADC report (Joseph, 2023, p. 28), traffic in landlocked SADC countries will exceed 50 million tonnes by 2030, increasing to 148 million tonnes by 2040, reflecting an 8.2% annual growth rate. The current inadequate regional road infrastructure, and lack of road TDM guidelines call for a realistic regional transport preparedness review. Taking into account specific national circumstances, appropriate thresholds for implementation, and the roles of linkages between TDM, land use management, and transport supply management, the guidelines would serve as a blueprint for all areas of government regarding the full set of measures, and where and how they should be implemented.

The growing middle-income class can afford new vehicles, and the middle to low-income class is able to afford imported used cars, thus increasing the vehicle population across Southern Africa and contributing to increased congestion within countries and at borders. Infrastructure such as border approach roads, traffic lanes, and parking are insufficient, owing to inherent inefficiencies that cause cars and cargo to spend more time at border posts than necessary, putting additional strain on the infrastructure (Tralac, 2021). Other challenges include uncoordinated customs procedures, a lack of computerised and integrated customs management systems and insufficient capacity in terms of the employee complement. Moreover, due to a lack of current technology for inspections, document checking, and information processing, inspections are generally undertaken manually. This is an opportunity to harness modern technology to improve cross-border operations through automation. Automation of the abovementioned process would reduce delays and wastage of resources to expedite easy movement of goods and people across borders in Southern Africa. Furthermore, the application of LOC TRUCK Smart, developed by the researcher in this study, could facilitate seamless cross-border movement by integrating modern automation to minimise delays and resource inefficiencies.

The Road Authority's mandate is to sustainably maintain and develop Namibia's road network. Its current policy objective is to implement four key priority projects identified in the Harambee Prosperity Plan 2 (HPP2); namely Windhoek-Okahandja, Windhoek-Hosea Kutako, Swakopmund-Walvis Bay and Swakopmundd-Uis-Kamanjab at a cost of more than four billion Namibian dollars (Roads Authority, 2020).

2.6.4 Air transportation system

Air transport enables global economic integration and is critical for national, regional, and international connectivity. Thus, policymakers in both developed and developing countries commonly view the construction of new airports or the expansion of existing ones as necessary for economic advancement (Gibbons & Wu, 2017). Elburz, Nijkamp and Pels (2020) state that airports have become a critical component of regional transportation policies as a result of increased opportunities to utilise aviation infrastructure due to globalisation and trade openness. Dimitrios and Maria (2018) add that air transport and regional development policies should promote greater understanding of the need to address air transportation-related concerns in central and remote regions to stimulate economic competitiveness and social cohesion. According to Adler, Niemeier, Graham, Betancor, Antunes, Bilotkach, and Martini (2020), critical policy issues concerning air transport and regional development in relation to connectivity and accessibility should address dependency, airport governance and regulation, and air traffic control frameworks. This means that a regional developmental policy perspective should be adopted in assessing whether an air transport system is prepared to facilitate a logistics hub.

Furthermore, the increasing role of drones in the 21st century promises to enhance the efficiency of transportation networks and they could serve as a valuable tool to monitor and collect information within busy harbours and ports. The aviation authorities' approval of drone usage in SADC countries would simplify operations, but may also raise concerns related to security and privacy.

The Namibian Airports company (NAC) owns and operates eight airports across Namibia, including international airports in Windhoek and Walvis Bay and six domestic airports. Following declining growth in the aviation sector, the NAC has prioritised meeting the requirements of the International Civil Aviation Organisation (ICAO) audits in order for Namibia to maintain compliance with international civil aviation laws on safety, security and an improved passenger experience at the country's airports. Its current major project is the expansion of the Hosea Kutako international airport terminal near Windhoek in order to comply with the requirements of the ICAO audits.

2.6.5 Multimodal transportation system

A substantial proportion of Africa's transportation infrastructure was created during the colonial era, hampering interregional connectivity and smooth modal integration for intermodal benefits (Chenikwi & Wang, 2019; Okyere, Yang, Aning, & Zhan, 2019). Most developing countries' transportation systems have been degraded or neglected for an extended period of time, with a knock-on effect on the seamless interconnection of the transport modes necessary to sustain efficient transportation operations both within the country and for exports. Developing countries lack efficient multimodal transportation infrastructure, causing a disconnect between railway, sea, and airport systems (Onyemechi, Sule, Igboanusi, & Ezenwa, 2020).

Consequently, most developing nations are entirely dependent on road transport infrastructure to connect airports and seaports, overlooking other transportation modes. This practice is fraught with cost inefficiencies, greenhouse gas emissions, traffic congestion, accidents, high maintenance costs and service deficiencies (Okyere et al., 2019). According to Chenikwi and Wang (2019), the most popular means of travel in Africa is by road, followed by air, sea, and rail. Road-rail, road-maritime, road-air, and different additional intermodal combinations are available. It is critical to ensure high connectivity and integration in a transportation system to avoid connectivity issues.

Moyo, Kibangou and Musakwa (2021) emphasise that nodes or interlinks with significant spreading ability are recognised as influential in a regional transportation system. Identifying such influential nodes and ranking them based on spreading capabilities is vital, as this will ensure solid connectedness in the transportation system.

Many developed countries have integrated their transportation systems to improve accessibility and minimise commuting times (Moyo et al., 2021). The reality is different in developing countries where transportation modes are disintegrated. Previous transportation network topology studies focused on unimodal networks. This study aimed to fill this gap by investigating transportation networks' intermodality, connectedness, challenges and accessibility to facilitate a regional logistics hub.

Africa is regarded as the world's fastest-growing economic hub (Leke, Signé, & Initiative, 2019). Thus, meeting demand for critical infrastructure is prioritised. However, a lack of physical infrastructure remains one of sub-Saharan Africa's most pressing developmental challenges (Pottas, 2014). The previous section discussed individual modes of transport and it is clear that a regional logistics hub is required to invigorate regional modes of transportation. Inadequate transportation, ICT, water, and power infrastructure impedes increased economic activity, efficiency, and competitiveness (Bonga & Sithole, 2020). While the rest of the world wants to trade with Africa (Ilunga, 2017), access to the continent's markets, particularly landlocked countries, is difficult due to inadequate infrastructure.

The World Bank's Logistics Performance Index (LPI), a two-year interval interactive benchmarking tool, allows for global comparisons across 155 countries. The index aims to assist countries to identify trade logistics performance challenges, opportunities and areas for improvement. Countries are rated based on customs, infrastructure, international shipments, competence, tracking and tracing, and timeliness, which are scored out of five (World Bank, 2016). Namibia is ranked 79th on the LPI (World Bank, 2018). The World Bank's KPIs are also essential in identifying potential challenges in developing a logistics hub. The results presented in Figure 2.3, which depicts SADC countries' LPI ranking for 2016, support Pottas' (2014) claim that infrastructure remains the biggest challenge for African countries, specifically within transport.

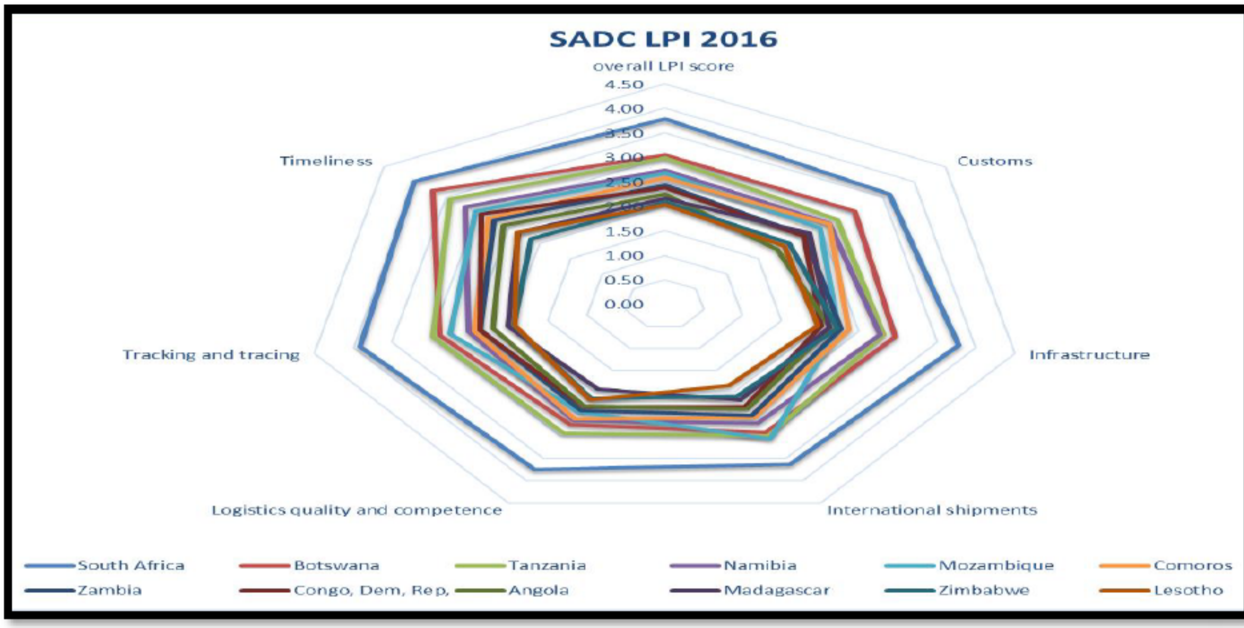


Figure 2-3: SADC 2016 Logistics Performance Indicators

Source: World Bank (2018)

South Africa is the best-performing country in the region, averaging overall performance of 3.78, followed by Botswana (3.05), Tanzania (2.99), Namibia (2.74) and Mozambique (2.68). SADC members such as South Africa (3.78), Botswana (2.96), Namibia (2.76) and Tanzania (2.81) performed above average on infrastructure factors, averaging 2.5, with Namibia at 2.63, Botswana at 2.74, and South Africa at 3.75. The rest of the SADC countries scored below average. This should be of concern, as it challenges intra-cooperative regional strategies (SADC RISDP 2020-2030, 2020). According to Liu (2020), disproportionate regional performance hinders unified efforts.

Figure 2.4 compares Namibia's performance with the rest of sub-Saharan Africa and the best-performing regions, Europe and Central Asia, using the 2016 World Bank LPI.

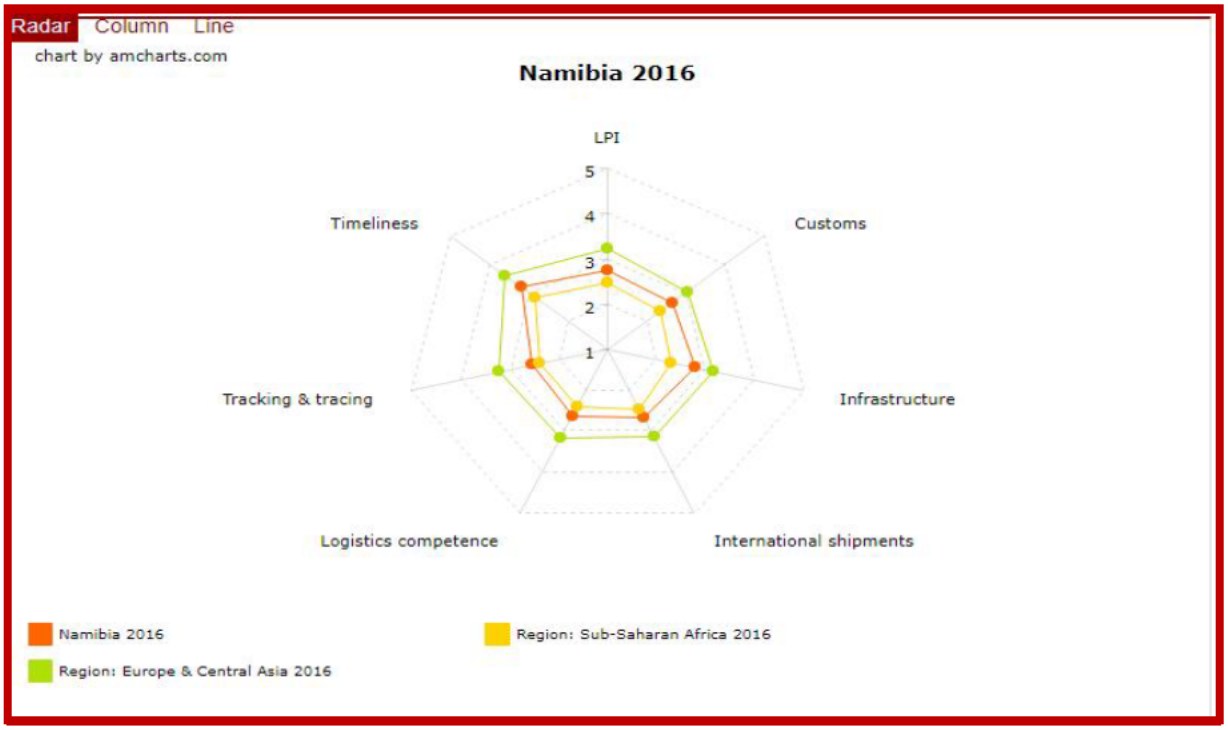


Figure 2-4: Namibia and sub-Saharan Africa vs Europe and Central Asia LPI

Source: World Bank (2018)

Compared to Europe and Central Asia, sub-Saharan Africa underperformed with an overall performance of 2.47, albeit improving (Jaramillo et al., 2018, p. 41). Namibia (2.73) performed just above the average for sub-Saharan Africa. However, the results highlight the significant performance gap when Namibia is compared with the best in the class, namely, Europe and Central Asia (3.23). Nonetheless, its performance is reasonably above average and not that far behind Europe and Central Asia. The LPI factors were used to review the challenges experienced in establishing a regional logistics hub.

Developing multimodal transportation systems is critical for efficient and integrated African logistics operations. However, the region faces challenges with intermodal connectivity, disintegrated transport modes, and inadequate infrastructure. To address these issues, it is necessary to prioritise integrating transportation modes, improve intermodal connectivity, and invest in physical infrastructure. This will enhance accessibility, reduce transportation costs, and promote regional economic growth and competitiveness. Establishing a regional logistics hub is crucial for facilitating trade, attracting investments, and stimulating economic development in

Namibia, particularly for landlocked countries. It requires coordinated efforts to improve road, rail, air, and maritime transportation systems, optimise logistics networks, and enhance intermodal coordination. By addressing these challenges and embracing multimodal approaches, Namibia can unlock its potential as a global economic hub and improve its competitiveness in international trade.

2.6.6 Transportation infrastructure

The quality of trade and transport infrastructure remains a significant challenge for regional logistics hubs. Trends show that even though infrastructure might be adequate for the host country, such as South Africa (see SADC LPI Figure 2.3), it is deemed inadequate to service regional transport demand, such as in SADC. Given regional differences and transport patterns, an index of satisfaction with the quality of transportation infrastructure could be utilised to compare the situation among regional countries (Schwab, 2018). Diemer and Dittrich (2019) note that infrastructure adaptation to new mobility patterns and the mobilisation of sustainable infrastructure present significant challenges that call for new investment and a new approach to network and business model design.

Saruchera (2020) argues that a seaport requires certain activities, processes, terminal facilities, and appropriate infrastructure attributes to fulfil integrated inland and maritime transport system functions. Savage, Fransman and Jenkins (2013) highlight dilapidated railway networks, road capacity and conditions, and restricted port capacity as infrastructural constraints that impact logistics operations and development. A regional logistics hub requires an efficient transport system that relies on unified regional investment in new infrastructure, refurbishment, and modernising the existing transport network.

While limited port capacity has been cited as one of the challenges, this study considered a new dimension in examining increased port capacity at Walvis Bay, which exerts pressure on public roads since roads are the most used intermodal transportation, compromising road safety. Furthermore, increased port capacity created numerous opportunities for the rail transportation mode, which have not been tapped. Lastly, the Namibian government has sourced funds to rehabilitate key links in the country’s rail network, including the Walvis Bay-Arandis (91 km) and Arandis-Kranzberg (119 km) section (AfDB, 2017).

2.6.7 Information and Communication Technology (ICT) infrastructure

Industry 4.0 introduced new technological solutions and Internet usage in business processes, which resulted in the concept of Logistics 4.0 (Yavas & Ozkan-Ozen, 2020; Amr, Ezzat, & Kassem, 2019). Amr et al. (2019, p. 2) explain that Industry 4.0 involves networking and integration of internal and external trade organisations and manufacturing facilities' logistics operations, all the way up to decentralised real-time control of logistics networks, including corresponding solutions such as Cyber-Physical System (CPS) for interconnectedness. An efficient and robust Logistics 4.0 system is essential for resource planning, warehouse and transportation management systems, intelligent transportation systems, and information security (Yava & Ozkan-Ozen, 2020). However, adopting Logistics 4.0 requires transport systems and hubs to adapt to new technological developments such as ICT, production technologies, digitalisation, big data usage, the Internet of Things (IoT), robotics and automation, blockchain and Radio Frequency Identification (RFID). Digitalised logistics infrastructure is crucial to developing and operating an efficient logistics industry. Deloitte (2020) states that one of the most severe developmental challenges facing sub-Saharan Africa is a lack of ICT infrastructure (Manda & Ben Dhaou, 2019). Inadequate communication infrastructure impedes more significant economic activity, efficiency, and competitiveness. There is global interest in conducting business in Africa; however, accessing the continent's markets, especially those in the hinterland, presents significant challenges due to inadequate infrastructure (Ma, Jia, She, Haralambides, & Kuang, 2021). Inadequate ICT infrastructure inhibits regional logistics hubs' ability to adopt intelligent transportation systems that enable the synchronisation of regional transport operations, given that developing countries have challenges in adopting new technologies despite the available resources. Nevertheless, there is an opportunity to start small by using modern technology in corridors, the intelligent system in ports (simple tracking and tracing), and billing or information technology in integrated systems for supply chain members.

2.6.8 Customs regulations

Digitalised logistics systems are crucial to developing and operating an efficient logistics industry free from lengthy cross-border procedures and hindrances in administrative and customs clearance. Cumbersome and time-consuming administrative and customs clearance procedures negatively impact global trade shippers and clients; for example, cumbersome and inconsistent reporting and inspection procedures for notifying the port, coast guard, immigration and health authorities, and other government agencies, cargo handling requirements, and other vessel services required. Moreover, global trade confronts customs and border control challenges such as import/entry processes, tariff classification, customs automation, valuation, country of origin labelling, duty assessment and timely and accurate customs decisions (Liutkevičius, Pappel, Butt, & Pappel, 2020; Konstantinus, Zuidgeest, Christodoulou, Raza, and Woxenius, 2019; Bell, 2017). Lengthy cross-border procedures and barriers are also a significant challenge. Revamping complex regional administrative systems should thus be a priority. Due to the extensive customs bureaucracies, formulating operational and administrative procedures to improve services is challenging, particularly at the regional level. Developed and developing countries have distinct, stringent customs law regimes (Bell, 2017). As a result, stakeholders in logistics hubs are required to familiarise themselves and comply with various countries' customs laws to mitigate freight delays. For example, according to Japanese customs regulations, the declaration and clearance process is only complete once the shipment is moved to a bonded area. Therefore, a paradigm shift is required in most customs laws to improve regional customs efficiency (OECD, 2015). This implies that the public authorities should act as transformative proactive strategists, coordinators, catalysts, regulators, and operators. In a regional logistics hub context, customs regulations must be coordinated by all member states (Kormych, 2018).

2.6.9 Access to international markets

Macroeconomic factors generally raise the cost of services and may make it challenging to arrange low-cost shipments (Rodrigue & Notteboom, 2020; Zhou, Soh, Loh, & Yuen, 2020). Facility utilisation rates and operational charges influence the ease of arranging competitively-priced shipments (Amin, Mulyati, Anggraini, & Kusumastanto, 2021; Elentably, 2017; Çelebi, 2019). However, longer cargo dwelling times at ports can offset any cost advantage due to delays and more complicated import and export procedures (Kahyarara and Simon, 2018). Furthermore, a transportation system that is heavily reliant on roads incurs high maintenance costs, congestion, negative environmental impacts, and road safety costs (Li, Liu, Wang, Liu, & Meng, 2020). As noted by Dominković, Bačeković, Pedersen, and Krajačić (2018), high energy costs are significant impediments to road transport and commerce. Moreover, 'international shipments' are determined by private sector actions within regulated market constraints informed by public policies (Monios, 2019). Government policies are also critical in promoting economic efficiency in a transportation system (Mi & Coffman, 2019). Increased use of rail and inland waterways provides low-cost connections between landlocked areas and the logistics hub, allowing bulk cargo volumes to be transported over longer distances at a lower unit cost.

2.6.10 Logistics competencies

Globalisation has transformed international trade into a complex and rapidly changing activity. Redmond and Nasir (2020) define international trade as the worldwide transfer of money, goods, and services across national boundaries. Logistics is critical in a global market as it supports the effective and efficient flow of materials and goods; therefore, the interdependence of international trade and logistics competencies remains prevalent in today's global economy (Roberts, 2020; Edirisinghe, 2017). Logistics competencies refer to the logistics hub's ability to provide competitive services to global users at the lowest possible cost (Fahim, Rezaei, Montreuil, & Tavassz, 2021; Maiboroda, Bezuhla, Gukaliuk, Shymanska, Momont, & Ilchenko, 2020). The quality and efficiency of logistics services are highly dependent on macroeconomic factors, including government interventions, which are collectively referred to as logistics performance in accordance with the World Bank LPI (McKinnon, Flöthmann, Hoberg, & Busch, 2017). There are significant disparities in developing countries' logistics performance, which puts strain on logistics capabilities and jeopardises capacity to facilitate successful logistics hubs (Enaifoghe & Adetiba, 2018). While other interventions that affect logistics performance—transport infrastructure, trade corridors, regulations, and services—have been extensively reviewed, several studies have identified a knowledge gap in relation to developing skills and capacities to enhance competencies, particularly in developing countries (LePan, 2021; McKinnon et al., 2017). This study evaluated how inadequate skills and expertise affect regional logistics hubs and explored how to develop and improve logistics competencies, especially at a regional level.

2.6.11 Tracking and tracing

Due to the fact that global supply chains are characterised by diverse suppliers, the likelihood of patriated goods, and customers' need for increased visibility, product tracking and tracing are imperative (Banerjee & Venkatesh, 2019). It is critical to determine each consignment's exact location and its entire transportation route (Ghaderi & Burdett, 2019). Feng, Wang, Duan, Zhang, and Zhang (2020) state that improved traceability leads to more reliable distribution channel processes, a more effective risk management system, and an improved transport system. A supply chain integrates ICT technologies such as the IoT, RFID, cloud computing and blockchain to create a unified method to digitally track and trace products (Banerjee & Venkatesh, 2019). This is accomplished by fully integrating supply chain applications with core ERP software. The IoT connects the physical world to the digital world. Technically, it connects RFID or GPS and other data detection devices to the Internet, thus availing these technologies remotely (Smys, 2020).

Consequently, supply chain participants benefit from information transparency, enabling communication and collaboration. The IoT, RFID, GPS and cloud computing have revolutionised monitoring, tracking and tracing of the product and process by providing information such as the price, date, location, quality, and certifications (Varriale, Cammarano, Michelino, & Caputo, 2021). However, these technologies also pose several challenges linked to a lack of security, standardisation, compatibility and distribution among the players. Blockchain mitigates these challenges by enabling management of products' traceability and visibility through a unified, reliable and tamper-proof shared ledger that is globally accessible by all intermediaries or trusted partners (Varriale et al., 2021).

Information and Communication Technology improves tracking and tracing by enabling information gathering, organisation, and re-distribution with regard to products, services, and trade regulations (Suresh & Vasantha, 2018). However, the high investment risk of advanced ICT systems is a barrier to their adoption, mainly when governments' communications policies and spectrum allocation are uncertain (Lee, 2019). As a result, governments must keep up with the evolution of ICT and create a stable communications framework that allows the private sector to plan logistics. The Organization for Economic Cooperation and Development (OECD) (2015) suggests that country measurement of ICT use for tracking and tracing should focus on 1) a computerised border clearance system, 2) e-government services and e-signatures, 3) telecommunications services that support logistics, 4) encouraging the development of ICT services, 5) cutting-edge tracking and monitoring systems, and 6) sharing trade and logistics data platforms. These measures will significantly reduce border inefficiencies related to time delays, manual operations, the safety and security of goods and passengers, and labour costs.

2.6.12 Timeliness

Consistency in delivery times is captured by measuring shipment timeliness. The regularity with which shipments arrive at consignees within scheduled or expected delivery timeframes is referred to as timeliness (World Bank, 2018). Derhami, Montreuil, and Bau (2021) state that various factors influence shipment times, including product type, planning and management, logistics services, and distance. They can also be hampered by political risks or adverse weather conditions (Board, 2019). Shipment timeliness is primarily an indicator of supply chain reliability (Liu, Huan, Hafeez, & Yuan, 2018). A long lead time is not necessarily a problem if delivery is predictable and demand is stable. However, long lead times are a problem if future demand is unknown (Dalal & Üster, 2021). According to the OECD (2015), possible causes of delays that are not directly related to the performance of domestic services and agencies include mandatory warehousing/trans-loading, pre-shipment inspection, maritime transhipment, criminal activity, and informal payment solicitation. In addition, one of the significant causes of delivery delays has been the need to reroute shipments due to political instability and war in neighbouring countries (Ojala, 2015). Cycle and dwelling time are significant KPIs to measure terminal container performance, affecting cargo transit costs. Cycle time is the average amount of time required to load and unload containers at a port terminal (Tolok & Shemayev, 2021) while dwelling time measures "the average time a container remains in the port before movement from the yard" (UNCTAD, 2016, p. 24).

Prolonged cargo stay times in ports are a critical concern in sub-Saharan African countries since import process delays result in significant trade loss. An efficient truck cycle time is less than one hour, while the dwelling time should be five days (Aminatou, Jaqi, & Okyere, 2018). West Africa has an average dwelling time of 20 days (Raballand, Refas, Beuran, & Isik, 2012, p. 73), whilst Southern Africa has an average truck cycle time of four hours and a dwelling time of ten days (Humphreys, Stokenberga, Dappe, & Hartmann, 2019). Efficient terminal administration, pre-booking, IT management systems and enhanced port access infrastructure can reduce cycle time (Mundy & Penfold, 2008, p. 6). Furthermore, the current different practices and regulations to access infrastructure and markets lead to suboptimal routes, some of which are limited by capacity constraints (Hodzi, Nilsson, Komba, Sutinen, Kautonen, and Laakso, 2020). As a result, shipping times are extended, and costs increase. Any uncertainty at border crossings leads to unpredictability and delays, increased transactional costs, and even the loss of business and opportunities. Multiple and contradictory documentation requirements or lengthy inspection procedures imposed by various government agencies such as the customs, immigration, health and sanitary authorities, police, and other security agencies can contribute to such unpredictability (OECD, 2015). When combined with existing network vulnerabilities, extended dwelling and cycle time, natural disasters, wars, political disputes, or government-imposed legal constraints can cause pervasive, systematic interference, with severe consequences for stakeholders.

2.6.13 Regional intra-port cooperation

The Southern African Development Community is a regional economic community that was established in 1992. It is committed to regional integration, eliminating poverty in Southern Africa through economic development, and maintaining peace and security (Enaifoghe & Adetiba, 2018). The region has experienced rapid, significant, and sustained growth in GDP, foreign investment, and international trade since the late 1990s (Enaifoghe, 2019). Therefore, demand for port services in the region has also increased significantly (Bronauer & Yoon, 2018). To cope with increased demand, member states with a coastline focus on developing and expanding their ports, leading to decentralised port governance in the region. Such decentralisation might intensify competition among ports, leading to overcapacity or underutilisation of facilities. Regional governments should thus direct their attention to port partnerships to reduce the potential adverse effects of competition (Zhang, Zheng, Geerlings, & El Makhloufi, 2019). Huo et al. (2018) suggest that intra-port cooperation simplifies and strengthens trade links to expand a port's hinterland regions and increase its throughput for improved synchronisation and network optimisation. There are diverse types of port cooperation (Huo, Zhang, & Chen, 2018) that aim to intensify stakeholder partnerships and systematic integration. Regional stakeholders with a vision to become a regional logistics hub cannot decentralise their ports. Instead, they should partner with regional members and be firmly embedded in geo-political and geo-economic policies to align with regional transport systems. Huo et al. (2018) propose that regional member states develop associated policies to establish regional port cooperation strategies.

2.7 Transport system key performance indicators (KPIs)

The proverb "what gets measured gets done" highlights the significance of measuring the right things and excluding irrelevant ones. When an organisation measures its values, it prioritises what can be measured. Transport systems' KPIs are a compilation of measurable metrics that a transport organisation uses to evaluate its performance and determine if it is fulfilling its strategic and operational objectives (García-Arca, Prado-Prado, & Fernández-González, 2018). Trucking companies use transportation KPIs to evaluate their teams' performance, cut expenses, and increase customer satisfaction (Chytilova, Demirova, & Jurova, 2019). Key performance indicators are specified for traffic efficiency, including mobility, reliability, and the condition of the system. The mobility KPI primarily considers journey times on roads and transportation networks and ease of access between specific representative origin-destination pairings. The reliability KPI reflects the ease of mobility and addresses the occurrence and duration of traffic congestion on both the road and transportation networks (Zhou, Wang, & Yang, 2019). Rodrigue and Notteboom (2020) assert that an organised transportation system is required for any nation's socioeconomic development and therefore, a performance measurement tool must be established to track performance. Avrampou, Skouloudis, Iliopoulos and Khan (2019) define performance measurement as assessing progress toward goals, including critical information on infrastructure efficiency, the quality of achieved results, and the effectiveness of institutional operations and their contribution to shared goals.

It is vital to identify appropriate KPIs when conducting performance measurement (Hwang, Han, & Chang, 2020). Djordjevic and Krmac (2016) defined KPIs as metrics used to quantify system efficiency and effectiveness. Almström et al. (2017) summarise the two concepts: a measure results directly from a measurement activity performed to acquire crucial information, while an indicator is compiled using two or more criteria, and is thus more detailed and resourceful for determining or estimating behaviours (Domínguez, Pérez, Rubio, & Zapata, 2019). According to the Environment Protection Agency (2011), transportation performance measurements forecast, assess, and monitor the extent to which the transportation system meets predetermined goals. Therefore, KPIs are objectives that rely on measurements to gain an overview of the transportation system. Data and analytics are used to determine if the system is operating as expected as well as its strengths and weaknesses (García-Arca, Prado-Prado, & Fernández-González, 2018). To ensure the performance of a transportation system, KPIs must be understood and monitored. The performance indicators discussed below are used to measure a transport system.

2.7.1 Uptake of the transport system

This KPI examines the percentage of potential users that uses the transportation network. Although this dimension does not necessarily measure quality, it is a definite indicator of its popularity or users' specific transportation needs. This KPI explores the modal composition of accessible transport and the distance travelled (OECD, 2015). Transportation systems, particularly in transition and developing countries, should be viewed against a socioeconomic backdrop. These KPIs may include interconnection, transport modes' status quo, the availability of different modes of transport, traffic flow (level of activities), the cost of these activities, the safety and accident rate, travel time, speed, security, and traceability (Victoria Transport Policy Institute, 2019). Furthermore, most developing countries rely excessively on one mode of transport, mainly road, resulting in significant modal overuse. Other modes are underutilised due to operational and capacity constraints or because they are non-existent. Ignoring modal usage imbalances may result in biased KPIs. The current study investigated the applicability of these KPIs in gaining a systematic overview and determining the regional logistics hub's uptake of the transport system.

2.7.2 Transport system resilience

Congestion, accidents, weather conditions, special events, inadequate investment, and other costly delays threaten transportation systems. While policy responses typically prioritise delays in order to improve transportation system efficiencies (Ganin, Kitsak, Marchese, Keisler, Seager, & Linkov, 2017), a regionally integrated transport system requires efficient policy frameworks. However, investment decision-making should be data-driven to strengthen transport system resilience, which refers to recovery from disruptions (Yanjun, Jianming, Xinhua, Lishuai, Ping, & Hansen, 2019). In practice, investment in resilience entails identifying and quantifying risk or protecting existing transportation system components from identified threats (Weilant, Strong, & Miller, 2019). The COVID-19 pandemic disrupted pipeline projects and policy frameworks relating to transport systems. Likewise, the transportation system should include formal partnerships with regional governments and other entities to promote investment in transportation (Lam & Yang, 2020). Shared missions and goals should be redefined for better collaboration and recovery from the COVID-19 pandemic. The implication is that resilience should be explicitly considered in transportation system project selection, and investment opportunities should be justified for clear target outcomes of the regional logistics hub (Ganin, Kitsak, Marchese, Keisler, Seager, & Linkov, 2017). Transport system planning should incorporate resilience to optimise all possible transportation routes (Wan, Yang, Zhang, Yan, & Fan, 2018) for all modes.

2.7.3 Transport system efficiency

No single factor determines why one route is more popular than others; however, affordability and accessibility are frequently the primary factors that attract users to a particular logistics hub. If the use of a hub is based on a person's free choice, transport efficiency will be a critical factor in determining uptake of the service (Yanjun, Jianming, Xinhua, Lishuai, Ping, & Hansen, 2019). Three primary factors influence the efficiency of transportation systems: reliability, operational effectiveness, and service coverage. Numerous studies (Rodrigue & Notteboom, 2020; Hu, 2020; Hwang, Han, & Chang 2020; Kumar & Anbanandam, 2019; Amakali, 2017) provide a comprehensive list of the performance indicators used to assess the efficiency of a transportation system. Transportation system performance can be measured in terms of accessibility, reliability, level of service, available infrastructure, mobility, multimodal performance and safety (Djordjevic, Boban, Krmac, & Evelin, 2016). Most transportation authorities have implemented operational efficiency performance standards that identify certain performance thresholds. However, functional efficiency performance requirements are frequently geographically constrained and are not harmonised. Efficiency should be evaluated regionally, particularly when the transport system serves a region, as in the case of a regional logistics hub. This review revealed a gap in the literature as most studies focus on transport system efficiency from a country perspective, with few offering a regional perspective, particularly in relation to Southern Africa.

2.7.4 Transport system safety and security

According to Rodrigue and Slack (2020), safety and security are critical components of a transportation system's ability to sustain itself and improve users and the broader community's quality of life. The hacking and infiltration of Transnet's systems in South Africa in 2021 indicates the danger of cybersecurity breaches in different ports. Rodrigue and Slack (2020) suggest that safety and security issues affect both modes of transportation and terminals in terms of cycle time and dwelling time in ports. Transportation security is a sensitive issue that affects passengers, freight, infrastructure, and transportation providers (Véronneau & Yoho, 2020). Collaboration with security and intelligence stakeholders should thus be strengthened. The protests in KwaZulu-Natal and Gauteng, South Africa in July 2021 rattled the international trade community and extended partners who put their cargo in the hands of freight transporters. However, security should not be so intrusive as to make travel unpleasant.

According to Shange (2017), the shipping industry is exposed to various security risks including cybercrime, terrorism, piracy, trafficking of goods and people, theft, illegal maritime trade, trespassing, environmental damage, and robbery. These risks have intensified due to the industry's extensive international operations and limited regulation. According to Bueger and Edmunds (2020), the large number of ports, the vast global shipping fleet, the variety of products carried on vessels, and the challenge of detection all contribute to difficulty in addressing shipping security. As gathering and dispersal points for people and freight, terminals have long been a source of security and safety problems (Kim, 2019).

Since train stations and airports are among the world's most densely populated sites, management has long been concerned with crowd control and safety concerns (Zhou, Yang, & Li, 2018). Access is regulated and monitored, and movement is guided along channels that ensure the safety of passengers boarding and departing from platforms and gates (Bogue, 2017). However, according to Otu and Ani (2018), road transportation is one of the most frequently used transportation modes in developing nations, and torching and hijacking of trucks disrupt the flow of goods. As the developing world's population increased during the past decade, so did the number of vehicles. While road networks have improved, growing vehicle traffic has intensified safety issues, as household members own cars due to the growth of the middle-income group.

Furthermore, corruption by security and safety authorities through the abuse of roadblocks and checkpoints, especially in relation to road freight trucks departing from Namibian and South African ports to neighbouring countries such as corridors to Eswatini, Botswana, Zambia, Zimbabwe, Mozambique and others, as well as commuters' get-rich-quick mentality, resulted in a deterioration of road safety policies (Otu & Ani, 2018). As a result, the road transport system's ability to move goods and commuters between regional borders is ambitious and insecure (Vourgidis, Maglaras, Alfakeeh, Al-Bayatti, & Ferrag, 2020).

Furthermore, security concerns in the freight business have centred on the following issues: worker safety, freight trucks on national roads, theft, hijacking, robbery and safety. Historically, freight terminals were hazardous workplaces (Gou & Lam, 2019; Saruchera, 2017). Accidents were common as massive consignments were transported and physically loaded into vehicles utilising various material handling equipment, and investment in mechanisation and smart cranes in different ports is critical (Flodén & Woxenius, 2021). Cybersecurity is the most evident and rapidly growing security threat, and transportation infrastructure and businesses are particularly susceptible (Kimani, Oduol, & Langat, 2019). Increased reliance on IT and its associated networks enables remote access, control and management of transport systems (Serrano, 2018). As a result, complex interconnected corporate information networks are vulnerable to hacking and disruption. The advent of Industry 4.0 technology should serve as a solution to these hindrances to a seamless transport system.

2.7.5 Transport system inter-modality

The importance of freight efficiency to a nation's economy has become more evident to legislators, and it has emerged as an increasingly vital component of land transportation rules and regulations (Peprah, Amponsah, & Oduro, 2019). For example, the USA enacted the Intermodal Transportation Efficiency Act of 1991 (Dilworth, 2019), while the National Intermodal Transportation System Act seeks to promote sustainable efficiency and enable the country to participate in the global economy (Dilworth, 2019; Gorev, Solodkiy & Enokaev, 2018). In most developed regions such as America and Europe, it has been the practice to establish national intermodal transportation system policies (Young, Cradock, Eyler, Fenton, Pedroso, Sallis, & American Heart Association Advocacy Coordinating Committee, 2020). Although most developing countries have significant multimodal resources such as seaports, waterways, railways, and roads, they are not sufficiently well-connected to realise intermodal benefits (Okyere, Yang, Aning, & Zhan, 2019). As a result, most of these nations have not enacted policies to integrate their transport systems for seamless regional logistics hubs such as the one envisaged in Namibia.

According to Rodrigue and Slack (2020), the lack of integration between modes was exacerbated by public policy, which either prohibited enterprises from acquiring firms in other modes (as in the USA before deregulation) or placed a mode under direct state monopoly control (as in Africa, Europe, and East Asia). Intermodal transport combines the accessibility of inland transport modes with the long-haul capabilities of ocean shipping (Dilworth, 2019). According to Govender and Mbhele (2014) and Peng, Wang, Wang, and Jiang (2019), containerisation enables multimodal transportation. Heavy containers, infrastructural damage, and frequently severe traffic congestion result from the linkage between containerisation and road transportation. Containerisation and the development of an intermodal transportation system have considerably influenced the shipping industry's structure, administration, and operations.

Rodrigue and Slack (2020, p. 245) define intermodal transportation as

> "the mobility of passengers or freight from the point of origin to a final destination relying on several modes of transportation. Each carrier issues its ticket (passengers) or contract (freight). Transfers from one mode of transport commonly occur at a specifically designed terminal. Therefore, intermodal transportation refers to exchanging passengers or freight between two transportation modes."

As the sub-Saharan African region navigates the path towards a sustainable distribution network and imports vaccines against COVID-19, an intermodality strategy is required to cater for the cold chain implications and transport the vaccine to the vaccination site using the last mile. Kumar and Anbanandam (2020) argue that railways and ocean shipping are economically efficient and environmentally friendly for both developing and developed economies.

Integrating these modes into the primary route can result in significant cost reductions in the supply chain. Africa's geographical characteristics, with its predominantly land surfaces, pose a challenge to achieving efficient and effective development of seamless transport systems. This hinders the intermodality of transportation, particularly in connecting land-based modes of transport to ports. The Hub-and-Spoke theory is a suitable network structure for Africa to simplify a sea-road-rail intermodal transport system. Wang, Yang, Yang and Gao (2018) suggest that improving the sea-road-rail intermodal transportation system results in (1) improved service quality and increased intermodal transportation frequency, (2) economies of scale achieved by centralising activities at the intermodal hub, and (3) the given region gaining market share and competitiveness. Therefore, regional inter-modal transportation streamlines customs clearing procedures (Yang, 2017).

2.8 Transport demand management (TDM)

According to Rodrigue (2020), the capacity of specific transportation facilities and modes over time is referred to as transportation supply. Transport supply between locations i and j is often denoted by Aij. It indirectly combines intermodal supply, which is the ability to tranship traffic from one mode to another, with modal supply, which measures a mode's ability to support traffic. For instance, when providing an air service between two cities, both the airport and air corridor capacities must be considered. The availability of some modes of transportation, like road transportation, depends more on modal capacity, but the availability of other modes, like maritime and air transportation, relies on intermodal capacity. Rodrigue (2020) further defines transportation demand as mobility needs for the same time period, even if they are only partially met. Tij, or the demand for transportation between points i and j, is a measure of transportation demand. The potential transport demand is the amount of traffic that would exist if transportation expenses were minimal or if there were nearly no restrictions on mobility. The amount of transport would be limitless. The traffic that actually occurs, specifically as a function of the transportation costs between origins and destinations, is the realised transport demand, which is a subset of the prospective transport demand. Thus, the limitations imposed by the current transport supply result in the realised demand.

Since the 1970s, when TDM was introduced in the USA, the concept has become broader and somewhat ambiguous due to its widespread application in many professional fields. For example, engineers perceive TDM as a traffic flow control and technology problem (Mohammed, Ambak, Mosa, & Syamsunur, 2019). For their part, economists view it as a derived demand and price issue (Ferguson, 2018), and policymakers view TDM as a means of regulating transportation networks (Swett, 2018; Barcik & Bylinko, 2018). Ferguson (1990) defined TDM as the art of modifying travel behaviour, usually to avoid a more expensive expansion of the transportation system. Mbara (2002) asserted that TDM measures are concerned with altering travel behaviour to enhance efficient use of the existing road infrastructure and facilities. Likewise, the Victoria Transport Policy Institute (2017, p. 2) defined TDM as “a general term for various strategies that increase transportation system efficiency”. Both definitions highlight that TDM focuses on maximising existing infrastructure rather than concentrating on physical expansion. The shared approach is characterised by a strong emphasis on managing mobility demand rather than supply, with significant grey areas. Thus, TDM sees mobility as a tool, not a goal in itself. Numerous TDM approaches exist, each with a distinct effect. As illustrated in Figure 2.5 below, several strategies expand accessible modes of transportation, while others provide incentives to alter travel dates, routes, modes of transport, or destinations. Yet others minimise physical travel by making greater use of existing land or utilising alternate modes of transportation (Barcik & Bylinko, 2018). Whilst most individual TDM solutions have a modest effect on overall travel, the cumulative impact of a holistic TDM approach can be significant.

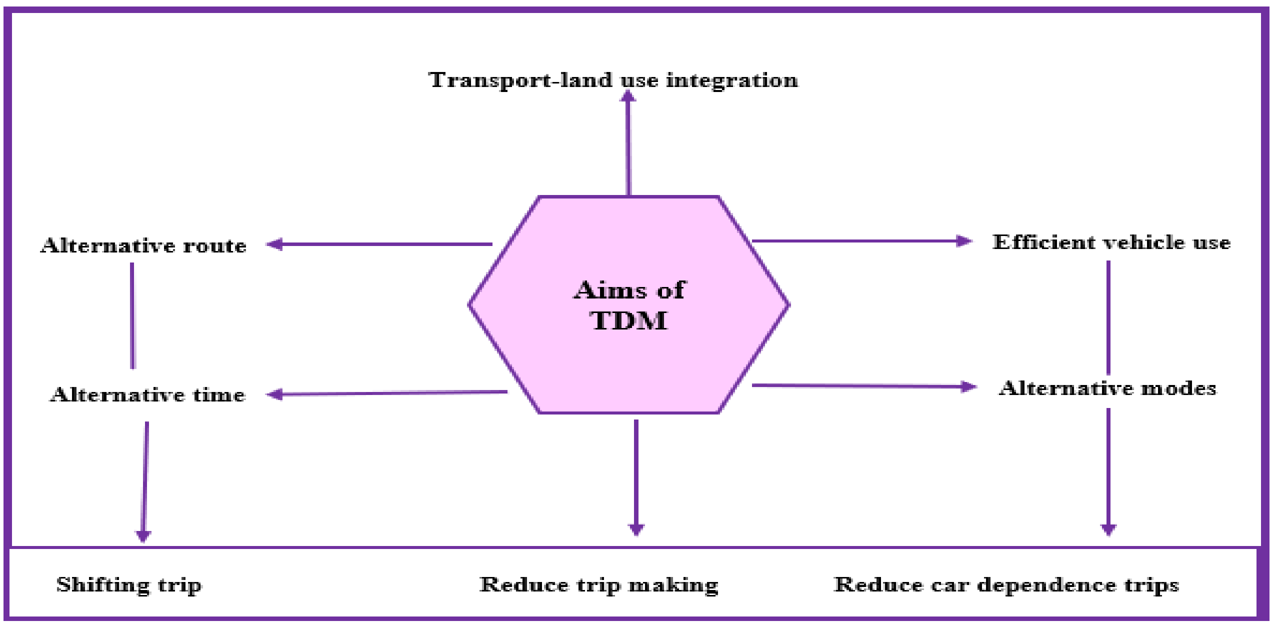


Figure 2-5: TDM Aims and Strategies

Source: Mbara (2002) and Barcik and Bylinko (2018)

The literature reviewed (Farahmand, Gkiotsalitis, & Geurs, 2021; Hörcher, Singh, & Graham, 2021; Swett, 2018; Barcik & Bylinko, 2018; Victoria Transport Policy Institute, 2017; Ferguson, 1990), shows that TDM research has focused on public transportation. As a result, the complexities of freight transportation have received relatively little attention, especially at a regional level, resulting in a knowledge gap. According to Rühl and Boltze (2016), economic growth, the minimisation of regional and international trade barriers, and the trend towards mass customisation have contributed to a significant increase in freight traffic over the past few decades. The development of regional logistics hubs also resulted in a substantial increase in freight traffic. Despite several initiatives to shift traffic to railways, development in freight transport has predominantly focussed on roads (Ottemöller & Friedrich, 2019). Furthermore, there are few alternatives to road freight transportation, particularly in developing countries. Although road freight transport is vital to economic progress, the negative implications of its rapid growth are becoming more evident. Numerous initiatives have been implemented to minimise the adverse effects of freight transportation by improving delivery system efficiency and encouraging collaboration between the public authorities and enterprises (Islam, Bissenbayeva, & Zunder, 2022). Nonetheless, current habits must change; for example, government agencies should assess the influence of their actions on business processes, and businesses should account for the increased traffic generated by their operations (Victoria Transport Policy Institute, 2017). This means that demand for freight transportation must be managed. While mobility management has been used for more than two decades to control passenger traffic demand (Rühl & Boltze, 2016), traffic management still lacks a paradigm shift to influence freight transport demand. This study aimed to close this research gap by developing a TDM framework for a regional logistics hub.

2.9 Synthesis and research gap

Global trade has witnessed several notable trends in the delivery of trade logistics service efficiency and effectiveness, which has fuelled the rise of global transportation systems (Tien, 2019). Economic growth, regional and international trade liberalisation and the trend toward mass customisation all contributed to a significant increase in freight traffic over the past few decades (Rühl & Boltze, 2016). Furthermore, increasing geographic fragmentation of global production, manufacturing, and distribution processes accelerated the evolution of global transportation systems, leading to the emergence of regional logistics hubs (Lorenzen, Mudambi, & Schotter, 2020; AfDB, 2019; Kingombe, 2014). The literature reviewed further highlights that demand for port capacity is rising rapidly, particularly in emerging countries, which have been positioning themselves as regional gateways (Kano, Tsang, & Yeung, 2020; Savage et al., 2013). However, port development efforts are anchored on countries' perspectives rather than regional perspectives.

Furthermore, nationalist regimes invested in port construction, resulting in a proliferation of ports and competition between them. In pursuit of regional development, regional integration schemes were implemented in all sub-regions of sub-Saharan Africa (East, Central, Southern, and West) to manage joint projects and complicated multilateral concerns (political, security, and economic). This could be viewed as a counterforce against counterproductive competitiveness (Olukoju, 2020), hindering regional harmonised development efforts, which are critical for regional economic growth (Frederick, Jarvis, Lansiquot, Roland, & Tuitt, 2019; Akinyemi, Efobi, Osabuohien, & Alege, 2019; Bronauer & Yoon, 2018; Huo, Zhang, & Chen; 2018). The literature suggests that port investments have diminishing economic value (Jung, 2011; Deng, Lu, & Xiao, 2013; Deng et al., 2013).

Ports' expanding role as a focal point for regional development through the provision of value-added logistical services can counteract the negative economic impact due to the fact that 80% of all trade is seaborne (Yan, Wang, Zhen, & Laporte, 2021, p. 1). Few studies have examined the strong positive correlation between regional economic activity and value-added port activity. However, a few studies have been undertaken on the relationship between transportation systems and logistics hubs from a regional perspective.

The literature reviewed further revealed that transport system functional efficiency requirements are frequently geographically constrained and not harmonised (Olarinde, 2021; Aniche, 2021). Efficiency should be evaluated regionally, especially when the transport system serves a region, as with a regional logistics hub. Furthermore, most of the literature focuses on transport system efficiency from a country perspective, with limited research from a regional perspective, particularly in Southern Africa (Frederic, Huang, & Mao, 2021; Pungnirund, 2020; Ma, Li, Sun, Liu, Wang, & Bai, 2018). This has resulted in ambiguity regarding the relationship between transport network indicators and network performance, the impact on the broader socioeconomic system, and insights into the most effective strategies to expand networks regionally. There is thus a knowledge gap on how transportation networks contribute to regional logistics hubs and how port development corresponds to transport system development.

The lack of empirical investigations that systematically review the transport system as a whole is thus evident. In terms of the current transportation network topology, most studies concentrated on unimodal networks, where transport systems are viewed from a single viewpoint, such as ports, roads, rail, etc. Nevertheless, a few focused on the relationship between transport systems and how each sub-system affects the other. For example, some studies have investigated how port expansion, a rising trend in developing nations, impacts the operational efficiency of various transport modes.

This study applied network analysis, and the Hub-and-Spoke and stakeholder theories to address this research gap by assessing connectivity, accessibility, and centrality within regional transportation systems. The theories were also employed to examine the relationships between the studied variables. They postulate the economic benefits of transportation systems by conceptualising how connectedness enhances network resilience, reliability, and performance while lowering costs (Hamidov, 2019; Tanuja, Ivan, & Chi, 2018). They are able to identify influential nodes within the SADC regional transportation system and rank them according to spreading capabilities to determine the system's connectivity, accessibility, and centrality.

As highlighted in the literature, these criteria are critical in formulating the integrated transportation system necessary to facilitate the development of a regional logistics hub. This study on Namibian transport systems' preparedness to facilitate a regional logistics hub offers valuable insights into traffic flow, travel demand, network centrality, and connectivity to transportation planners and relevant stakeholders.

2.10 Conclusion

The study employed a thematic literature review approach while the theoretical postulations and propositions entrenched the structure. The findings of the review suggest that the world has evolved into a global village, and today's businesses' supply chains have become more globalised as transportation and logistics have become more efficient. All forecasts predict that global trade will grow, mainly through these gateway regions. Therefore, transport systems must be efficient and effective to facilitate regional gateways. Transport systems are represented by networks comprising a series of connecting points or routes. Economic and social networks determine any region's structure, resulting from a trade-off between the desire to connect as many points as feasible and the cost and infrastructure development constraints.

When the transportation system is considered regionally, these connections become more challenging. The majority of regional transport systems face challenges related to transport and ICT infrastructure (Yava & Ozkan-Ozen, 2020; Diemer & Dittrich, 2019; Schwab, 2018), nonharmonised customs regulations (Liutkevičius, Pappel, Butt, & Pappel, 2020; Konstantinus, Zuidgeest, Christodoulou, Raza, and Woxenius, 2019; Bell, 2017), accessibility to international markets (Rodrigue & Notteboom, 2020; Zhou, Soh, Loh, & Yuen, 2020), logistics competencies (Fahim, Rezaei, Montreuil, & Tavassz, 2021; Maiboroda, Bezuhla, Gukaliuk, Shymanska, Momont, & Ilchenko, 2020), tracking and tracing (Feng et al., 2019), timeliness (World Bank, 2018; Liu et al., 2018) and regional intra-port cooperation (Huo et al., 2018; Zhang et al., 2018).

Furthermore, the EU has notable influence in Africa, including Namibia where this study was conducted. Inadequate infrastructure and silo planning approaches hinder Africa's ability to achieve its full economic potential. The EU promotes regional cooperation in relation to transport systems and infrastructure to address this. It advocates for standard trade policies and unilateral deregulation to overcome the effects of silo transport systems, such as cabotage regulations. However, it is worth noting that the literature primarily focuses on transport system efficiency from a country rather than a regional perspective, particularly in developing nations. Nevertheless, the EU's influence in Africa, including Namibia, is evident through its support for infrastructure development, trade promotion, and efforts to overcome transport-related challenges.

The literature also highlighted a trend towards the development of regional logistics hubs. However, few studies have focused on the relationship between the vision of a regional logistics hub and integrated transport systems. A research gap prevails in terms of a holistic review of transport systems' preparedness to facilitate a regional logistics hub. Moreover, the complexities of freight transportation have received relatively little attention, particularly at a regional level, resulting in an additional knowledge gap. This study used TDM as a tool to manage freight transportation. Incorporating the concepts of network analysis, and the Hub-and-Spoke and stakeholder theories, it aimed to assess connectivity, accessibility, and centrality within regional transportation systems to determine the system's connectivity, accessibility, and centrality to a regional logistics hub. Furthermore, the study aimed to develop a TDM framework for such a hub.

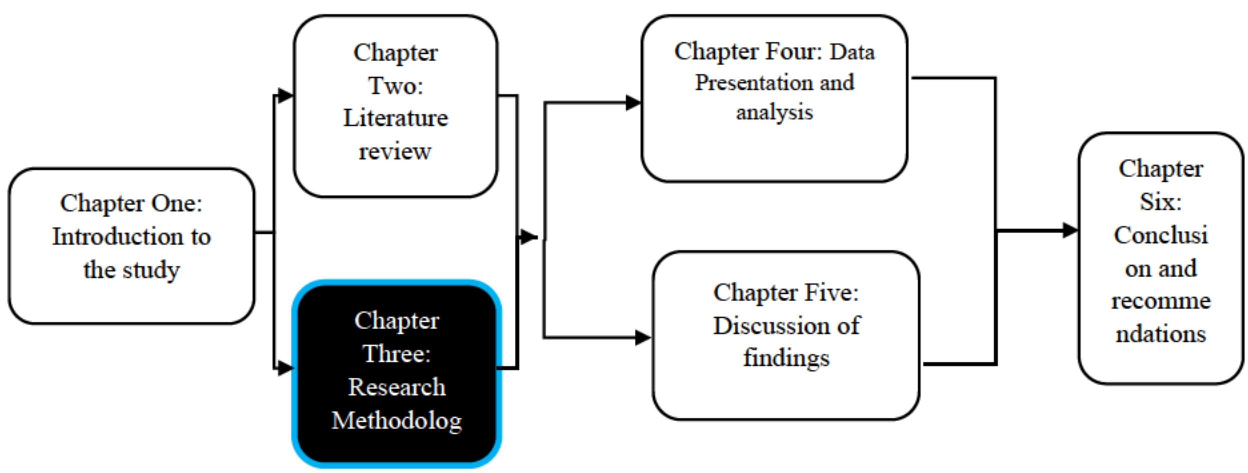
CHAPTER THREE:

RESEARCH METHODOLOGY

"What's unique about transportation is that it's the one function that repeats itself throughout the supply chain." ~ John Murphy

3.1 Introduction

This chapter discusses the research methods and methodologies used to conduct the research and highlights the data analysis methods that were used to produce the findings presented in Chapter four. It covers the research design and paradigm, which provided the basis for this investigation; the framework for data collection, focusing on the study site, population, sampling strategies, the sample size and the quantitative and qualitative data collection tools; and the ethical considerations taken into account in conducting the study.



3.2 Research design

Akhtar (2016) defines a research design as a blueprint that sets out how a study will be conducted. This study employed a mixed method design, which involved documentary analysis and interviews, as well as the administration of a questionnaire to determine the association between transport systems (independent variable) and the logistics hub (dependent variable). Creswell (2014) notes that a causal design measures the impact of a specific change on an existing norm and assumption. McCombs (2019) states that a causal approach can be employed to explore a phenomenon in depth and understand its causal effect. The mixed method design enabled internal validity by cross-examining the findings from the data gathered by means of closed-ended questions through in-depth interviews. Similarly, the questions posed in the interviews and questionnaire were validated by being taken as they were or as notions emanating from previous studies. Analysing the efficiency of a method to support cause and effect statements enables an assessment of the extent to which a particular study's outcomes can be generalised (Hair, Page, & Brunsveld, 2019).

The theory that underpinned this study suggests that logistics hubs depend on transport systems for increased efficiency (dos Santos Vieira & Luna, 2016). Therefore, the research aimed to measure the extent to which Namibia's transport system is prepared for the envisioned logistics hub or how becoming a hub will advance existing transport systems. The mixed method research design enabled the researcher to gather both qualitative and quantitative data to identify the challenges that inhibit the development of a regional logistics hub in Namibia and to analyse the extent of transport networks' connectivity and accessibility to facilitate such a hub.

3.3 Research Philosophy

The research study adopted a pragmatic philosophy, allowing for a mixed method design that combines quantitative and qualitative methods to build on each technique's strengths and overcome its weaknesses. Creswell (2018) explains that a mixed methodology is an evolving research technique that involves the systematic combination or mixing of quantitative and qualitative techniques and data within a single study or ongoing investigation. Choy (2014) argues that a mixed method is superior to a mono-method approach in three ways. First, when using the mixed method approach, the researcher has the opportunity and flexibility to answer research questions that other techniques cannot tackle. Secondly, the interpretations reached using a mixed approach are contextual. Thirdly, the methodology allows for free expression of divergent views.

A convergent parallel mixed method approach was used in which the researcher collected qualitative and quantitative data at around the same time and integrated the information when interpreting the results. Pragmatism views the effects of concepts and behaviours as essential components of meaning and truth (Collis & Hussey, 2018). According to Creswell (2014), a pragmatic paradigm is a worldview that prioritises practical effectiveness over objective truth or reality. Malhotra (2016) describes a paradigm as an underlying presumption that supports a broad worldview. The mixed method approach used a pragmatic worldview and simultaneous qualitative and quantitative data collection, giving the researcher sufficient freedom to use any technique deemed necessary at any stage.

The study was systematically developed to ascertain the experiences of stakeholders in the transport and logistics industry to inform the development of a logistics hub. Bosch-Rekveldt (2015) states that one of the pragmatism phenomenon's function is to test hypotheses and explain the causal relationships between variables as well as to assess the influence of various factors on phenomena like a logistics hub, transport systems, and transport systems' preparedness towards a regional logistics hub. This approach is practical when exploring individual experiences and perceptions. The research question that formed the basis for the formulation of the hypotheses was the extent to which transport networks facilitate the Namibian vision of developing a regional logistics hub. The following hypotheses were tested:

Table 3-1: Study Hypotheses

Source: Author's compilation (2022)

Hypothesis 1 General Preparedness H_{01} H_{A1}	(H_0) – The transport systems' preparedness in Namibia has no impact on attaining a regional logistics hub status.
	(H_1)- The transport systems' preparedness in Namibia has an impact on attaining a regional logistics hub.
Hypothesis 2 tested on Rail Cargo H_{02} H_{A2}	(H_0) There is no significant difference in rail cargo received between 2015 and 2019.
	(H_2) There is at least one year with a different mean rail cargo from the rest.
Hypothesis 3 tested on Road Cargo H_{03} H_{A3}	(H_0) There is no significant difference in cargo received between 2015 and 2019.
	(H_3) There is at least one year with a different mean cargo from the rest.

Hypothesis 4 tested on Sea Landed Cargo **H_{04} H_{A4}**	(H_0) There is no significant difference in cargo received between 2015 and 2019.
	(H_4) There is at least one year with a different mean cargo from the rest.
Hypothesis 5 tested on Mean Cargo for Road, Rail and Sea H_{05} H_{A5}	(H_0) There is no significant difference among the group means.
	(H_5)There is a significant difference among the group means.

3.4 Study Site

The study site is an "area of study or a location where researchers or people conduct research" (Mishra & Alok, 2017). Cohen, Manion and Morrison (2018) state that geographical boundaries, known as study areas, are used to specify the scope of the researcher's investigation. A study area is further described by Collins and Hussey (2018) as a place that is purposefully chosen because no research on a subject matter has been done in that region. The study site for this research was Walvis Bay, in the Kunene region, Erongo province in Namibia, as it hosts the logistics hub and is therefore central for all stakeholders. Walvis Bay is Namibia's largest logistics hub that has provided a gateway for goods and equipment within Southern Africa, especially landlocked countries. As the site where the Southern African region's significant logistics and transport services link with the rest of the world, it was ideal to obtain relevant data to answer the research questions.

3.5 Target Population

The target population refers to the entire population or group that the researcher intends to investigate and analyse (Creswell & Creswell, 2017). Ragab and Arisha (2017) explain that the sample is drawn from a fraction of the target population, known as the study population. It goes beyond the concept of a sample frame in scope. The group of elements to which the researcher wishes to apply interpretation is the target population (Leavy, 2022). The study population comprised a list of 733 Walvis Bay port stakeholders and 12 port users obtained from Namport (Namport, 2019). The researcher solicited the views of employees and management working for the targeted 733 stakeholders. The research population thus encompassed all operational and management personnel working for these companies.

3.6 Sampling Strategies

Sampling is a "statistical research process in which a set of samples are taken for measurement from a larger sample" (Nordgaard & Correll, 2018, pp. 31-46) Kennedy and Montgomery (2018) describe the various methods used to select participants or respondents from the study population. Ragab and Arisha (2017 explain that sampling refers to the procedures employed to select a sub-group from which conclusions are drawn about the broader population. Thus, the sampling approach must provide the confidence and statistical power necessary to draw the correct inferences (Hair, Wolfinbarger, Ortinau, & Bush (2020). This study employed both probability and non-probability sampling strategies. In the probability category, strata sampling was used to define categories for the unit of analysis and select respondents in the identified categories. Given that the phenomenon of regional logistics hubs is a multi-sectoral issue, a broader stakeholder approach was deemed necessary to ensure the collection of robust, complementary data.

Strata sampling allowed all possible levels of the population to participate. The stakeholder list was classified into the following existing strata: regulatory customs and border control, direct stakeholders, freight forwarders, trucking companies, and vessel agents (see Table 3.2). In terms of non-probability sampling, convenience sampling was employed to select interviewees in line with the time frame and their availability. Available participants within the defined strata were selected. The researcher evaluated the size of each stratum and determined if it was feasible to include all participants from each stratum. If a stratum was too large, including all participants was challenging or impractical. Therefore, the researcher included available participants from those strata. Qualitative data were collected through interviews with participants in almost all the strata that ranged from regulatory customs and border control, to direct stakeholders, freight forwarders, trucking companies, and vessel agents, while quantitative data were simultaneously collected by means of a questionnaire using the same strata. The use of probability and non-probability sampling was enabled by the fact that the study adopted a pragmatic view, which allows for flexibility in using the most appropriate strategies and techniques that enhance the research.

3.7 Sample Size

A sample is a selected subset of the population chosen to participate in the research study. It represents a portion of the population under investigation (Hungler & Pilot, 2015). The researcher employed a probability sampling technique in the form of strata sampling to divide the population into the clusters listed in Table 3.2. The logistics hub users were grouped according to their roles and interest in the hub following the Japan International Cooperation Agency (JICA) report that provided guidelines on critical issues and key informants in relation to what constitutes the development of an ideal hub. Stratified sampling methods were employed, with sample representatives drawn from each of these strata, as shown in Table 3.2. Each stratum had an equal chance of being part of the study.

The study employed the Cochran formula, which enables calculation of an optimal sample size given a required level of precision, a specified level of confidence, and an expected proportion of the attribute in the population. Cochran's formula is deemed particularly applicable in circumstances involving a very large population (Cochran, 1977). For the quantitative questionnaire, the study employed this formula to obtain a sample size of 384. The saturation concept was used for the qualitative interviews in which 12 participants were reached. This is a common practice in qualitative research, wherein researchers opt not to set predetermined sample size criteria. Instead, they strive to comprehensively investigate the research area until reaching a state of satisfaction or until data redundancy is reached, signifying the lack of new novel information. Saturation level was reached at 12 participants, and the researcher determined that sufficient information had been gathered to adequately address the research questions and explore the themes of interest.

Equation 3.1: Cochran's formula

$$n_0 = \frac{Z^2 pq}{e^2}$$

Source: (Sekaran & Bougie, 2016)

Where:

- $Z=1.96^2$
- e is the desired level of precision of 0.05^2
- p is the (estimated) proportion of the population which has the attribute in the question of 0.5
- q is $1 - p$ or 1-0.5

Sample size calculations:

$$n_o = \frac{1.96^2 \times 0.5 \times (1-0.5)}{0.05^2}$$

$n_o = 384$

Table 3- 2: Sample size (quantitative)

Source: Author's compilation (2022)

Strata	**Sample group**	**Population per strata**	**Sample size**
Government	Regulatory customs and border control	5	3
Operators (public and private)	Direct stakeholders	431	228
Rail transporters	Freight transporters	98	49
Agencies	Freight forwarders	113	59
Truckers	Trucking companies	32	17
Sea transporters	Vessel agents	54	28
Total		**733**	**384**

A sample size of 384 was determined using the Cochran formula.

3.8 Data collection methods

Hair, Page, and Brunsveld (2019) describe data collection as a systematic method to obtain accurate data from various sources that is used to test a hypothesis or conduct an experiment. Kennedy and Montgomery (2018) note that it involves obtaining and examining precise data from various sources to identify solutions to the study problem, as well as patterns and probabilities, and assess the potential consequences. Bryman (2012, p. 11) describes a "data collection instrument as a technique that a researcher uses to collect data". This study adopted a mixed method approach using three data collection methods to fulfil the research objectives, namely, documentary analysis, semi-structured interviews, and a questionnaire.

3.8.1 Document analysis

Hair, Wolfinbarger, Ortinau and Bush (2020) state that document analysis is a structured qualitative research approach to comprehend written evidence to answer particular research questions. Cohen, Manion and Morrison (2018) also describe it as a qualitative research method that uses a rigorous technique to examine documentary proof and answer particular research questions. It requires repeated inspection, analysis, and interpretation of data to develop meaning and empirical understanding of the construct investigated. Mishra and Alok (2017) elucidate that document analysis is a qualitative research method in which the researcher or assessor interprets documents to give context and meaning to the topic under examination. Essentially, it entails using a methodical approach to comprehend and evaluate documents. The researcher analysed different related documents and interpreted them, giving voice and meaning to the assessed topic. The documents were sourced online and also included printed copies, including public records – the Namport annual report, TransNamib annual report, Transport and Logistics blogs, the Namibian Master Plan for Logistics for SADC, transport and logistics and transport geography journals, maritime logistics handbooks and the 2020 State of Logistics Report. These documents were analysed by coding the content into themes.

Document analysis produces secondary historical data. The documents used were previously released records detailing the past performance of organisations in Namibia's transport and logistics sector, with particular emphasis on those active in this sector. This data required thorough verification and validation to ensure it was reliable for use. The researcher determined what data was needed from these records, validated that it was meaningful and judged whether or not it was manipulated to paint a rosy public image of the reporting entities.

3.8.2 Semi-structured interviews

Kennedy and Montgomery (2018) and Ragab and Arisha (2017) state that a semi-structured interview poses questions that enable the interviewer to probe for more information as and when he/she feels it necessary, which means that the questions are neither arranged nor phrased. Malhotra (2016) suggests that in this kind of interview, the interviewer may prepare a list of questions, but they may not all be asked or covered in full. Instead, interviewers will use these inquiries to direct the discourse.

The researcher developed an interview guide with questions based on the research objectives. The discussions were recorded to allow for further analysis and identification of major or emerging themes. All the data generated by the interviews were fed into NVivo software for coding and analysis.

An interview is a series of structured questions posed to a respondent during a face-to-face discussion. Interviews aim to gather primary data, which involves interacting with the respondent. They allow the researcher to observe the respondent's body language, which may also contribute to providing answers to the research questions. Interviews also allow respondents to answer freely without any limits on how to answer a question and enable them to clarify a question before answering. However, they may not gather adequate and relevant information as some respondents may not feel free to provide complete answers if their identity is known.

An interview provides data of a primary nature, meaning that the data is collected directly from the intended respondent without the assistance of a third person or entity. This therefore required validation of the responses to ensure that the answers provided by targeted respondents were not biased and that they possessed factual data. Due to the increase in COVID-19 cases and the need to avoid human contact, the researcher used online interviews with the targeted respondents using virtual systems, which allow for face-to-face meetings with the aid of cameras and screens.

The responses from the 12 participants listed in Table 4.59 in the following chapter enabled key information to be obtained from stakeholders in the transport and logistics sector. They included freight transport executives, business development managers, supply chain experts, a Director: Transport network, Senior Technician: Railway infrastructure, a customs declaring agent, an operational manager, project manager, transport regulatory inspector, retail procurement specialist and a logistics and distribution manager. The interviews aimed to identify the challenges inhibiting development of the regional logistics hub in Namibia and strategies to overcome these impediments.

An interview guide was designed, and several open-ended questions were posed to participants based on their responsibilities and industry experience. With the participants' agreement, the interviews were recorded. They lasted at least 30 minutes and each participant agreed that the researcher could email or contact him/her for clarification or to answer more questions if necessary. Interviews were conducted until data saturation was reached. This was done to address several concerns and ensure that the findings were accurate and dependable in expressing what the participants meant.

The next step in this investigation was data familiarisation and absorption. This entailed the researcher immersing herself in the data and identifying various trends and tendencies supported by unique data sets. The data were coded, and themes were selected and labelled to allow the data to be matched to the study's purpose. The use of themes and coding divides data into sections, occurrences, and observations, some of which are combined to answer the research questions and achieve a study's objectives. This enabled the researcher to compare comparable data throughout this phase and gain a fresh perspective on it. New themes emerged during the analysis, and the researcher frequently realised that a single theme might embrace numerous sub-themes. The analysis and findings are presented in accordance with the themes in Chapter four.

3.8.3 Questionnaires

Creswell (2017) characterises a questionnaire as an instrument that contains written questions or statements that are presented to respondents to either tick the correct answer or fill in their opinions regarding a matter. Cohen, Manion and Morrison (2018) describe a questionnaire as a research tool consisting of predetermined questions that are posed to one or more respondents to collect statistically significant information on a specific topic. Hair, Wolfinbarger, Ortinau, and Bush (2020) note that a questionnaire survey collects statistical data on a community's characteristics, beliefs, or behaviours using a predefined set of questions. This study employed a questionnaire comprising 17 questions in open- and closed-ended format. This design allowed the respondents to freely express their opinions and elaborate on their answers through open-ended questions, while closed-ended questions provided predetermined options for selection. The questionnaire had four sections: Demographics; Challenges inhibiting the logistics hub; Transport systems' connectivity, accessibility, and centrality; and Transport systems' KPIs.

The questionnaire incorporated the use of a Likert scale, a widely-utilised rating scale in survey research that enables respondents to indicate their agreement or disagreement with a series of statements using various response options, for instance, a five-point Likert Scale ranging from strongly disagree to strongly agree on the performance indicator demonstrating a factor's high or low ranking. The Likert Scale had the benefit of not requiring the respondents to answer yes or no, but allowed for a degree of opinion and even no opinion. With qualitative data, it is not feasible to develop a scale in advance, but the NVivo system developed themes that were used for analysis, making the data relatively easy to present, interpret and analyse. An online survey using the Survey Monkey platform was administered to a total of respondents employed in government ministries, rail freight transporters, freight forwarders, direct stakeholders, trucking companies, and vessel agents. Consequently, the questionnaire was tailored to collect qualitative data by employing open-ended questions, facilitating exploration of the respondents' experiences with transport systems. The data collected from the survey were subsequently compared with publicly available strategic plans, regulations, and policies to ensure consistency and alignment.

Data collection posed a number of challenges. First, remote data collection relies on telecommunications and digital methods, such as telephone calls, online surveys, and virtual communication tools. However, connectivity was a significant obstacle and a lack of digital literacy or access to digital technologies was an additional one. To address these challenges, the researcher scheduled meetings with the respondents and repeatedly reminded them of the appointments. Meetings were arranged well in advance and continuous contact was maintained with the participants before and during data collection.

Secondly, most of the contact details obtained and available before the COVID-19 restrictions were put in place were office numbers; due to the pandemic, most employees worked from home and used their mobile phones for business purposes. The researcher had to request informants' contact details from their employer to notify the participants. Contacting them on their mobile phones proved to be the best option; most opted to be contacted after hours, whereas had they been in their office, the researcher would have been obliged to contact them during working hours.

Thirdly, as most respondents were working from home, it was difficult to access information documented manually. Respondents would have to get a colleague in the office to access the files before providing the researcher with the data. The researcher had to send numerous reminders on WhatsApp or text to the respondents.

Fourth, the list of companies was not up to date, resulting in fewer companies participating. Given the envisioned regional logistics hub, many transport, trucking and freight forwarding companies were established in Namibia. The researcher had to contact Business and Intellectual Property Authority and the Ministry of Finance for a list of registered and active transport and logistics organisations.

3.9 Data Quality Control

According to Creswell (2018), validity and reliability are two critical measures to determine data quality, with the former presuming the latter. More explicitly, if a measure is unreliable, it cannot be valid. Collins and Hussey (2018) elucidate that data quality is the degree to which a data set fulfils its intended function; data quality measures are based on attributes like precision, exhaustiveness, consistency, validity, originality, and timeliness. Trustworthiness is the extent to which the readers of a research report trust the methods, findings, interpretations, and conclusions (Hair, Wolfinbarger, Ortinau, & Bush, 2020). In qualitative research, reliability is maintained by ensuring credibility, transferability, and dependability. After developing the instruments, the researcher submitted them to colleagues in the same field to proofread and check whether simple English or communication was used and to ensure that the questions were not vague, but complete and understandable within the study parameters. To further validate the data, the researcher pilot-tested the questionnaire with 15 respondents in the targeted industry or trade for whom email addresses were available, while the interview guide was piloted with five of these 15 participants before conducting the final study. To improve both validity and reliability, closed-ended questions were triangulated through open-ended ones.

3.9.1 Pilot study

The primary objectives of the pilot survey were identifying potential issues that may arise concerning clarity, and ensuring that the questions would yield data that answered the research questions. In the pilot study on the questionnaire with 15 respondents, the generated composite reliability and Cronbach alpha for the constructs and questions fell above the required range of 0.5 for the social sciences (Creswell, 2017) (see Table 3.3). This meant that the questions, that had been scrutinised by experts, attained reliability and the main study could be conducted.

Table 3-3 Questionnaire – Pilot study reliability statistics

Source: Author's compilation (2022)

Construct	Number of items	Composite reliabilities	Cronbach alpha
Inhibiting Challenges	22	0.653	0.670

Transport Infrastructure	4	0.875	0.894
Transport KPIs	11	0.808	0.849
Accessibility, Centrality and Connectivity	3	0.735	0.797
TDM	3	0.628	0.647

In piloting the interview guide with five participants, the researcher intended to establish whether the broad questions assessed Namibia's preparedness to become a logistics hub. These broad areas or questions were used as points of departure to probe for more information with insights developed or emerging during the interview process. Table 3.4 shows the relative importance participants placed on each broad area. All the areas were found to be suitable for the final interview process.

Table 3-4 Interview pilot survey

Source: Author's compilation (2022)

Broad area/ Question	Observations noted from Participants 1 – 5 in the pilot study
Discuss the challenges inhibiting Namibia's vision of becoming a regional logistics hub.	A discussion on the challenges or factors that inhibit the development of a logistics hub was considered extremely important by all the participants in the pilot study; thus, the researcher maintained this area as critical for further in-depth interviews and analysis.
The extent of centrality, accessibility and connectivity.	Similarly, probing in relation to measuring centrality, accessibility and connectivity as pillars or conduits of a logistics hub in the interviews was maintained as all the participants in the pilot study confirmed that it was extremely important.
Critical aspects of transport infrastructure for a successful regional logistics hub in Namibia.	The researcher maintained the critical aspects of transport infrastructure for further in-depth data collection and analysis as the participants in the pilot study indicated that assessing such was very to extremely important in demonstrating the current level of preparedness and mapping a way forward in developing the envisioned logistics hub.
Transport systems' KPIs.	Identifying and assessing transport systems' KPIs was also considered very to extremely important by the participants in the pilot study; thus, the researcher maintained this area in the in-depth interviews to gain

	more information on the critical indicators for the development of a logistics hub.
Travel demand management	Participants in the pilot study reiterated that it was very and extremely important to examine travel demand management as this would assist in identifying if there is need to develop a logistics hub. On the positive side, high demand signifies the need to scale up transport systems; thus, this aspect was maintained to identify the rationale for developing a logistics hub.

3.9.2 Credibility

Ragab and Arisha (2017) state that credibility relates to how plausible and suitable a study's findings are, which depends on the depth of the material rather than the volume collected. Creswell (2018) explains that the term "credibility" describes an approach and rules for guaranteeing that data integrity, quality, and reliability are always maintained. Mishra and Alok (2017) note that credibility is the degree to which an assessment is believable and appropriate, particularly in relation to the level of consensus between the participants and the researcher. The findings in this study precisely mirror the respondents' sentiments, observations, and encounters through the straightforward portrayal of decisions taken in relation to the procedures used to explore issues. The mixed method approach used in this study ensured data triangulation to guarantee credibility using interviews, a questionnaire and secondary data. Thus, the strategy was to explore the respondents' knowledge via meetings and an open-ended survey. The researcher ensured validity by utilising an audio recorder and taking notes; the recordings and notes could thus be revisited to confirm any assertions.

3.9.3 Conformability

According to Saunders, Lewis, and Thornhill (2019), conformability relates to the researcher's impartiality during the process of data collection and analysis. Bougie and Sekaran (2019) emphasise that there must be agreement between two or more independent parties regarding the data's precision, applicability, or significance. High-quality data are necessary for high-quality research, which depends on effective procedures to monitor data quality. Hair, Page and Brunsveld (2019) suggest that the credibility, transferability, dependability, and conformability of qualitative research instruments and outputs are critical elements of reliability. Credibility is the same as the quantitative paradigm's internal and external validity. When contrasted with the quantitative paradigm, dependability equals objectivity, dependability, reliability, and conformability to transferability (Creswell & Creswell, 2017). In this research study, the outcomes depended on the respondents' reactions, rather than the researcher's inclinations or thought processes. To guarantee that the researcher did not influence understanding of the respondents' reactions, the researcher archived the strategies for checking and rechecking the information throughout the investigation, especially for information accumulation and examination. Following the study, an informal review was conducted to analyse the information collection and examination methods and decide on the potential for predisposition or manipulation.

3.9.4 Important transport network metrics

Rodrigue (2020) states that transportation networks are composed of numerous nodes and links, and comparing them becomes more challenging as their complexity increases. According to Gould (2018), transport network analysis provides accessibility and connectivity metrics and enables comparisons across regional networks inside and between nations to evaluate system performance. Its description of the arrangement of nodes, their interactions, and the lines or links that connect them makes network analysis a crucial component of transport geography (Cumelles, Lordan, & Sallan, 2021). Rodrigue (2020) adds that it is crucial to conduct a centrality analysis on the nodes of transport systems to determine key nodes, comprehend transporter/travellers' choices, and evaluate the system's performance. A node's degree of centrality is the proportion of the network's nodes that are directly connected to it (Zhu, Li, Wang, & Wang, 2021). This research study measured the centrality of the data, especially that gathered using secondary records and the questionnaire. This aspect of network analysis expatiates on cyclomatic numbers and measures the whole area's accessibility and centrality.

The formulae for centrality are:

$$Beta = \frac{e}{v}$$

Where *e* represents the number of links/routes/networks, and *v* represents the number of nodes/vertices. A connected network result with one cycle has a value of 1, as shown in Table 4.10 in Chapter four. The data analysis showed a commendable level of connectivity for Road (1.11) and Rail (0.79)

$$Alpha = e - v + s$$

where s represents the sub-graphs or additional entities in the area, linked by a network or route. Note that e and v maintain their initial definitions. The Alpha index for road network connection is 0.09, where a commendable value should be close to 1; the value of 0.09 is shown in Table 4.18 in Chapter four. The data analysis suggested that although the road network in Namibia displays a higher level of network connectivity based on the Beta and Gamma indices, it is still very low in terms of the maximum number of circuits that could be connected. The rail Alpha index result is negative (see Table 4.18 in Chapter four), indicating that the level of rail connectivity based on the Alpha index is too low for this index to calculate.

$$Gamma = \frac{e}{3(v-2)}$$

All the variables remain as defined. The value of Gamma ranges from 0 to 1, indicating the centrality level. The Gamma index helps to compare two or more network structures, for instance, the road and rail network structures in Namibia, and the index calculated in Table 4.17 in Chapter four shows poor values for Road (0.38) and Rail (0.28).

3.9.5 Reliability

It is paramount to test research tools for reliability before applying any statistical tools to the collected data. Mishra and Alok (2017) highlight that reliability shows that the research tools will produce the same results if the study is repeated. This study applied Cronbach's alpha coefficient, which should be 0.70 and above to be considered reliable (Creswell, 2018). Reliability was attained as the Alpha value reached 0.8. Pre-test activities were performed on the interview guide and the questionnaire to confirm the reliability of the research instruments in stimulating the responses required for the study. The tests involved consulting experts in the field who were not part of the research population on the use and structure of the language, and the significance and validity of questions. Ambiguities within the questions were discovered, and the interview guide and questionnaire were redesigned to address these. The tests were beneficial in assuring the researcher that the responses would assist in achieving the research objectives.

3.9.6 Data Validity

Validity is the quality of being well-grounded, sound, or correct (Ragab & Arisha, 2017). It is determined in the following three specific categories that were considered in the questionnaire and interview questions:

3.9.6.1 Construct validity

Scharp and Sanders (2018) define construct validity as the extent to which conclusions on the theoretical constructs on which the operationalisations in one's study were based can be drawn with reasonable justification. In simple terms, it concerns how research adheres to or lives up to its claims (Mishra & Alok, 2017). It further explains if a variable's operational definition reflects the concept's true theoretical meaning (Creswell & Creswell, 2017). This research study investigated transport systems' preparedness towards a regional logistics hub in Namibia. The targeted respondents were asked to respond to the questionnaire and interview questions, which allowed them to express their perceptions regarding this issue. Construct validity was tested in terms of whether the researcher used the correct methods, techniques, and instruments to measure the impact of the transport systems' preparedness in achieving a regional logistics hub.

3.9.6.2 Content validity

Content validity is a measure of the degree to which the theory assumes all facets of a particular condition (Creswell, 2018). It refers to the extent to which the items on a test are reasonably representative of the entire domain the test seeks to assess (Saunders, Lewis, & Thornhill, 2019). In simple terms, content validity is how well an assessment tool measures the specified construct (Bougie & Sekaran, 2019). This research study measured whether transport systems' preparedness would aid Namibia in attaining regional hub status. The researcher first ensured that essential factors contributing to transport systems' preparedness were considered in the research questions.

3.9.6.3 Criterion-related validity

Criterion-related validity is the level at which a measure is related to an outcome (Nowell, Norris, White, & Moules, 2017). Comparison of a measure to a single standard that is claimed to be a direct measure of the idea under study is known as criterion validity (Scharp & Sanders, 2018). The researcher ensured concurrent validity by conducting comparisons between the transport systems' preparedness and Namibia attaining regional logistics hub status through provision of transportation and logistics services to the Southern African region.

3.10 Scale Measurement Analysis

At least four types or tiers of scale measurements are identified in social science research, namely, nominal, ordinal, interval, and ratio (Hair, Wolfinbarger, Ortinau, & Bush, 2020). According to Creswell (2018), a nominal scale is a scale that exists only in name, with no greater or smaller measure; an interval scale improves on the ordinal scale by introducing the distance property, and a ratio scale is an improved interval scale in that it allows responses to be compared between respondents. Ordinal scales were adopted to measure accessibility, connectivity, and centrality in assessing the road and rail systems' preparedness to make Namibia a logistics hub. The rankings were primarily based on KPIs or transport and logistics performance indicators.

3.11 Saturation

Saturation is reached in an investigation when no new information is forthcoming, whether it is desk or field analysis; in other words, when different information from previously acquired information is forthcoming, saturation has not been reached. The current study considered saturation at two levels, initially through ensuring that important aspects of transport and logistics systems had been covered from the documents acquired and reviewed. Secondly, saturation was reached during the interview process by collecting information and probing for more from identified participants. The information collected from each interview was recorded and transcribed and specific themes were created. The interviews ceased when the information provided by a participant in response to the questions became more and more similar to that provided by previous participants.

3.12 Triangulation

Triangulation involves using more than one technique to collect the same or similar information. It can be used to improve the consistency of responses and therefore the quality of a study. Triangulation was achieved in two ways in the current study; firstly, the researcher conducted a literature review to assess the issues that are critical aspects of the transport system, and cross-checked for these aspects in the review of transport systems documents and reports and secondly, critical issues and themes that emerged through the document review assisted in developing the questions for the questionnaire and interviews.

3.13 Data Quality Control

3.13.1 Quantitative

The study's reliability was assessed using the alpha and the sample adequacy test. The Cronbach Alpha value ranged from 0.706 to 0.875, with a KMO value of 0.908 at a significant p-value of less than 0.001. The validity of the study was attained at the following levels: (a) Content by reviewing the literature to identify the variables and constructs that relate to the problem, (b) Criterion by analysing similar studies and identifying their strengths and loopholes in order to identify the most appropriate techniques; in this case a mixed method approach was adopted and, (c) Confirmatory by ensuring that the case of strategies to enable Namibia to realise its vision of becoming a logistics hub was affirmed by other cases of logistics hubs.

3.13.2 Qualitative Trustworthiness in the thematic analysis process

In a bid to achieve credibility and trustworthiness in the thematic data analysis, the researcher followed the following process:

a) Data familiarisation

Following each interview, the researcher converted the recorded data into verbatim written form. The handwritten notes taken during the interviews were also transcribed verbatim.

Where a vernacular language was used that the researcher did not understand, the services of a local person were used to translate the data into English. The researcher also made an effort to re-check with the interviewee (with the help of a local person) whether what had been transcribed was what he/she intended.

b) Codes generation and searching for themes

The researcher started searching for themes by identifying responses and patterns that were similar, which would form a code. The decision rule used was that if an issue was repeated for the third time by a participant or more than one participant, it could be assigned a potential code, while in relation to issues raised once or twice, a decision was made based on the gravity or density of the issue vis-à-vis those affected or the findings from the document analysis.

c) Reviewing themes

Codes that were elevated to themes were reviewed, firstly, against what other participants said in relation to them, and secondly, by using the document analysis to determine how this issue affected empirical evidence on the ground.

d) Defining and naming themes

The themes were reviewed and concrete evidence was developed in the form of support by other participants or the document analysis. The literature review was referenced to establish the proper naming of such. The researcher did not develop a target sample size but arrived at such by identifying the recurrence of codes that developed into the same themes and noting when no new information emerged that would develop new themes.

e) Report production

Apart from manually generating codes and themes and italicising participants' responses to cement the themes identified and demonstrate their intensity, the researcher also used NVivo to develop tree and network analysis together with cloud and text search query reports on the major codes that formed the study's themes.

3.14 Data Analysis

According to Collins and Hussey (2018), data analysis is the process of gathering, modelling, and evaluating data to derive knowledge that supports decision-making. Creswell (2018) describes it as meticulous application of logical and/or statistical approaches to describe, demonstrate, summarise, and assess data. Data analysis is the technique used to modify, process and clean raw data to obtain valuable, pertinent information that supports decision-making. It provides helpful insights and statistics, frequently presented in charts, graphics, graphs, and charts, which reduce the risks associated with decision-making (Saunders, Lewis, & Thornhill, 2019). The study used Monkey Survey, an online-based platform, to circumvent restrictions imposed as a result of the COVID-19 pandemic.

The data was extracted from a server in a comma-separated-values (CSV) format, and Microsoft Excel was used to clean it. Measures to minimise cleaning of the data were included when designing the questionnaire using accessory tools in Monkey Survey that enable a researcher to prevent the submission of a questionnaire unless all compulsory questions are answered. This rendered the cleaning procedure fluent and less time-consuming.

The data was then transferred into IBM SPSS 23 software and coded appropriately. IBM SPSS 23 was the primary data analysis tool used to analyse the data through tables shipped into Microsoft Office Excel to construct graphs. Microsoft Office Excel provided more visually-impressive charts or figures.

3.14.1 Quantitative analysis

Quantitative analysis was used for objectives two and three. Objective two was "To analyse the extent of connectivity, accessibility, and centrality of transport networks in facilitating a regional logistics hub", which involved measuring the multivariable of connectivity, accessibility, and centrality of the transport systems' impact on the development of the regional logistics hub. Objective three was "To evaluate Key Performance Indicators (KPIs) of the transport system in facilitating a regional logistics hub in Namibia". The identified KPI variables were measured in terms of how they facilitated a regional logistics hub. The quantitative data was gathered by means of a questionnaire with closed-ended questions in the form of a Likert Scale, which enabled coding of responses ranging from 'strongly disagree' to 'strongly agree'. SPSS software was used to analyse these responses employing descriptive analysis (tables, figures, frequencies, etc.) and, most importantly, other statistical analysis developed from factor analysis, which included reliability, ANOVA, MANOVA, etc. This enabled the researcher to assess or examine single or multiple variables' behaviour.

3.14.1.1 Bivariate analysis on cargo volumes of rail, road and sea transport (2015-2019)

The researcher employed ANOVA analysis to determine the mean differences in cargo volumes per mode of transport between 2015 and 2019. The overall mean for cargo volumes variances between the three modes of transport was greater than 0.05, meaning that there was a significant difference in the cargo volumes per mode of transportation. The tonnage data across the years 2015-2019 was obtained from the trade reports reviewed.

The tests were conducted through the use of the following hypothesis:

H_1 – There is a significant difference among the group means.

H_0 – There is no significant difference among the group means.

ANOVA examines the link between a categorical and numeric variable by comparing the differences between two or more means. It was used to test the above hypothesis to determine if there was a significant difference among the group means. The results in Table 4.39 in Chapter four confirm the H_1 hypothesis.

3.14.1.2 Descriptive statistics analysis

Ragab and Arisha (2017) state that analysis and reporting of descriptive statistics should include, but not be limited to frequency, mean, standard deviation, and standard error bars. Saunders et al. (2019) define the mean (M) as the responses' group average, while the degree of consistency or the spread of responses around the mean is represented by the standard deviation (SD). When the responses are the same, the standard deviation equals zero (Mishra & Alok, 2017), whereas a small standard deviation indicates non-uniform responses and the opposite is true. Descriptive statistics are analysed using a 5-point Likert scale, where five represents excellent, four very good, three good, two fair, and one poor.

3.14.2 Qualitative analysis

According to Hair Jr, Wolfinbarger, Ortinau, and Bush (2020), qualitative research entails gathering and evaluating non-numerical data (such as text, video, or audio) to better comprehend ideas, opinions, or experiences. It might be utilised to uncover intricate details about an issue or develop fresh research concepts. Analysing qualitative data such as text from interview transcripts is referred to as qualitative analysis.

Saunders et al. (2019) state that unlike quantitative analysis, which is mainly dependent on statistics and the researcher's analytical and integrative abilities, qualitative analysis relies strongly on the researcher's knowledge of the social context within which the data was acquired. In qualitative analysis, understanding a phenomenon or "making sense" of it is prioritised over foreseeing or explaining it. It thus calls for a participant-in-context mind-set, an ethically aware perspective, and a variety of analytical techniques (Bougie & Sekaran, 2019).

The open-ended questions in the research instrument were used to solicit the respondents' opinions, suggestions, or narrative discussion. NVivo software was used to create themes. The data were typed in a format that NVivo software could read and code, developing the possible themes. The data was analysed using the different qualitative statistical tools generated through NVivo, such as word cloud analysis and word frequency analysis. Objective one, “To identify challenges inhibiting the regional logistics hub in Namibia” explored the major or emerging challenges or themes that respondents identified as hindrances to Namibia becoming a logistical hub, and objective four, “To develop a transport demand management framework for a regional logistics hub” that examined the variables or issues that respondents considered important in developing an ideal framework for a logistics hub were both addressed using NVivo.

3.14.2.1 Thematic Analysis

Thematic analysis is a qualitative method for identifying, analysing, and reporting patterns within a data corpus (Scharp & Sanders, 2018). Due to the degree of academic freedom it offers, it is a highly adaptable approach that can be changed to meet the objectives of numerous investigations, offering a rich and detailed yet complex description of data (Braun & Clarke, 2006; King, 2004). Thematic analysis is a form of qualitative analysis in which data-related themes in a collection of texts such as interviews or transcripts are examined, classified, and presented. While it can be conducted in numerous ways, the most popular method involves the following six steps:

Step 1: Familiarisation - The first step is for the researcher to familiarise him/herself with the data. Prior to examining individual items, a comprehensive overview is required of all the data. This may involve transcribing audio recordings, reading the text and making initial notes, and perusing the data to familiarise oneself with it.

Step 2: Coding - Coding involves marking portions of text, typically phrases or sentences, and then devising abbreviated labels or "codes" to describe their substance.

Step 3: Generating themes – The codes generated are examined to identify patterns, and start developing the themes.

Step 4: Reviewing themes – The researcher must ensure that the themes extracted are both relevant and accurate representations of the data.

Step 5: Defining and labelling themes - In this step, the themes are developed, named and defined. Defining themes entailed articulating precisely what the researcher meant by each theme and determining how it contributed to understanding of the data. Naming them involved determining a concise and convenient name/word for each.

Step 6: Documenting – The final step is documenting the data analysis. As with all academic writing, this includes an introduction outlining the research topic, objectives, and methodology (Caulfield, 2019).

A frequency study of a subject can be linked to one of the entire content using thematic analysis. The researcher can use thematic analysis to determine the exact relationship between concepts and compare duplicated facts (Ibrahim, 2016).

3.14.2.2Documentary review

Document analysis was conducted for this study based on its function in methodological and data triangulation, the significance of documents in research, and its utility as a stand-alone approach for a customised qualitative study.

In comparison to other qualitative research methodologies, document analysis is a more efficient, less time-consuming, and more productive technique, involving data selection rather than data acquisition. Access to such documents has grown since the advent of the Internet. Numerous documents were located on public domains, which meant that they could be accessed without the authors' consent. Document analysis is a viable choice for qualitative research and locating public records is only limited by the researcher's creativity and diligence (Mishra & Alok, 2022). It is frequently utilised when collecting new data is impractical since it is less expensive than other research methods. The data contained in documents has already been collected; what remains is an evaluation of its substance and quality (Morgan, 2022). Documents are inconspicuous and non-reactive, or unaffected by the research procedure. Consequently, document analysis counteracts the reflexivity (or lack thereof) problems inherent in other qualitative research approaches. For example, the act of observing may alter the course of an event. Reflexivity, which demands awareness of the researcher's contribution to the formation of the meanings attached to social interactions and acceptance of the likelihood of the researcher's effect, is typically not a concern when utilising documents for research purposes (Cardno, 2018). Documents are non-reactive and stable; the presence of the investigator has no effect on what is being researched. The inclusion of precise names, references, and details of events makes documents useful for research. Furthermore, they offer extensive coverage and cover a lengthy period of time, several events, and numerous locations (Rapley, 2018).

The researcher employed documentary analysis to examine documents to evaluate Namibia's preparedness to become a regional logistics hub. In similar fashion to the examination of transcripts of interviews or focus group discussions, after collecting the necessary documents, coding the material into categories is known as the process of dissecting documents. This is a form of data collection that, in this study involved an analysis of documents containing reports and/ or policies on Namibia's transport and logistics issues. The documents comprised previously released records of entities detailing the past performance of organisations in Namibia's transport and logistics sector, with particular emphasis on those active in the sector. This data required thorough verification and validation to ensure it was reliable for use. The researcher had to determine what data was needed from these records or annual reports and then validate if it data was meaningful and ensure that it was not manipulated to paint a rosy public image of the reporting entities. Therefore, the researcher analysed different related documents and interpreted them, giving voice and meaning to the assessed topic. The documents evaluated included public records – the Namport annual report, TransNamib annual report, transport and logistics blogs, the Road Transport Sustainability Plan for Namibia, Yamoussoukro Declaration, Transport Master Plan for Namibia, transport and logistics, transport geography, and transport economics journals, maritime logistics handbooks and the 2020 State of Logistics Report. These documents were analysed by developing themes that spoke to centrality, accessibility, and connectivity.

In conducting document review, the researcher used content analysis which involved the following steps:

1. Identifying the resources, in terms of transport and logistics reports and policies;
2. Deciding how to organise the information, which was guided by measuring the degree of connectivity, accessibility, and centrality;
3. Ensuring authenticity by identifying the source and year of publication of the report or policy;

4. Checking for possible bias, which was enhanced by comparing documents and their sources in line with the objective, mandate or mission of the source;
5. Examining the material substance and structure of the document, identifying and naming the components of some classes of documents, specifying their interrelationships and detailing their properties; and
6. Compilation of a report on the content analysed in line with the major themes of connectivity, accessibility, and centrality.

The document review thus provided valuable data to assess Namibia's preparedness to become a logistics hub even though these documents were independently prepared with a different objective.

3.15 Ethical Considerations

According to Mishra and Alok (2017), ethical considerations in research are a set of guidelines that drive a researcher's study design and practices. Ethical principles include voluntary participation with informed consent, anonymity, confidentially, no risk of harm and dissemination of the results. An ethical clearance letter permitting the researcher to conduct the research was obtained from the University of KwaZulu-Natal's Ethics Committee through the ethical application process after obtaining the gatekeepers' letter from the Registrar's office at the University. This assisted the researcher in obtaining the necessary authorisation to conduct the research. The participants signed an informed consent form to which was attached a letter informing them of the aim, goal and benefits of the research. The participants' personal data were and will be treated confidentially, and the researcher coded the research instruments to guarantee that the respondents remain anonymous. The data and questionnaire will be kept in a safe place or password-protected laptop, with the information disposed of after five years Draper and Swift (2011) define the right to self-determination as the right to make decisions and choices. In this case, the participants were informed of their right to withdraw from the study at any stage should they so wish. The researcher also ensured acknowledgement of the use of previously published data. This was achieved by creating references for every piece of information obtained from a previously published document.

3.16 Summary

This chapter discussed the research methodology used to gather, present and analyse the data collected from the targeted respondents to produce results that met the research objectives set in the first chapter. It commenced by identifying the research design, which involved the use of both qualitative and quantitative data in a causal study methodology. The data consisted of secondary data as well as that obtained by means of semi-structured interviews and a questionnaire. The sample consisted of 384 respondents. Both qualitative and quantitative data presentation and analysis techniques were employed to present and analysis the data and produce meaningful results that achieved the research objectives.

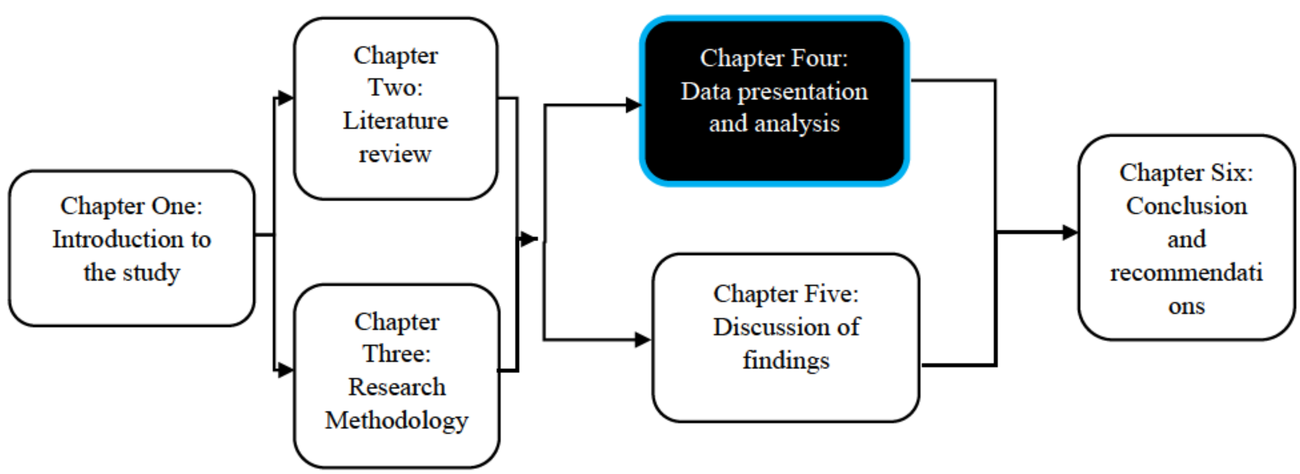
CHAPTER FOUR:

DATA PRESENTATION AND ANALYSIS

"If you believe your product or service can fulfill a true need, it's your moral obligation to sell it." ~Eleanor Roosevelt

4.1 Introduction

The preceding chapter discussed the methods employed to conduct the study. This chapter presents and analyses the results in line with the study's objectives to: (a) identify challenges inhibiting a regional logistics hub in Namibia; (b) analyse the extent of connectivity, accessibility, and centrality of transport networks in facilitating a regional logistics hub; (c) evaluate the transport systems' KPIs in facilitating a regional logistics hub in Namibia; and (d) develop a TDM framework for a regional logistics hub.



The chapter's major parts cover documentary analysis, the quantitative analysis (response rate analysis, socio-demographic characteristics, descriptive statistics, factor analysis, reliability and validity, and testing the research hypotheses) and the qualitative analysis (measurement of the extent to which the identified challenges inhibit a regional logistics hub in Namibia).

Data were collected using two approaches, initially by analysing and reviewing numerous documents, of which the master plan and the state of logistics reports were key documents; followed by fieldwork conducted using a questionnaire and interviews. Similarly, data analysis was conducted at two levels: analysis of the secondary data from the documents and analysis of the primary data from the questionnaire and interviews.

4.2 Part A: Document Analysis

Secondary data was obtained from base maps showing the road and rail network, including all the nodes and links to and from the port of Walvis Bay. Various trade reports were used to observe Namibia's trading activities and assess the current system's level of preparedness. Primary data in the form of travel time, impedance factors, and link and nodal conditions were obtained through field surveys.

4.2.1 Connectivity and centrality

Originally created to evaluate the connection of a street network, connectivity indices are derived as the ratio of links to nodes — the greater the ratio of links to nodes, the more linked the network. Three connectivity indices were used to quantify how well the rail and roadway network connects Namibia. The Beta Index, the Gamma Index and Alpha Index were used to triangulate the findings. It would be inadequate to make conclusions on network connectivity based on a single network index; rather, a composite of indices is required.

Accessibility

Accessibility is a measure of the ease or difficulty of reaching the desired destination; therefore, a place might be central and highly connected but still difficult to access. Thus, travel time is better compared to distance or connectivity measures.

Table 4.1 indicates the themes extracted from the documents analysed on the measures of connectivity, centrality, and accessibility.

Table 4-1: Themes from documents analysed on Connectivity, Accessibility and Centrality

Source: Author's compilation (2022)

Theme 1	**Sub-themes**	**Emerging Themes Measuring Indicators**	**Analytical Approach**	**Output/ findings**
PORT PERFORMANCE	Connectivity	Port connectivity matrix	Port connectivity matrix	Beta, Alpha and Gamma
		Port connectivity indices	Port connectivity indices	
	Centrality	Port connectivity matrix	Port connectivity matrix	Beta, Alpha and Gamma
		Port connectivity indices	Port connectivity indices	
	Accessibility	Accessibility indicators	Shimbel matrix analysis	Level of Service (LOS) analysis Delay
Theme 2	**Sub-themes**	**Emerging Themes Measuring Indicators**	**Analytical Approach**	**Output/ findings**
ROAD PERFORMANCE	Road traffic performance	Road capacity indicators	Highway Capacity Manual (2010)	Traffic volume to road capacity ratio (V/C ratio) LOS Average speed
		Road condition indicators		
		Road safety indicators		
Theme 3	**Sub-themes**	**Emerging Themes Measuring Indicators**	**Analytical Approach**	**Output/ findings**
RAIL PERFORMANCE	Rail network performance	Rail capacity indicators	Manual on Rail Capacity and Safety SA 2008	Tonnes Train-Miles LOS Terminal/Station Dwell Punctuality/Reliability Factor Delay
		Rail condition indicators		
		Rail safety indicators		

Table 4.1 provides an overview of the themes, sub-themes, measuring indicators, analytical approaches, and emerging findings from the document analysis on connectivity, accessibility, and centrality. The table has three main themes: port performance, road performance, and rail performance. Each theme includes specific sub-themes related to measuring indicators and analytical approaches. The emerging themes highlight the key findings obtained from the analysis. For example, under port performance, the sub-themes include connectivity, centrality, and

accessibility, with corresponding measuring indicators and analytical approaches. In this case, the emerging themes are related to the port connectivity matrix, port connectivity indices, and the level of service analysis for accessibility. Similarly, the table provides corresponding road and rail performance information, including measuring indicators, analytical approaches, and emerging themes in each category.

Table 4.2 presents a concise and comprehensive overview of the documents that were analysed on the topics of connectivity, accessibility, and centrality, specifically, the Manual on Rail Capacity and Safety SA 2008 and the Highway Capacity Manual (2010).

Table 4-2: Documents analysed on Connectivity, Accessibility and Centrality

Source: Author's compilation (2022)

Variables	**Measurement Indicators**	**Data input**	**Analytical Approach**	**Output/ findings**	**Key Findings**
PORT PERFORMANCE					
Connectivity	Port connectivity matrix Port connectivity indices	Number of nodes Number of links Link lengths	Port connectivity matrix Port connectivity indices	Beta, Alpha and Gamma	The results from the Beta and Gamma indices showed a relatively higher level of road connectivity. However, the Alpha index for road network connectivity is 0.09, which indicates that although the road network in Namibia shows a higher level of network connectivity based on the Beta and Gamma indices, it is still very low in terms of the maximum number of circuits that could be connected. This can be explained by the fact that the road network assumes a tree structure where it radiates from the port of Walvis Bay to various destinations (through the corridors) without any branch connections. The Alpha index result for rail was negative, meaning that the rail connectivity based on this index is too low to be computed by it.
Centrality	Port connectivity matrix Port connectivity indices	Number of nodes Number of links Link lengths	Port connectivity matrix Port connectivity indices	Beta, Alpha and Gamma	The highest degree of port centrality at a sum of 14 links each was observed on the Windhoek and Otavi nodes. Windhoek connects a minimum of three corridors: Trans-Oranje, Trans-Kalahari, and Walvis Bay. At the same time, Otavi connects the Trans-Kunene, Trans-Caprivi and Walvis Bay corridors. The nodes with the least connectivity are Opuwo and Cape Fria which are isolated from the rest.

Accessibility	Accessibility Indicators	Travel Time Distance Impedance factors (frictional factors) Network conditions Traffic conditions	Shimbel matrix analysis	Level of Service (LOS) analysis Delay	With an average speed of 70km/hr, all the corridors were experiencing a reasonable free-flow condition based on the LOS table. Reasonably free-flow traffic conditions translate to higher accessibility. This speed is acceptable for freight traffic; however, it could create delays, increasing the travel time for private motorists. This may induce aggressive driving behaviour (excessive speed, dangerous overtaking, etc.), a serious road safety concern.
ROAD PERFORMANCE					
Road traffic performance	Road capacity indicators Road condition indicators Road safety indicators	Traffic volume per hour Design capacity Traffic flow Modal split Number of accidents recorded	Highway Capacity Manual (2010)	Traffic volume to road capacity ratio (V/C ratio) LOS Average speed	Tables 4.19, 4.20, 4.21, and 4.23 present evidence that the port of Walvis Bay is generally accessible via all the corridors based on indicators of distance, average travel time (ATT) and average speed per corridor. The minimum average travel speed for freight traffic is 65km/hr (Trans-Cunene Corridor) and the maximum observed travel speed is 73km/h (Trans-Caprivi Corridor). Despite a generally high level of accessibility, some low speeds experienced from Walvis Bay to Karasburg, shown in Table 4.21, are due to unfavourable weather conditions. The standard deviation result indicates that the corridors do not show a significant difference in travel time, and they all show a higher level of accessibility to the port of Walvis Bay. This result corroborates with qualitative measures for highways' LOS. According to the Highway Capacity Manual (2000), the LOS quantifies the quality of traffic flow in a transportation facility based on several user surveys that capture drivers' perceptions of the quality of traffic under varied operating conditions. Table 4.23 depicts the service quality or LOS (A to F) and the various operational situations. At an average speed of 70km/hr, as shown in Table 4.23, all the corridors were experiencing a reasonable free-flow condition based on the LOS table. Reasonably free-flow traffic conditions translate to higher accessibility. To corroborate or triangulate the findings of the LOS, which are primarily qualitative based on drivers' experiences, the researcher calculated the v/c ratio to gain quantitative insight and the v/c ratio based on the maximum traffic flow for two-lane highways was 1 800 vehicles per hour per lane. It was found that the corridors experienced free-flow traffic conditions, albeit at lower speeds induced by a high heavy truck traffic mix. The v/c was below 0.6, which points to free-flow traffic conditions.
RAIL PERFORMANCE					

Rail network performance	Rail capacity indicators Rail condition indicators Rail safety indicators	Number of trains vs cargo moved Number of train derailments	Manual on Rail Capacity and Safety SA 2008	Tonnes Train-Miles LOS Terminal/Station Dwell Punctuality/Reliability Factor Delay	Rail speed in Namibia is up to 60mph (100km/hr). The anachronistic state of the railway puts strain on train operations, and new reduced speed limits are introduced each year. The poor state of the railway network impedes locomotive speed and service delivery for TransNamib's trains, as do regular derailments. The rails' restricted speeds and carrying capacity cause bottlenecks. The international standard for speed is more than 250 kilometres per hour (km/hr). A total of 195 rail accidents were reported from 2018-2021. In Great Britain, only 11 derailments were reported from 2013-14 to 2020-21. The net tonnage railed over the 2019/2020 financial year was 1651 511 tonnes per year, against the budgeted 1.8 million tonnages. Transnet, a South African rail transportation company, moved 183 million tonnes of goods in 2021, a 13.66% decrease from 2020.

Table 4.2 provides a comprehensive overview of the documents analysed on connectivity, accessibility, and centrality. The table presents key themes and sub-themes related to port performance, road performance, and rail performance, along with the measuring indicators, data input, analytical approaches, and key findings for each category. The findings reveal the road network's higher level of connectivity based on Beta and Gamma indices, challenges confronting rail operations, including reduced speeds and derailments, and the accessibility of the port of Walvis Bay through various corridors. The table offers valuable insights into the performance and characteristics of Namibia's ports, roads, and rail systems.

4.2.2 Master Plan for the Development of an International Logistics Hub for SADC (MPDILH)

The researcher reviewed the ten-year MPDILH for SADC countries in the Republic of Namibia developed by the Japan International Cooperation Agency (JICA) in March 2015. This is the only current document driving Namibia’s vision of becoming an international logistics hub for SADC. The purpose of the review of the Master Plan was to determine the extent to which Namibia has reached its intended goals. The plan aimed to provide a developmental framework to transform Namibia into one of SADC's regional logistics hubs. It also recommended a timeframe for a list of strategic and priority projects and a comprehensive intervention process. Table 4.3 indicates the themes extracted from MPDILH for the SADC region.

Table 4-3: Themes from Master Plan for the Development of a Hub for the SADC region

Source: Author's compilation (2022)

Theme 3	Sub-themes	Projections/Status
Goal /objective of the logistics hub master plan	The initiative aims to achieve Namibia's vision of becoming an international logistics hub for the SADC region by 2025.	2015 -2025 The project is still in progress.
	Efficient Port Management	Following completion of a container port expansion project in 2019, Walvis Bay's container facility can accommodate 750 000 TEUs.
	Integrated Border Management	Integrate and harmonise border management plans on land use, the layout of border infrastructure, bypass roads and truck stops. Integration of border management ICT systems Asycuda and Navis, Single Window and Risk Management System - Install "Corridor Net" to offer transporters information services.
	Transport Infrastructure	Road - upgrading of trunk roads to the port between Swakopmund and Karibib Rail - TransNamib and JICA's projections indicate that future cargo volume transported by rail might reach 4,8 million tonnes by 2020 and 4,9 million tonnes by 2025, based on cargo flow projections and the current mode split ratio. In the rail orientation scenario, rail freight would increase to 6 million tonnes by 2025, increasing the proportion of goods transported by rail from 12.1% to 14.7%.
	Capacity Building	Reduce skills gap

Table 4-4: Document analysis on the Master Plan for the Development of a Hub for the SADC region

Source: Author's compilation (2022)

Goal /objective of the logistics hub master plan	Projections/Status	Explanation or commentary
The initiative aims to transform Namibia's profile to become an international logistics hub for the SADC region by 2025.	2015-2025 The project is still in progress	Ten years for a project seems too long with limited risk analysis. The master plan relied on historical data, (e.g., the National Development Plan 3,4, and 5 and Vision 2030 of Namibia) to develop the master plan. The priorities of the Namibian government changed over the years. The developers did not anticipate the financial and economic downturn in 2016, a year after the policy was developed. The most

		significant global supply chain disruption was the COVID-19 pandemic. Consequently, implementers' expectations are not being met, making them irrelevant and rendering the document no longer relevant. The vast land size combined with a small population and limited industrialisation poses problems in terms of cost competitiveness. The port area in Walvis Bay is an impediment, and the high level of urbanisation has resulted in many people looking for employment.
Efficient Port Management	Following the completion of a container port expansion project in 2019, the Walvis Bay's container facility can accommodate 750 000 TEUs.	The Port of Walvis Bay noted an increase in calls of 252 vessels (24%) from April 2021 to January 2022. The core of Namport's business is general vessel traffic, and its two ports receive roughly 1 592 vessel visits and move more than 6.5 million tonnes of cargo a year. Copper, manganese ore, and wood items (timber) are key SADC exports through Namibia. Frozen poultry, automobiles, machinery, spare parts, tyres, mining chemicals, electrical items, and equipment are major SADC imports from Namibia. There is a lack of storage facility management, sub-hubs, warehouses and supply chain integration (data silos). Empty containers on returning, and a lack of intermodality and multimodality at the port are further challenges.
Integrated Border Management	Integrate and harmonise border management plans on land use, the layout of border infrastructure, bypass roads and truck stops. Integration of border management ICT systems (Asycuda and Navis, Single Window and Risk Management System - Install "Corridor Net" to offer transporters information services).	According to Namport's statistics, cross-border volumes increased by 10% between 2020-2021 and 2021-2022, rising from 1 464 000 gross tonnages to 1 606 984 gross tonnages. Due to a lack of knowledge of trade rules and customs procedures at the country's border posts, some traders utilise illegal crossing sites. If apprehended by border patrol, traders may face penalties, bribes, or confiscation of their goods. Complex customs processes and the numerous border agencies cause delays at the borders, reducing compliance and delaying goods clearance. Most Namibian border posts lack the infrastructure required to manage growing trade volumes such as ICT infrastructure and the IoT, and unharmonised policies increase traders' costs. A lack of facilities and resources creates challenges for traders, and poor customer service reduces transparency in the supply chain. Border operating hours were deemed to be restrictive, and countries worldwide continued to experience severe challenges at their borders as COVID-19 struck in 2020.
Transport Infrastructure	Road - the upgrading of trunk roads to the port between Swakopmund and Karibib. Rail - TransNamib and JICA's projections indicate that future cargo volume transported by rail might reach 4,8 million tonnes by 2020, and 4,9 million tonnes by 2025, based on cargo flow projections and the current	Namibia has a well-developed road network. A quality gravel trunk road, a primary, and a district road network totaling 48 117 km, including 4 500 km of tarred roads, connects most towns and localities. Roads connect the country to Angola, Botswana, South Africa, Zambia and Zimbabwe. The Trans-Kalahari, Trans-Caprivi, Trans-Cunene, Trans-Oranje, and Walvis Bay Corridor Highways were developed to connect Namibia's Atlantic coast port of Walvis Bay to landlocked neighbouring nations. However, climate change, delays in maintenance, heavy cargo, financial constraints, and disruptions to supply chains due to COVID-19 have seriously impacted road transportation development. The increase in heavy commercial vehicles, imported second- and now third-hand cars,

	mode split ratio. In the rail orientation scenario, rail freight would increase to 6 million tonnes by 2025, increasing the proportion of goods transported by rail from 12.1% to 14.7%.	aggressive driver behaviour, inexperienced drivers, long-distance drivers, and narrow single file lanes, especially between Swakopmund and Karibib to the port create delays and, at times, congestion, leading to alarming road safety concerns. Transport infrastructural developmental plans do not speak to the logistics master plan. TransNamib only railed 1.6 million tonnages of freight rail in 2021, less than half the projected cargo for 2020.
Capacity Building	Reduce skills gap	A shortage of skills hampers Namibia's economy, and the skills development system has not met expectations. The education sector is trying to build capacity by running transport, logistics, and many other programmes. Many graduates are unemployed, and COVID-19 worsened the situation as most up-and-coming big businesses had to close. Due to financial, economic and social constraints, Namibia's unemployment rate stood at 46.1% in 2018. It is impossible to forecast what will occur with regard to logistics globally or locally in Namibia until much more is known about the duration and after effects of the COVID-19 pandemic. The policy suggests that the skills gap should be filled by soliciting the services of international experts for Namibians to learn from. This could lead to xenophobic-related challenges, where nationals feel that jobs meant for Namibians are given to foreigners.

4.2.3 The State of Logistics Report of 2020

The researcher reviewed the Namibian State of Logistics Report of 2020, prepared by the Namibian German Centre for Logistics from 2018-2020, on the state of logistics development and the COVID-19 pandemic's impact on the industry. This study updated previous research on Namibian logistics undertaken between 2012 and 2017. This report is prepared on a five-year basis, and the researcher used the 2018-2020 version on the basis that it sits at the point where the master plan was developed in 2015, and would thus constitute a milestone point to measure the master plan's efficiency. Table 4.5 indicates the themes extracted from the 2020 State of Logistics Report.

Table 4-5: Themes from the 2020 State of Logistics Report of Namibia

Source: Author's compilation (2022)

Theme 1	Sub-themes	Projections/Status
	International Logistics Hub	Systematic benchmarking of "The State of Logistics" in Namibia

Goal /objective of the report	Efficient Port Management	Port expansion was completed in 2019
	Integrated Border Management	Efficient, effective border control management with smart infrastructure
	Transport Infrastructure	Increased rail and road capacity
	Capacity Building	Increase employability by diversifying skills, and reduce unemployment

Table 4-6: Document analysis on the 2020 State of Logistics Report

Source: Author's compilation (2022)

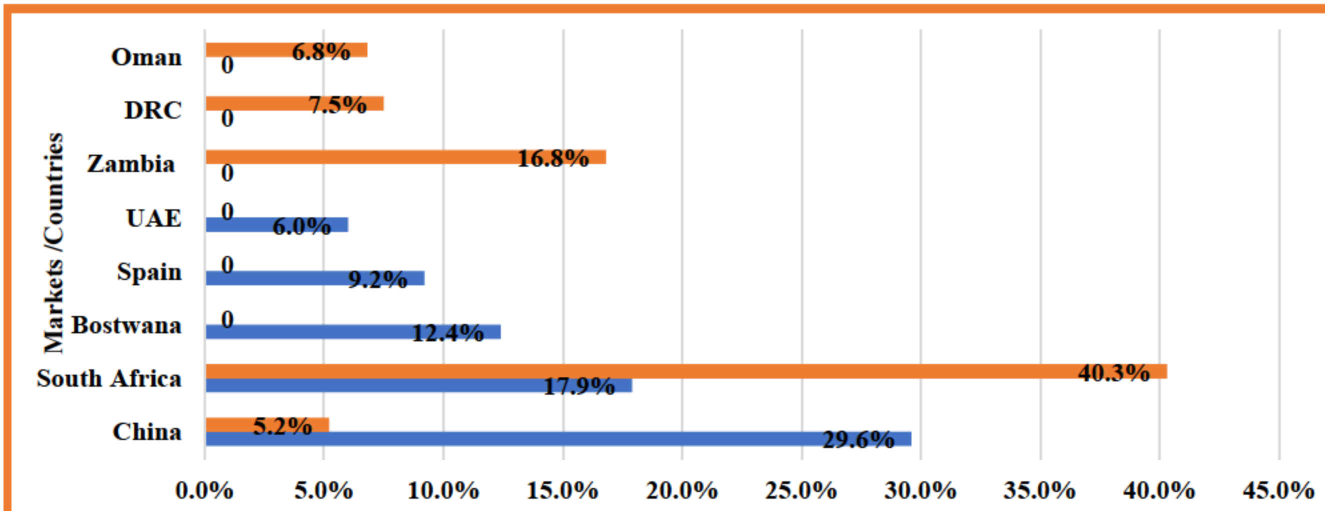
Goal /objective of the report	Projections/Status	Explanation or commentary
International Logistics Hub	Systematic benchmarking of "The State of Logistics" in Namibia	The previous state of logistics assessment suggested that Namibia had a good chance of becoming an international logistics hub. This report was written before the COVID-19 outbreak; thus, the current impact on trade and logistics was unforeseeable. Therefore, it is unrealistic to evaluate any developments to establish if the predicted potential has been realised, and it is not easy to judge if the optimism was warranted.
Efficient Port Management	Port expansion was completed in 2019	It is clear that some beneficial advancement had transpired as the port container terminal was constructed and increased the port's capacity. The port is outsourcing the dry port management facility to focus on core competencies.
Integrated Border Management	Efficient, effective border control management with smart infrastructure	The lack of modern infrastructure at the borders creates supply chain challenges. Time spent at the border post is deemed too long, as inspections are manual, much documentation needs to be completed, and there is congestion, procedural delays, a long transit time, a lack of safety and security, and much duplication of processes.
Transport Infrastructure	Increased rail and road capacity	It is vital to note that the government owns Namibia's rail infrastructure, and TransNamib operates the rail freight and passenger transportation. In 2018/2019, rail freight volumes increased by 8.5%. However, this is insignificant compared to road, which transports more than 70% of freight. Much remains to be done to construct more roads. Transport corridors are crucial to Namibia's economy, as they account for more than 72% of the country's total tonne-kilometres of commodities transported, including transit cargo. Namibia's road system is well-developed; however, critical routes need to be extended to a dual carriageway (Swakopmund-Karibib) to avoid road safety issues that have become dire. The lack of truck ports along the corridors increases road safety and security issues.
Capacity Building	Increase employability by diversifying skills, and reduce unemployment	Unemployment - about 20% of the respondents projected a substantial number of job losses owing to company closures due to the COVID-19 pandemic.

The master plan is a substantial and highly significant document, and the plan to grow Namibia into a regional logistics hub to service the region and landlocked nations is an excellent development endeavour. However, the policy is overly ambitious in several areas, particularly considering the project's duration, which is ten years. The identified infrastructure development requires Namibia to be financially sound. The country is heavily dependent on foreign loans and investments for "survival". The document examined port development in detail, noting the programmes that must be established to make the port competitive. The master plan addressed the port's development as an independent variable, while the important feeder variables would be addressed in a separate programme. The country's financial and economic outlook deteriorated in 2016, just a year after the document was enacted. The extent of the risks and the actions was not specified. The 2020 report shows no significant progress because critical information and statistics are lacking. Instead, it focuses on COVID-19's impact on the industry. The report lacks statistics on progress and the project's overall sustainability.

A review of annual reports and trade bulletins was conducted by the researcher to establish Namibian major trading activities. Figure 4.1 shows Namibia's major trading partners. Trade is vital to the country's development because it fuels economic growth, supports decent jobs, raises living standards, and enables the provision of affordable goods and services. Social and political stability are essential to develop bilateral ties with any country. Figure 4.1 below lists the countries that Namibia trades with from the port of Walvis Bay.

4.2.4 Namibian import and export markets

Secondary data was collected on the country's major trading partners, and Figure 4.1 shows Namibia's major import and export markets. It captures the magnitude and patterns of Namibia's trade flows, shedding light on the country's economic interactions with its global counterparts.



	China	South Africa	Bostwana	Spain	UAE	Zambia	DRC	Oman
Import	5.2%	40.3%				16.8%	7.5%	6.8%
Export	29.6%	17.9%	12.4%	9.2%	6.0%			

Figure 4-1: Top Five Namibian Import and Export Markets

Source: Namport (2022)

Figure 4.1 depicts Namibia's major trading partners, which accounted for 76.6% of all imports and 75.2% of total exports in July 2021. China dominates exports at 29.6%, followed by South Africa at 17.9% and Botswana at 12.4%. South Africa leads when it comes to imports at 40.3%, followed by Zambia at 16.8% (Namport, 2022). It is vital to understand the significant trading partners as they impact transport system demand. This will ultimately dictate what infrastructure is required and where it is required. Consequently, trading partners should take cognisance of the transportation linkages within an efficient transport system. These statistics place Namibia as a highly import-dependent economy.

The researcher also examined SADC's export and import market share through the port of Walvis Bay. These statistics were critical in determining and assessing the busiest network paths within the regional transport system and they provided valuable information on the distribution of traffic and trade flow patterns. Figure 4.2 presents a comprehensive outline of Namport's user base and their respective contributions to overall market share.

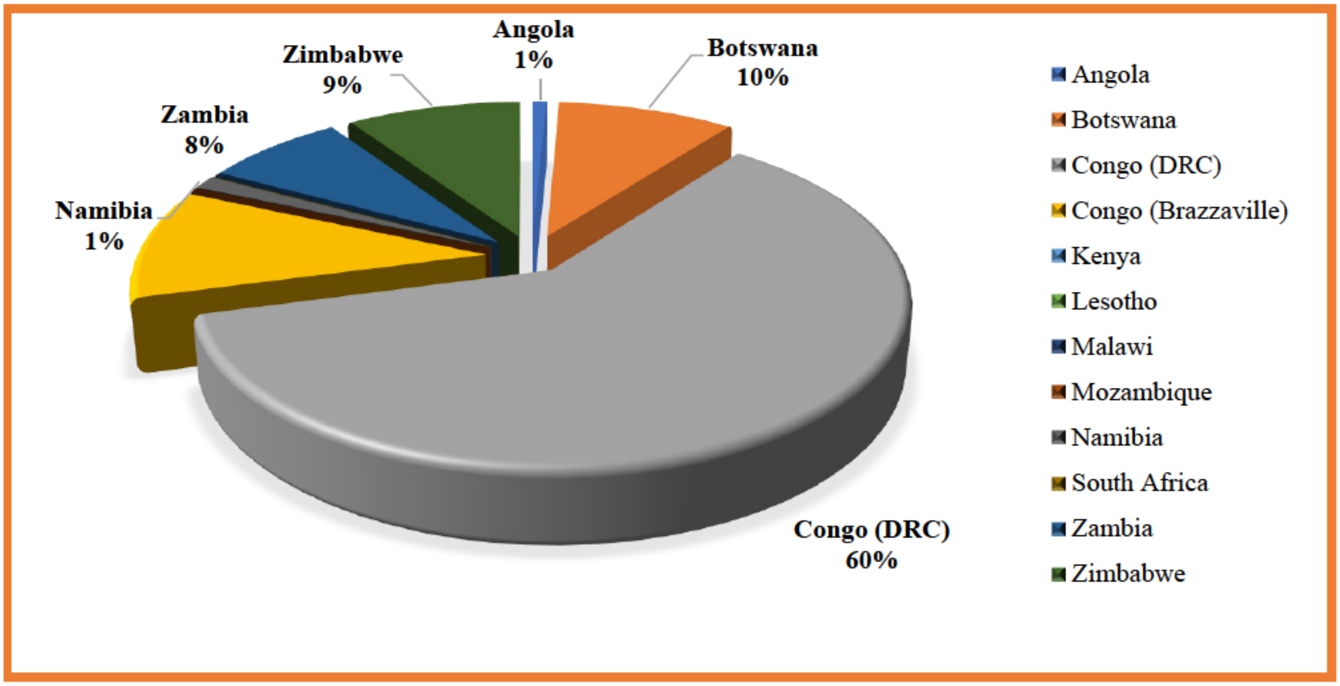


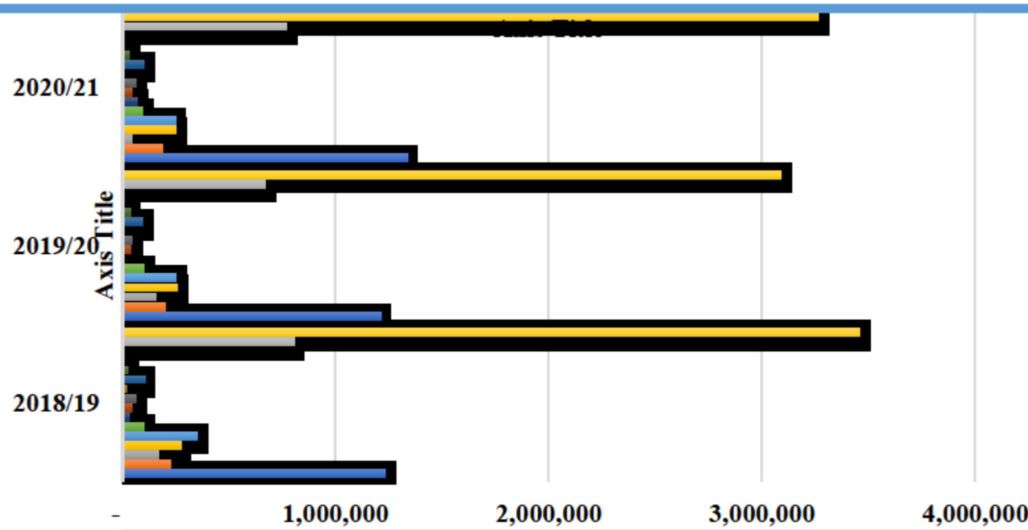
Figure 4-2: SADC Import and Export Market Share through the Port of Walvis Bay (2021-2022)

Source: Namport (2022)

Figure 4.2 indicates that, at 60%, the DRC is by far the major player in the import and export market, followed by Botswana (10%), Zimbabwe (9%), and Zambia (8%). These imports are transported through the port of Walvis Bay. Angola and Namibia have the smallest share of the import market at 1% each (Namport, 2022). The statistics illustrate transport system usage by SADC member states, showing which nodes are busier than others. Moreover, they are an excellent indicator to measure the adequacy of each leg of the transport system. The respondents also highlighted that extracting and manufacturing essential raw materials drives Namibia and the SADC region's economies. The region remains a net capital and consumer goods importer while exporting unprocessed goods. Respondents who transport via the Trans-Caprivi corridor noted that the road on one side from the Namibian border post to the port of Walvis Bay is in poor condition. They stated that the main cause is the heavy mining of raw materials imported from the DRC. Trade in international goods is crucial to Namibia's economic development because it connects producers and consumers from various countries in the global economic system.

4.2.5 Main cargo handled at the Walvis Bay Port

Figure 4.3 provides a detailed breakdown of the types of cargo handled at the port of Walvis Bay, presenting the volumes of each cargo type in terms of freight tonnes. This offers a comprehensive view of the diverse range of goods transported through the port, enhancing understanding of the major commodities and their respective quantities landed at this strategic maritime gateway.



	2018/19	2019/20	2020/21
Total	3,458,340	3,090,906	3,264,103
other Cargo	805,550	671,743	770,881
Wooden Products	4,749	5,207	3,103
Ammonium Nitrate	2,007	5,015	-
Spare Parts	25,128	35,495	34,646
Wheat	104,944	97,543	102,497
Sodium Carbonate	18,370	5,192	6,818
Chemicals	65,653	46,883	64,259
Machinery	44,877	39,894	44,405
Coal	32,848	-	71,498
Sugar	100,071	103,544	95,685
Copper/Lead and Concentrates	352,157	251,980	249,286
Vehicle	274,504	258,982	253,453
Sulphuric acid	170,217	158,558	44,062
Fish & fish products	222,919	198,601	187,615
Petroleum	1,234,346	1,212,267	1,335,869

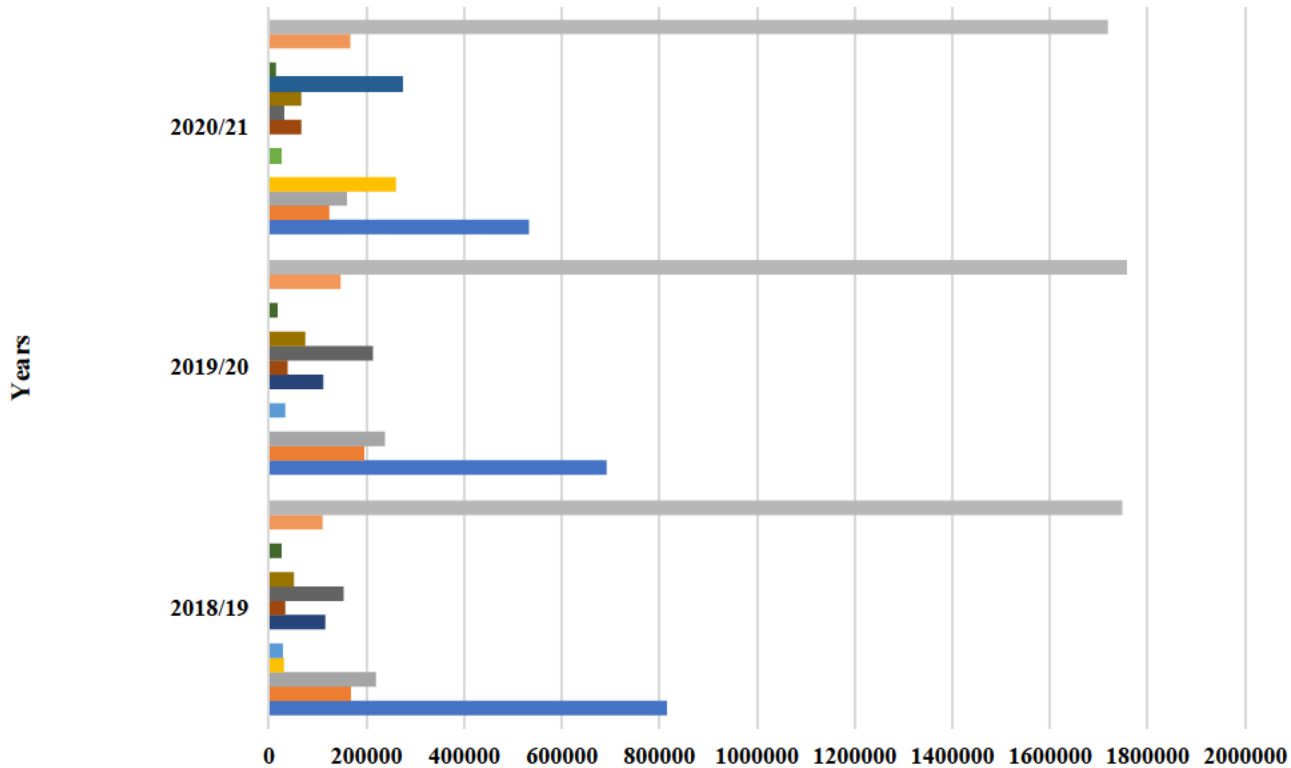
Figure 4-3: Landed Cargo Handled at the Port of Walvis Bay

Source: Namport (2022)

Figure 4.3 shows that, in the three years from 2018/2019 to 2020/2021, the port of Walvis Bay handled over 3 million tonnages of cargo in total. The outbound of this cargo requires land-based transportation modes to reach its final destination. Petroleum averages 39% of the freight received in volume, followed by copper/lead and concentrates accounting for 9% of total cargo landed. Vehicles are third, accounting for 8%, followed by fish and fish products representing 6%. Comparing these statistics with the active modes of transportation within the Namibian transport systems raises new concerns about whether the system is adequate. For example, Moradi and MirHassani (2015) suggest that a pipeline is the preferred mode of transportation for petroleum. However, the pipeline mode is close to non-existent within the Namibian transport system.

4.2.6 Shipped cargo handled at the port of Walvis Bay

The researcher collected secondary data on the distinct categories of cargo managed at the port, with the objective of understanding the characteristics and variety of commodities transported. Figure 4.4 illustrates the diverse range of cargo categories transported via the port of Walvis Bay.



	2018/19	2019/20	2020/21
Total	1747461	1757310	1718744
Other Cargo	109317	146841	166022
Building Materials	616	110	616
Flat Cartons	25464	17771	13955
Zinc/Ore/Concentrates			273196
Wooden products	50776	73836	65692
Charcoal	152768	212696	31174
Scrap Steel	33044	37818	66265
Marble and Granite	114958	111286	
Fluorspar			25344
Manganese Ore	28468	33396	
Lithium Ore	30321		260254
Copper/Lead & Concentrates	219222	237204	159932
Fish and Fish Products	167713	195331	123413
Salt	814794	691022	532612

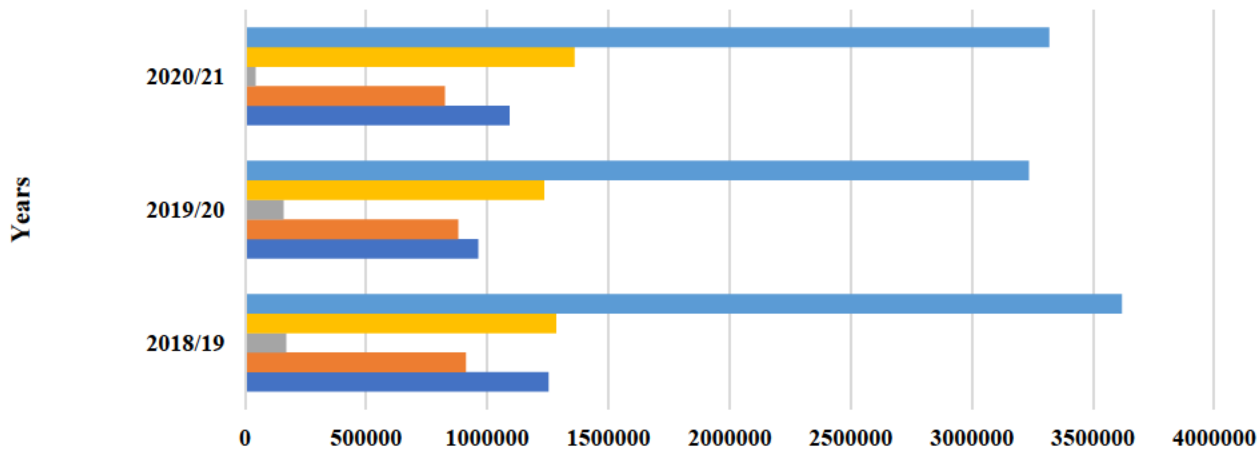
Figure 4-4: Shipped Cargo handled at the Port of Walvis Bay (Freight tones)

Source: Namport (2022)

Figure 4.4 illustrates the cargo shipped through the port of Walvis Bay. Salt accounts for 39%, followed by copper (12%) and fish and fish products (9%). Mining commodities account for 52%, which is vital as mining products are characterised as heavy. Thus, the railway would be the ideal mode of transport. It is also worth noting that this cargo come from all over SADC.

4.2.7 Periodic Cargo handled at the port of Walvis Bay (freight tonnes)

Secondary data was also gathered on the total amount of cargo handled from 2018 to 2021. Figure 4.5 provides an overview of landed freight at the ports of Walvis Bay and Lüderitz.



	2018/19	2019/20	2020/21
Total	3618595	3234424	3319222
petroleum landed	1283819	1234216	1359279
Sulphuric acid	170217	158558	44062
Containerised	911512	879423	824030
Bulk and break bulk	1253047	962228	1091852

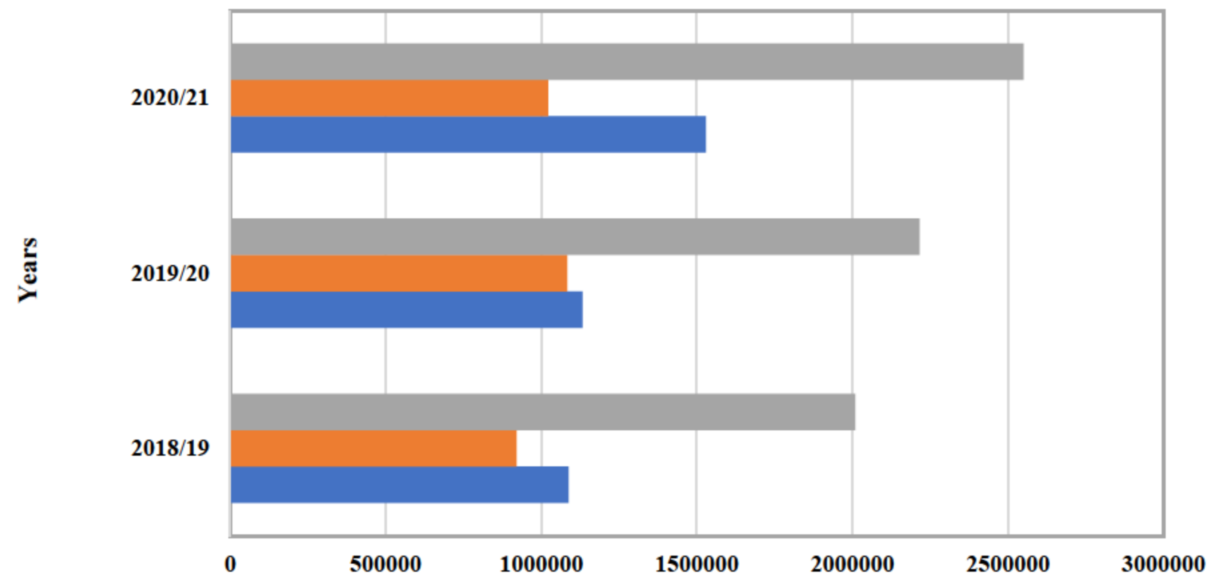
Figure 4-5: Cargo landed: ports of Walvis Bay and Lüderitz (freight tonnes)

Source: Namport (2022)

Figure 4.5 shows that, on average, petroleum takes the lead at 38%, followed by bulk and breaking, which account for 32%. Containerised freight makes up 26% of cargo handled at Walvis Bay and Lüderitz ports. This outline assists in clarifying shipments' transportation needs. The volumes handled require a transport system with adequate railways, pipelines and road transport.

4.2.8 Products' shipment mode into Namibia

The researcher conducted a comprehensive examination of various documents encompassing details pertaining to the shipping techniques utilised for the transportation of goods into Namibia. The aim was to analyse and determine the primary means of transporting goods into the country by comparing the prevalence of containerised shipments with bulk and break bulk shipments.



	2018/19	2019/20	2020/21
Total	2008784	2215479	2550603
Containerised	920927	1083436	1021808
Bulk and break-bulk	1087857	1132043	1528795

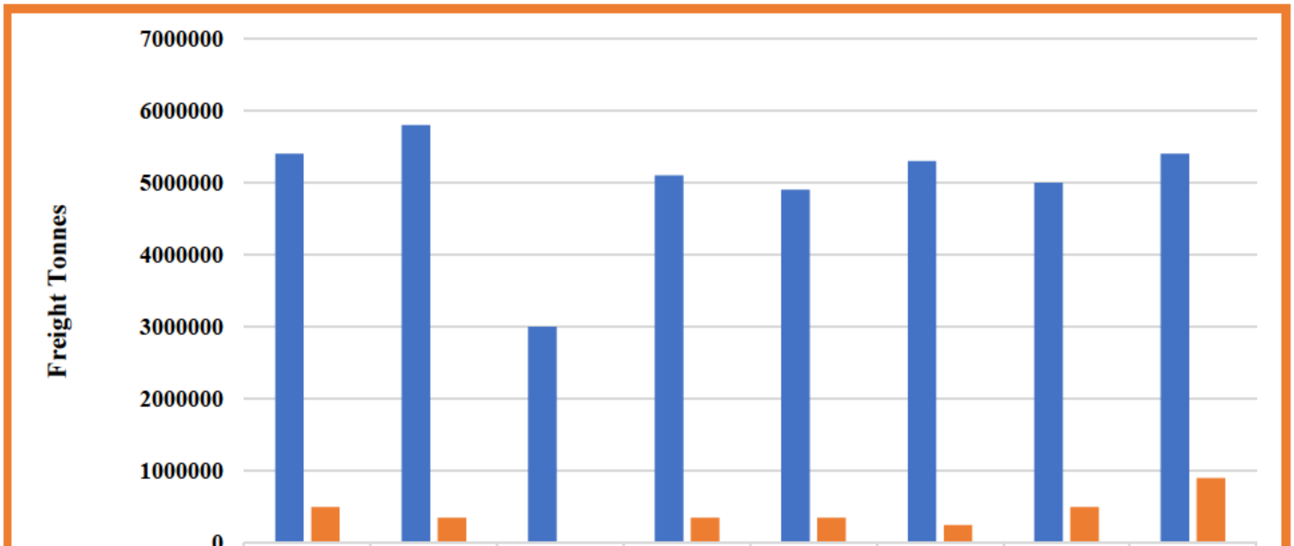
Figure 4-6: Products' shipment mode in Namibia

Source: Namport (2022)

Figure 4.6 indicates that the shipments are categorised as bulk and breaking or containerised. Bulk and break-bulk account for 55% on average, while containerised cargo stands at 45%. In 2020-2021, there was an increase in break-bulk cargo as the port received the largest vessel to dock with a loading capacity of 9 000 containers.

4.2.9 Comparison of cargo shipments: ports of Walvis Bay and Lüderitz (freight tonnes)

A comparative analysis was conducted of the cargo transported through the ports of Walvis Bay and Lüderitz, highlighting the study's focus on Walvis Bay. This analysis underscores the significance of examining the specific dynamics of the Walvis Bay port by comparing the trade volumes and patterns between the two ports. This further validates the importance and relevance of the research.



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Walvisbay Port	5400000	5800000	3000000	5100000	4900000	5300000	5000000	5400000
Luderitz Port	500000	350000	20000	350000	350000	250000	500000	900000

Figure 4-7: Cargo comparison ports of Walvis Bay and Lüderitz 2013-2021

Source: Namport (2022)

Figure 4.7 highlights that the Walvis Bay and Lüderitz's ports receive more cargo than they are shipping; between the two, Walvis Bay port handles the most freight. Despite COVID-19, the ports experienced a constant increase in shipments between 2018/2019 and 2020/2021, while landed cargo declined in exports and imports by transport mode.

4.2.10 Transport modes used in Namibia

Documentary analysis was employed to identify the diverse modes of transportation employed to transport cargo. The analysis yielded comprehensive data, which is visually represented in Figure 4.8. The figure provides a clear illustration of the distribution and significance of each mode of transportation within the area under study.

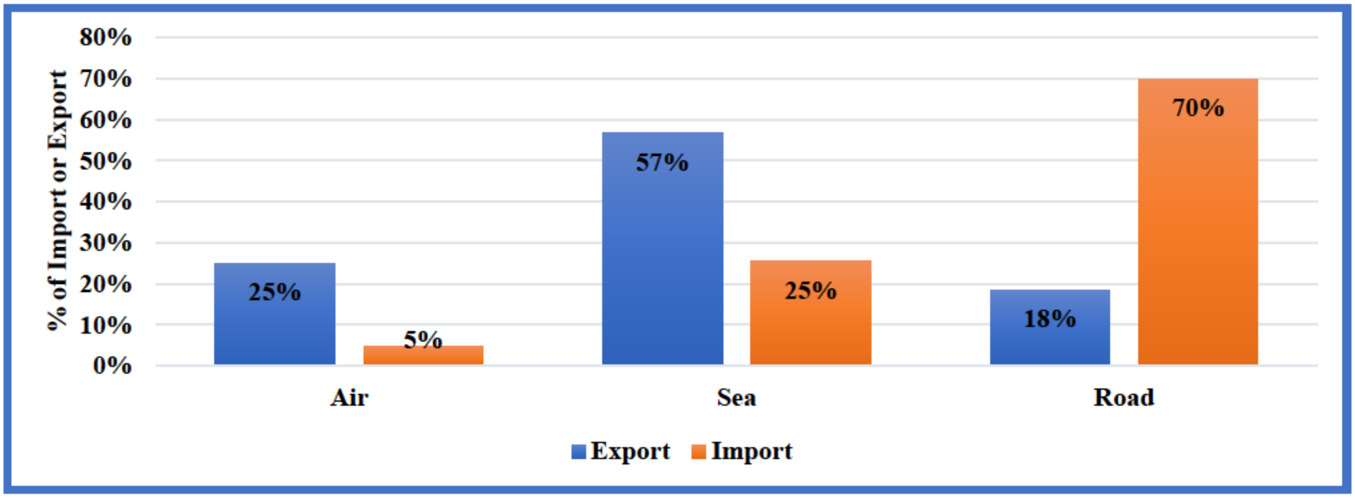


Figure 4-8: Exports and Imports by Mode of Transport

Source: Namport (2022)

Figure 4.8 shows that in 2021 exports representing 57% were transported via sea. Air and road transportation accounted for 25% and 18.4% of total exports, respectively. In contrast, transport by road accounted for 70% of imports. Sea transportation accounted for 25%, while air only accounted for 5%. In terms of the impact of COVID-19 on transportation modes, the trends show that the predominant mode of transportation was still road for imports, whilst sea transportation was the predominant mode for exports. Namibia is a mining, fishing and beef intensive market which is dependent on the export of produce to external markets. This implies that sea transportation would be the appropriate mode of transport. The data highlights a road-dependent transport system, due to high imports of consumables from larger economies such as South Africa.

4.2.11 Cargo time-series data

The data from the documents reviewed on tonnages transported by rail, road, and sea from 2015 to 2020 were used to make projections up to 2023.

4.2.11.1 Rail cargo

Figure 4.9 presents a comprehensive representation of the data pertaining to railway cargo for the period 2015 to 2020. It offers a detailed overview of the trends, patterns, and volumes associated with the transportation of goods by rail during the specified time frame. By examining the data presented in Figure 4.9, researchers and readers gains valuable insight into the historical dynamics and fluctuations of railway cargo, facilitating deeper understanding of the role and significance of railways in the transportation of goods over the period under study.

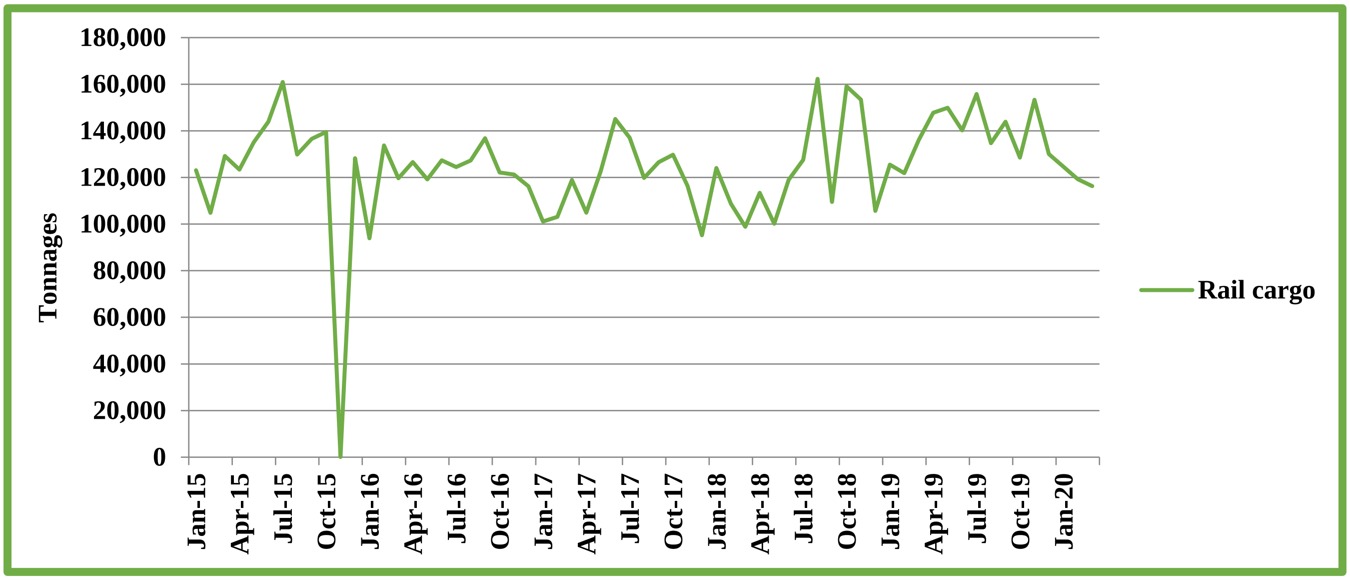


Figure 4-9: Rail cargo (tonnages)

Source: Namibia Statistics Agency (2022)

Figure 4.9 shows a line plot of the rail cargo received from January 2015 to March 2020. The highest peak was recorded in July 2018 at 162 308 and the lowest in October 2015 at 83 tonnages. Despite the drop in October 2015, the railway experienced a constant increase in usage over the five years. Nonetheless, the data reveals an under-utilised railway system.

4.2.11.2 Time-series data projection for rail

Figure 4.10 presents anticipated trends and estimates of cargo tonnages on the railway system until 2023.

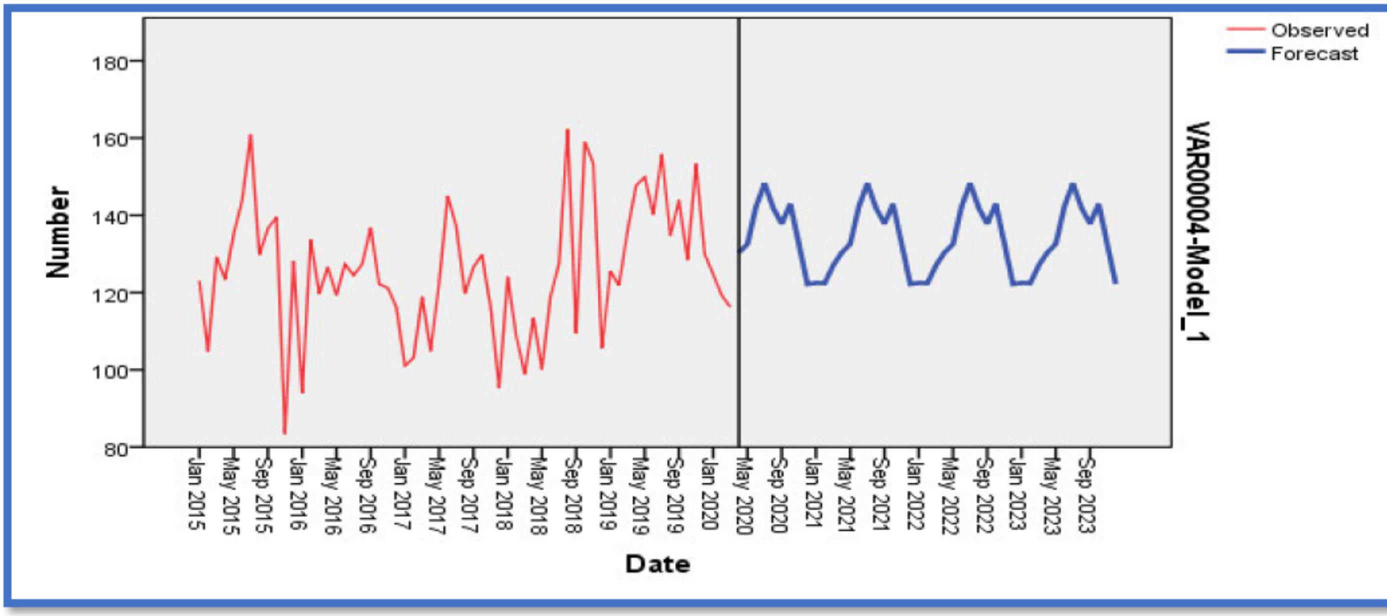


Figure 4-10: Railway cargo forecast (tonnages)

Source: Namibia Statistics Agency (2022)

The forecast presented in Figure 4.10 indicates steady future demand; as indicated in the ANOVA analysis, there was no difference in most years when the mean cargo for each year was tested. However, this data might not depict the reality on the ground, as the railway is not operating at full capacity. Therefore, current data might be skewed due to current rail infrastructure inefficiencies.

4.2.11.3 Road cargo (tonnage)

Figure 4.11 below presents comprehensive data regarding road tonnage cargo for the period spanning 2015 to 2020. This figure provides a detailed overview of the trends, patterns, and volumes associated with the transportation of goods by road during this time frame.

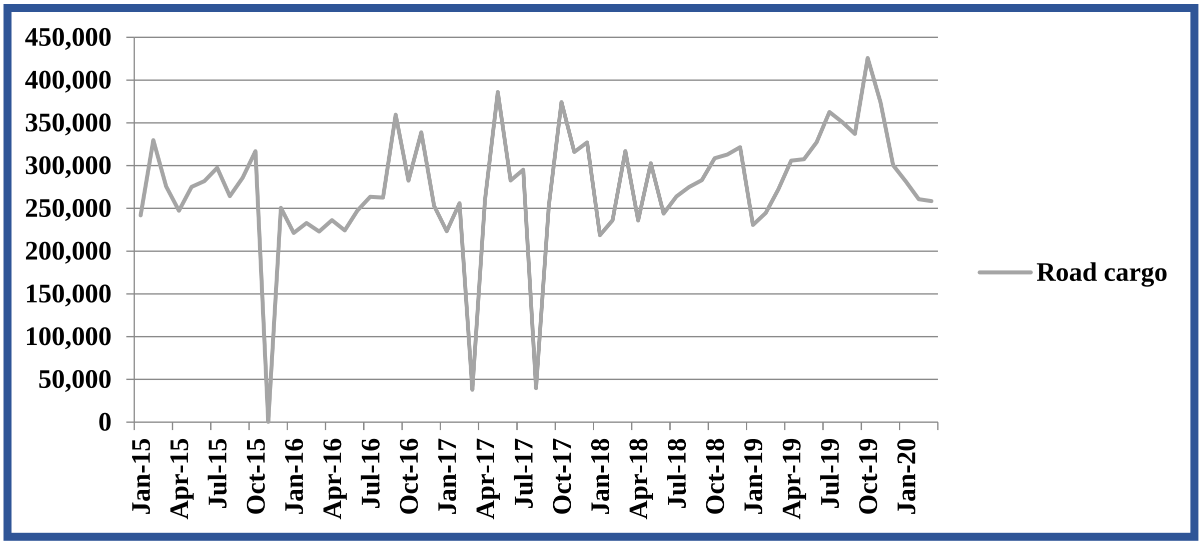


Figure 4-11: Road cargo (tonnages)

Source: Namibia Statistics Agency (2022)

Figure 4.11 depicts a line plot of road cargo in tonnages received between January 2015 and March 2020. The highest peak was 425 822 tonnages in October 2019 and the lowest total was 328 tonnes in November 2015. Despite the decline in use in November 2015, March 2017, and August 2017, road utilisation increased steadily increased over these five years. However, due to the COVID-19 pandemic, there was a significant decline from December 2019.

4.2.11.4 Road cargo (tonnage) forecast

Figure 4.12 presents the forecasted road usage in tonnages until 2023, utilising time series analysis as a predictive methodology to estimate anticipated demand for road transportation.

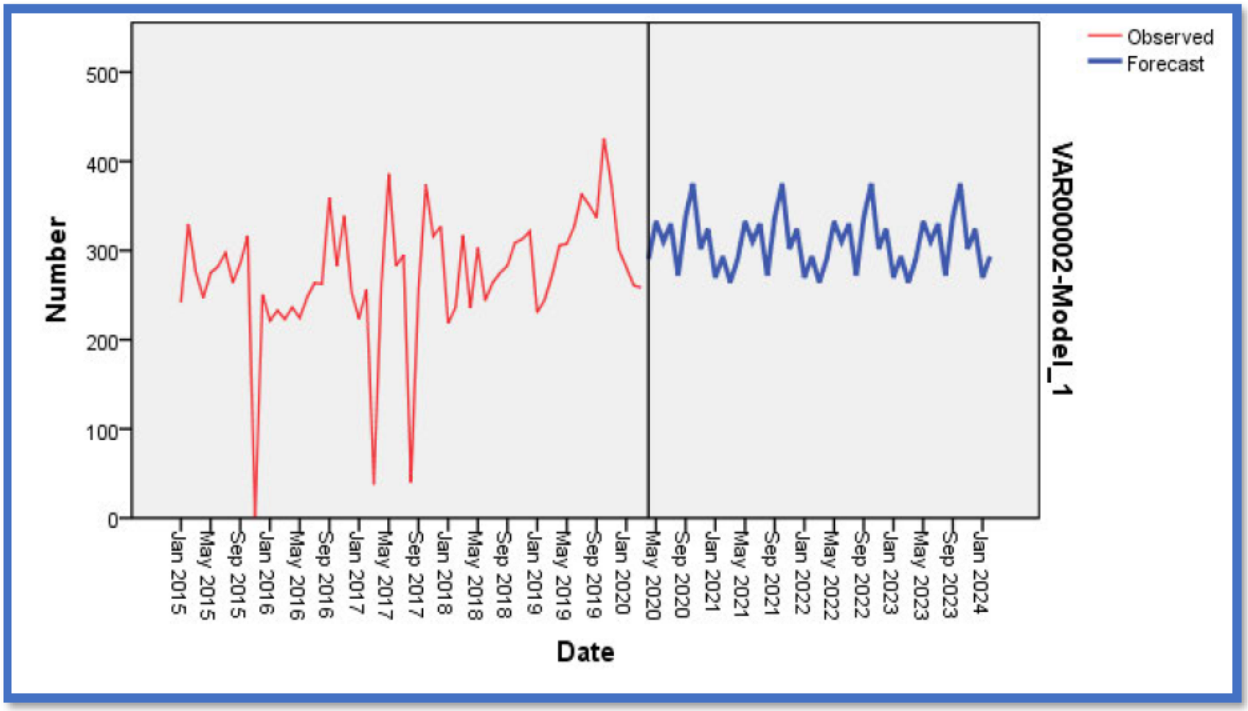


Figure 4-12: Road cargo forecast to January 2023

Source: Namibia Statistics Agency (2022)

As depicted in Figure 4.12, the forecast suggests constant demand in the future. However, as noted previously, a decline commenced in December 2019. The forecasting method minimised the discrepancies produced by COVID-19.

4.2.11.5 Sea-landed cargo

Figure 4.13 presents comprehensive data on sea-landed cargo in tonnages for the period from 2015 to 2020. It provides an in-depth overview of the trends, volumes, and patterns associated with the transportation of goods through sea routes during 2015-2020.

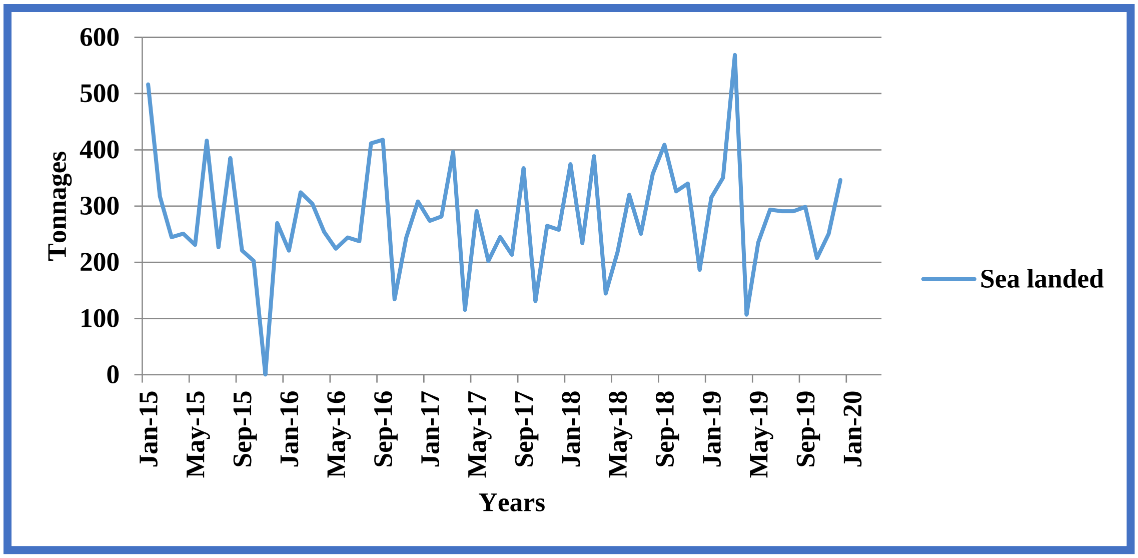


Figure 4-13: Sea-landed cargo (tonnages)

Source: Namibia Statistics Agency (2022)

The line plot of road freight received between January 2015 and March 2020 in Figure 4.13 shows that the highest peak was in March 2019 at 568 785 tonnes, while November 2015 had the lowest total at 0.35 tonnes. In section 4.4, Levene's test is performed to validate data stability.

4.2.11.6 Sea-landed cargo forecast

Figure 4.14 presents the projected forecast for sea-borne landed tonnages until 2023, utilising time series analysis as a predictive approach to estimate anticipated demand for maritime transportation. This figure offers valuable insights into expected trends and patterns of sea-borne cargo volumes, providing stakeholders and researchers with a comprehensive understanding of future demand for transportation of goods by sea.

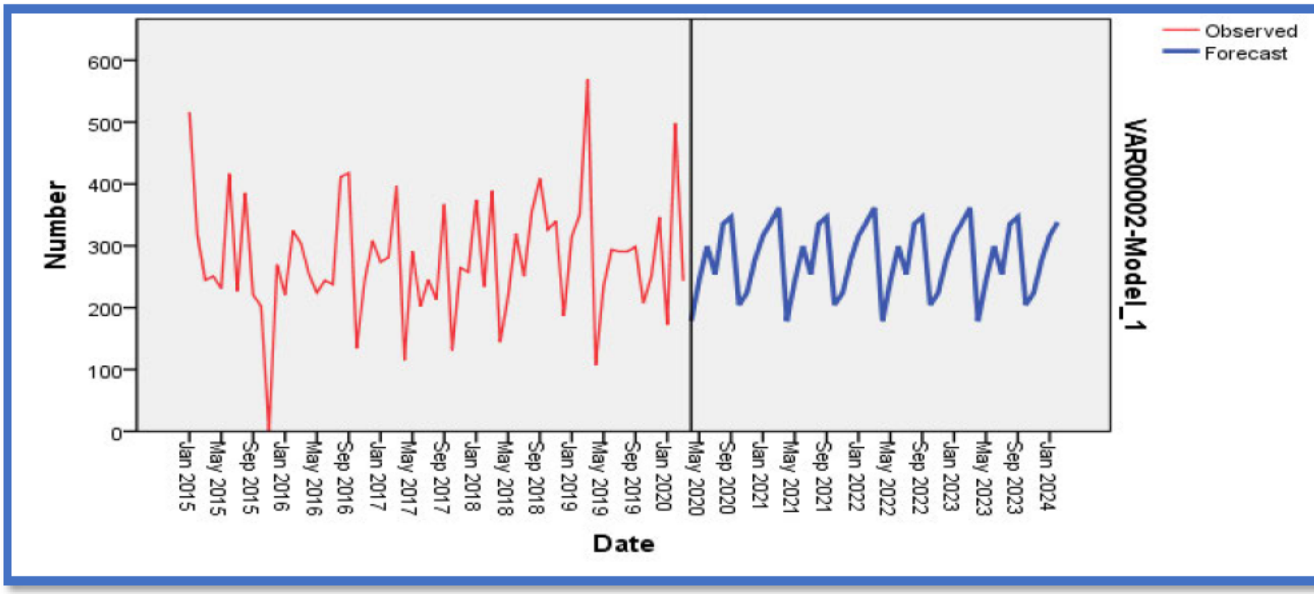


Figure 4-14: Sea-landed cargo forecast

Source: Namibia Statistics Agency (2022)

As depicted in Figure 4.14, the forecast suggests constant demand in the future. Similar to road cargo estimations, the decline that was experienced in 2019 due to the COVID-19 pandemic was minimised to reach a constant of sea-landed forecast.

4.2.11.7 Road quality

Figure 4.15 provides a graphical representation of Namibia's road quality index for the period 2012 to 2019. It offers a comprehensive overview of the measured road quality over time, showcasing the changes and trends in the condition of the country's road infrastructure.

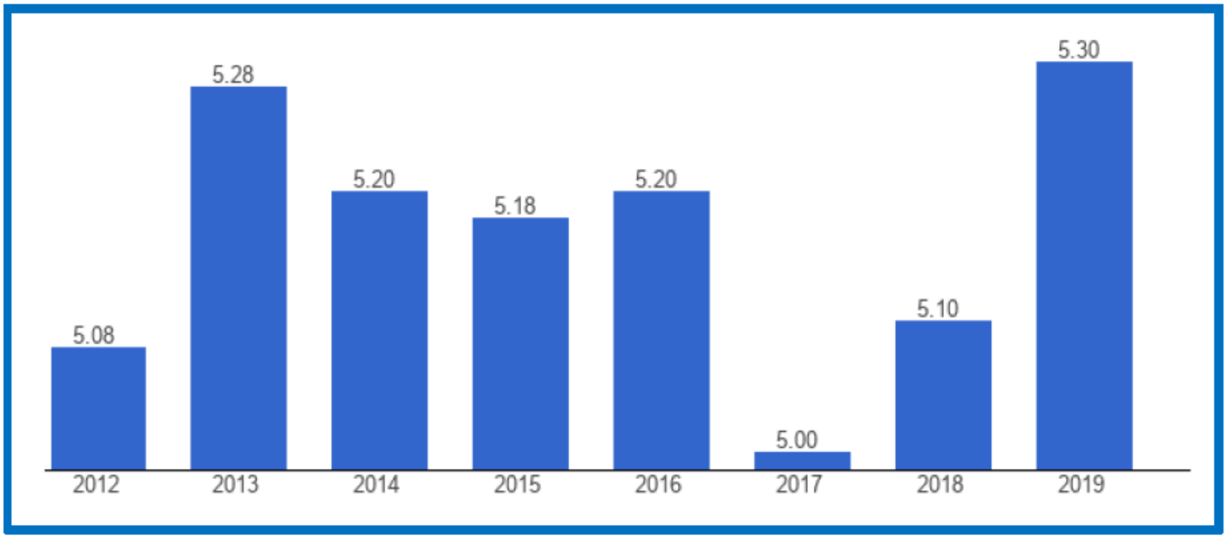


Figure 4-15: Namibia's road quality index (2012-2019)

Source: The Global Economy.com

One of the measures of the Global Competitiveness Index that is compiled and released on an annual basis by the World Economic Forum is an indicator measuring the condition of roads. It represents an evaluation of road quality globally. Respondents are asked to rank the roads in their country of operation on a scale of 1 (undeveloped) to 7 (developed) (extensive and efficient by international standards). Individual responses are combined to generate a country score. Data on Namibia is available for this indicator from 2006 to 2019. The country's average value throughout that period was 5.24 points, with a low of 5.00 points in 2017 and a high of 5.30 in 2019. In 2019, the global average based on 141 nations was 4.07 points.

4.2.11.8 Port infrastructure and service quality

Figure 4.16 presents a visual representation of the infrastructure quality index for the Walvis Bay region from 2012 to 2019. This figure provides a comprehensive overview of the measured quality of infrastructure in the Walvis Bay area during this time period.

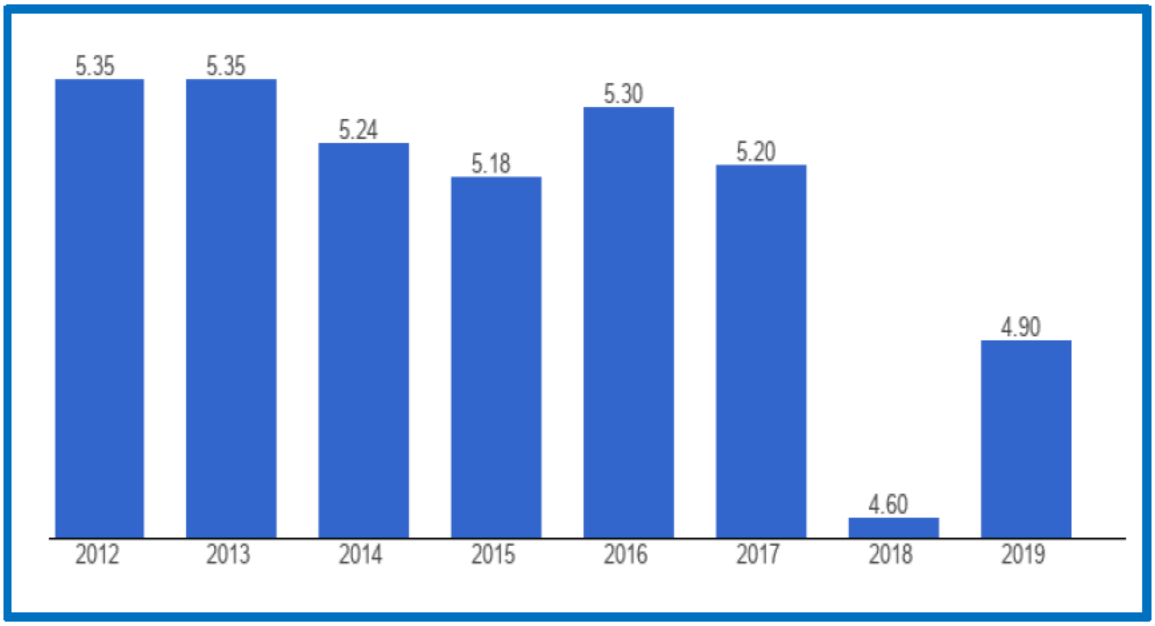


Figure 4-16: Walvis Bay infrastructure quality

Source: The Global economy.com

The World Economic Forum publishes an annual Global Competitiveness Index, which includes the Quality of Port Infrastructure indicator. This data is used to gauge the quality of port facilities in a country. Data on Namibia is available for this indicator from 2012 to 2019. The country had an average score of 5.21 points over that period, with a minimum of 4.6 points in 2018 and a maximum of 5.64 in 2010. The most recent figure is 4.9 points from 2019. By contrast, the global average for 2019 is 4.03 points based on 139 different nations.

4.2.11.9 Vehicles involved in road accidents in Namibia, 2012-2014

Table 4.7 provides an illustration of the number of vehicles involved in road accidents in Namibia from 2012 to 2014. It includes information on the prevalence and severity of vehicle-involved road accidents in the country during this time period.

Table 4-7: Vehicles involved in road accidents in Namibia, 2012-2014

Source: Chatukuta, 2020, p. 451

Type of vehicle	Accidents (N)	% (95% CI)	Injuries (N)	Deaths (N)	Injury rate per 100 reported accidents	Death rate per 100 reported accidents
Sedans	6,725	48.0(47.2-48.9)	7,669	689	114	10.3
Pick-ups	4,765	34.0(33.3-34.8)	1,306	772	158	16.2
Trucks	1,012	7.2(6.8-7.7)	1,744	194	129	19.2
Buses	583	4.2(3.8-4.5)	760	112	299	19.2
SUVs	560	4.0(3.7-4.3)	190	73	136	13.0
Motorcycles	240	1.7(1.5-1.9)	142	19	792	7.9
Vans	112	0.8(0.7-1.0)	142	21	127	18.8
Total	13,997	100	19,33	1,880	138	134.3

Table 4.7 shows that 13 997 road accidents were reported from 2012-2014, with 19 330 injuries and 1 880 deaths. Crashes involving trucks, pick-ups and vans amounted to 5 889 or 42% and deaths for these types of vehicles totalled 987 or 52.5%. Considering Namibia's population of 2.8 million, these figures spanning just two years are high and cause for concern. Indeed, Namibia is rated as one of the countries with the highest per capita death rate from road accidents.

4.2.11.10 Annual growth rate of vehicles in Namibia

Figure 4.17 shows the annual growth rate of vehicles in Namibia from 2013 to 2018. It provides a comprehensive overview of fluctuations in the number of vehicles registered in the country during this time period.

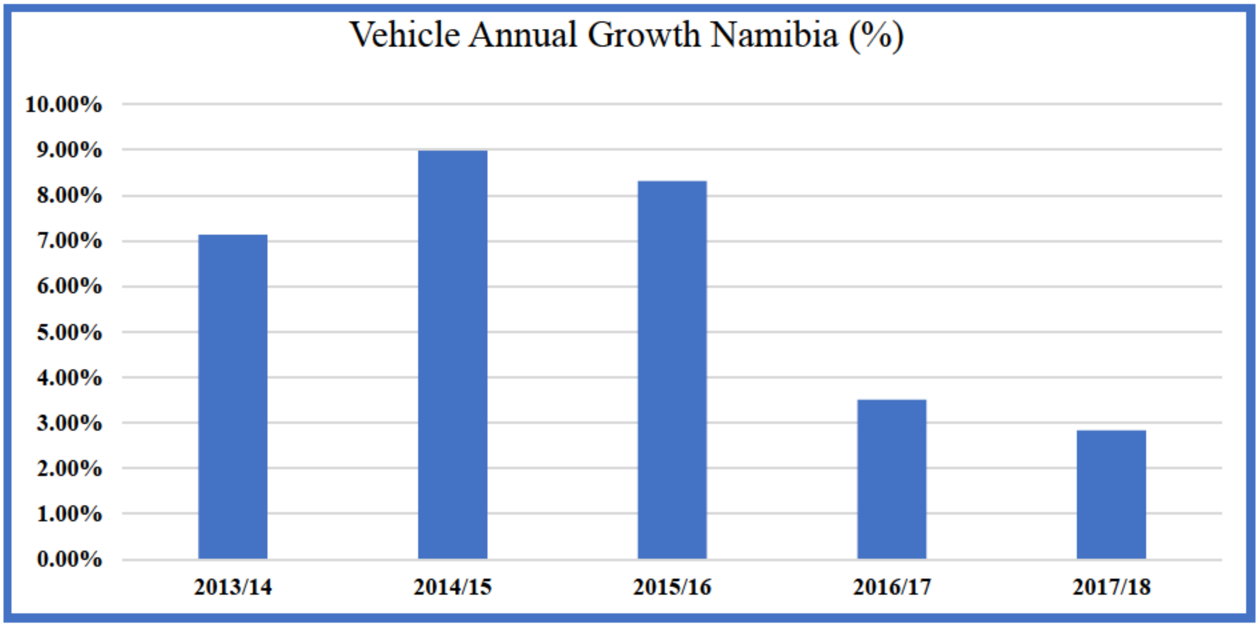


Figure 4-17: Annual growth rate of Vehicles in Namibia

Source: Tjikotoke, 2022

Figure 4.17 shows that the number of vehicles in Namibia grew by 9% in 2014/2015, 8.3% in 2015/2016 and 7.2% 2013/2014. The two years with the lowest increase were 2016/2017 (3.5%) and 2017/2018 (2.9%).

4.2.11.11 Vehicle population in Namibian regions

Figure 4.18 depicts the percentage distribution of Namibia's vehicle population across its various regions. It offers valuable insight into the spatial patterns of vehicle ownership and utilisation.

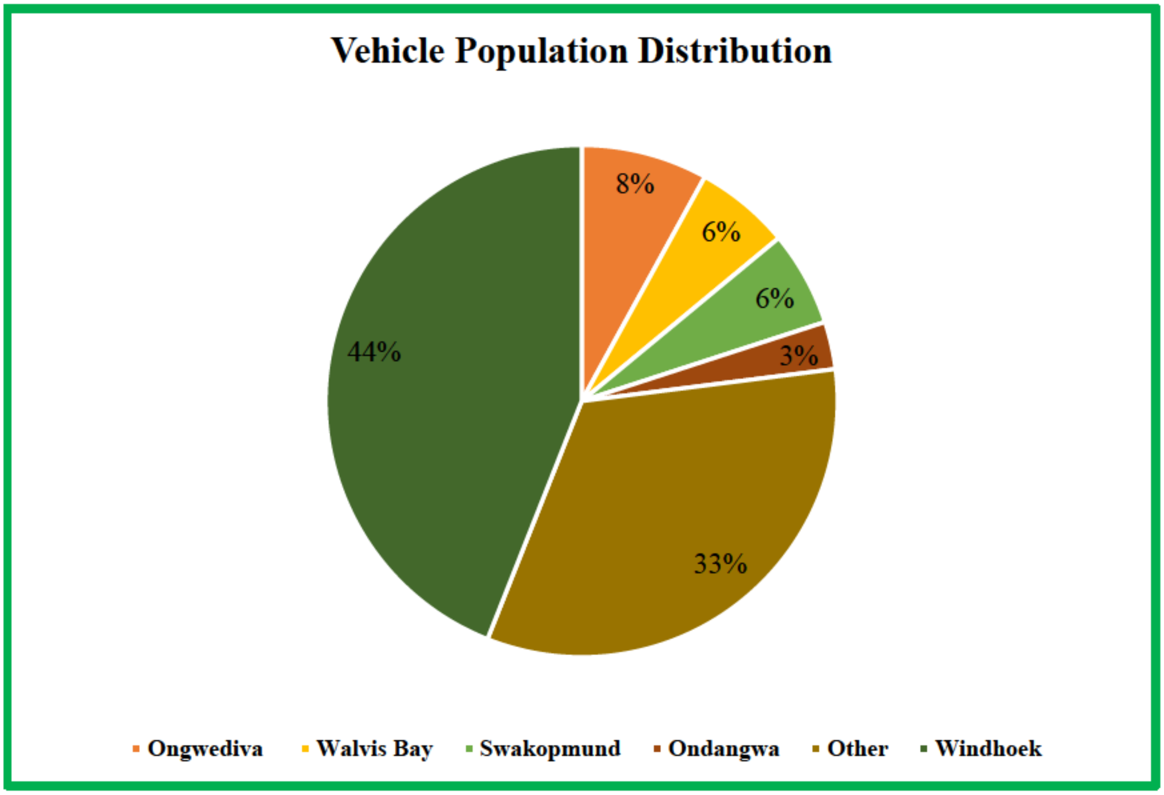


Figure 4-18: Vehicle population distribution in Namibia

Source: Tjikotoke, 2022

Figure 4.18 indicates that the highest vehicle population is in Windhoek, which is the capital city of Namibia. The second highest is in Ongwediva and Ondagwa (8%+33%=41%) in the northern part of the country, where a quarter of the population resides. Walvis Bay and Swakopmund, which are coastal towns, are rated third.

Figure 4.19 lists the top five products imported into Namibia, with vehicles the third most imported product, accounting for a significant share of 5.9%. This figure offers valuable insights into the composition and significance of Namibia's import market, highlighting the prominence of vehicles as a major imported commodity.

LOC TRUCK Smart has the potential to reduce the vehicle population in Namibia by optimizing logistics and transportation processes, leading to more efficient cargo handling, reduced waiting times, and streamlined cross-border operations. This increased efficiency can discourage unnecessary vehicle accumulation and congestion, contributing to a more sustainable and organized transportation system.

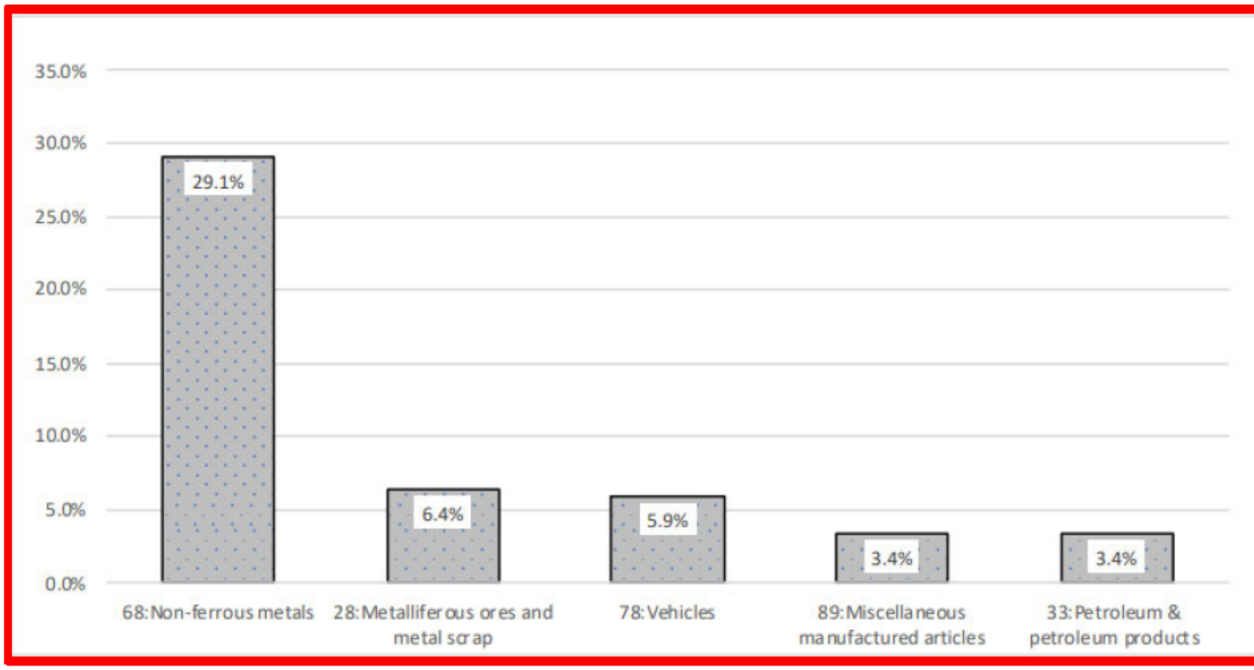


Figure 4-19: Top five product imports in Namibia (percentage share)

Source: Namibia Trade Statistics Bulletin, 2021

4.2.11.12 Distance and Transit time from inland to the world

Comparison of the distance and transit time from inland Namibia to various global destinations, as well as the corresponding measurement in kilometres (km), is essential to understand the logistical dynamics and challenges associated with international trade and transportation. Analysing the distances involved in reaching different parts of the world from inland Namibia provides insight into the geographical complexities and logistical considerations that influence transit times.

Table 4-8: Comparison of distance and transit time from inland to the world

Source: Moshi et al., 2013

Origin	Destination	Distance (km)	Transit time	Note

Kitwe	Walvis Bay	2 480	4-5 days	
Kitwe	Dar es Salaam	1 968	12-14 days	
		2 579	7-10 days	Zimbabwe route
Kitwe	Durban	2 796	7-10 days	Botswana route
Kitwe	Beira	1 293	6-8 days	

Table 4.8 compares distance and transit times from Kitwe to Walvis Bay, Dar es Salaam, Durban and Beira ports. The Port of Walvis Bay has a 2-3-day time advantage with regard to exports to cover 2 480 km for cargo destined for Asia and North America. In comparison, it takes 6-8 days to reach the port of Beira, with the shortest distance of 1 293 km. The port also seems to have a cost advantage. However, it should be noted that this preliminary calculation is "one way". In reality, it is quite easy to get return cargo in Durban, unlike at Walvis Bay; therefore, the total trucking cost is much lower for the Durban route. The higher availability of return cargo is an important factor that makes the Durban route most preferred. Improving the return load is thus one of the critical factors for Namibia to reduce land transport costs in preparation for the logistics hub.

4.3 Part B: Quantitative Data Analysis

This section on the quantitative data analysis presents the response rate analysis, socio-demographic analysis, descriptive statistics, factor analysis, reliability, validity, ANOVA and MANOVA.

4.3.1 Response Rate Analysis

Following Cochran's formula, the target sample for the study was 384 thus the researcher distributed 384 questionnaires. The response rate analysis is shown in Table 4.9 below.

Table 4-9: Response Rate Analysis

Source: Author's compilation (2022)

	Administered	Completed	Response rate
Questionnaires administered	384	384	100%
Interviews	12	12	100%

As shown in Table 4.9, the response rate was 100%. Mishra and Alok (2017) define an adequate and acceptable response rate on data collection instruments administered and returned or targeted respondents' feedback as 70% or higher. Thus, a response rate of 100% for the questionnaire and 100% for the interviews in this study was satisfactory and suitable for further data analysis. Before exposing the data to other statistical tests, the data set was cleaned, and data screening checks were performed to ensure data reliability (see Tables 3.3 and 4.3.1).

4.3.2 Univariate Method

Demographic data is essential to ascertain the respondents' characteristics (Kothari, 2004; Ragab & Arisha, 2017). Rodrigue (2020) emphasises that socio-demographic variables impact transport services within the transportation and logistics realm. This study measured four socio-demographic variables: position, duration of employment, level of education, and employment sector to contextualise the responses.

4.3.2.1 Frequency Distribution of Socio-demographic data

The distribution of respondents' positions plays a vital role in understanding the occupational structure and workforce composition within the logistics and transport context. This analysis enables researchers to examine the distribution of respondents across various employment levels, providing valuable insights into the employment landscape and the hierarchy of positions within a given organisation or industry.

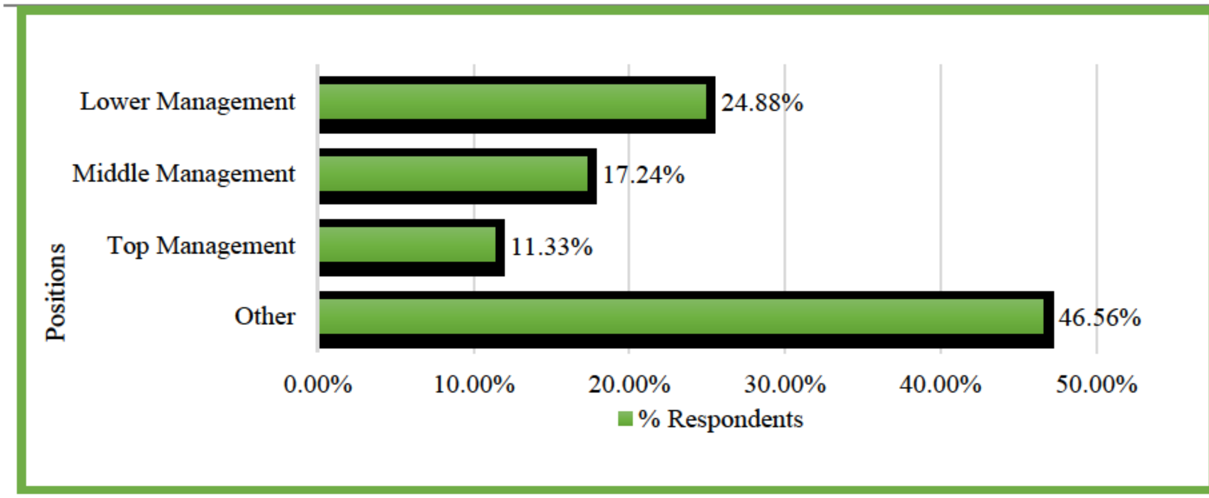


Figure 4-20: Respondents' Level of Employment
Source: Author's compilation (2022)

Figure 4.20 shows that 24.88% of the respondents were in lower management positions (supervisors, demand planners, officers, and traffic controllers), with 17.24% in middle management (managers, transport analysts, engineers, and transport inspectors) and the smallest proportion (11.3%) in top management (chief executive officers, general managers, executive management, directors, deputy directors, and specialists). All levels of management were fairly represented without bias. The remainder of the respondents (46.56%) fell into the category of "other" including drivers/operators, clerks, assistants, administrators, technicians and mechanics, cargo and freight agents, customs and excise officials, graduate trainees and unemployed graduates.

a) Distribution of years of employment

Figure 4.21 presents an overview of the data on the respondents' years of employment, offering insights into the length and tenure of their professional experience. It provides a visual representation of the distribution of the respondents across different categories based on the number of years they had been employed.

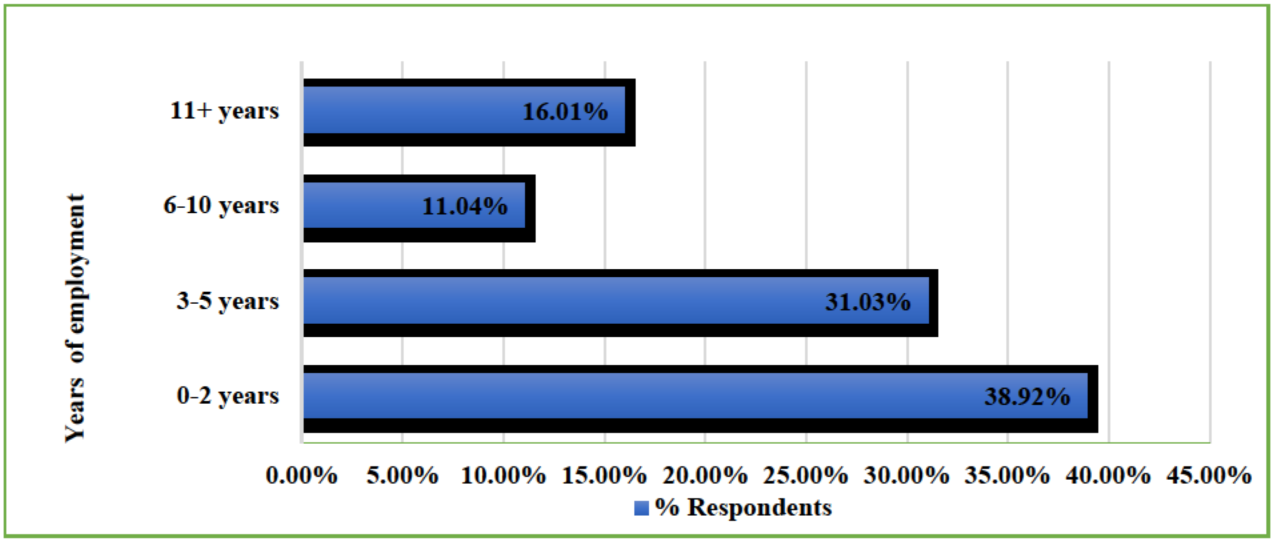


Figure 4-21: Respondents' years of employment

Source: Author's compilation (2022)

Figure 4.21 illustrates that the majority of the employees (38.92%) had served for 0 to 2 years in their positions, with the second most frequent (31.03%) being those that had served for 3 to 5 years. This can be interpreted as a high employee turnover rate, resulting in minimal work experience. Those who had served for 11 years+ comprised 16.01%, while 14.04% represented respondents with 6 to 10 years' experience. The demographic information on respondents' years of employment in Figure 4-21 provides valuable insight into the workforce's level of experience and tenure within the transport systems. By understanding the distribution of years of employment among the respondents, it is possible to gauge the extent of work experience available within the industry. The higher percentage of employees (38.92%) with 0 to 2 years' service suggests a potential challenge of limited expertise and knowledge due to a relatively higher turnover rate. This information could shed light on the human resources dynamics and potential implications for the preparedness of transport systems towards a regional logistics hub in Namibia.

b) Level of Education

The comprehensive assessment of the respondents' level of education aimed to gain insight into the educational background and qualifications of the surveyed population. Figure 4.22 shows the distribution of the respondents based on their level of education.

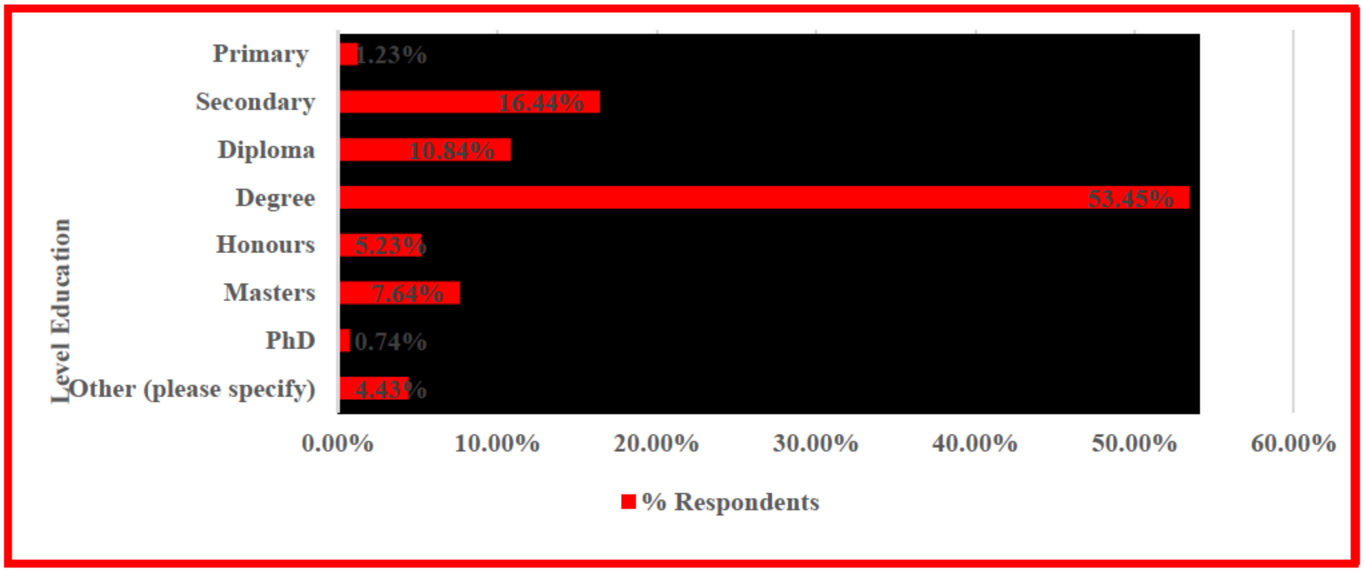


Figure 4-22: Respondents' level of education

Source: Author's compilation (2022)

Figure 4.22 presents the disaggregation of the respondents' educational levels. Most held a degree (53.45%), followed by those with secondary education (20.44%). The figure further shows that 1.23% of the respondents had a primary level of education, while 72.67% had achieved a tertiary-level qualification.

c) Employers/ Employment sector

The analysis of the respondents' employers aimed to gain insight into the diversity and representation of various organisations within the surveyed population. Figure 4.23 presents the distribution of the respondents based on their employers.

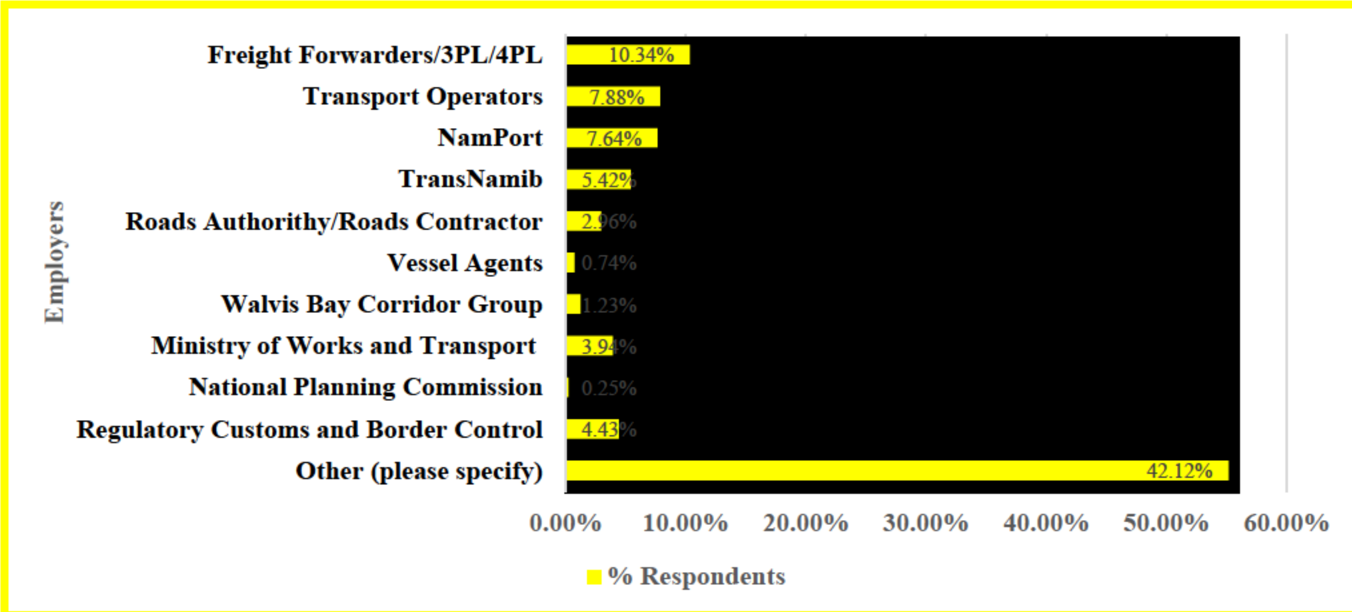


Figure 4-23: Respondents' employers

Source: Author's compilation (2022)

The findings in Figure 4.23 indicate that 57.88% of the respondents worked directly in the logistics and transportation sector. Thus, key stakeholders within the transport and logistics sectors were fairly represented. The researcher ensured the anonymity of the participants in disclosing this information. However, "other" industries accounted for 42.12% of the respondents. The researcher utilised a graph analysis methodology to examine and ascertain the particular industries encompassed within the classification of "other industries". The methodology entailed an examination of the interdependencies and interrelationships among various industries in order to ascertain their classification within this category. The results of this analysis are depicted in Figure 4.24, offering a comprehensive representation of the sectors that fall under "other industries".

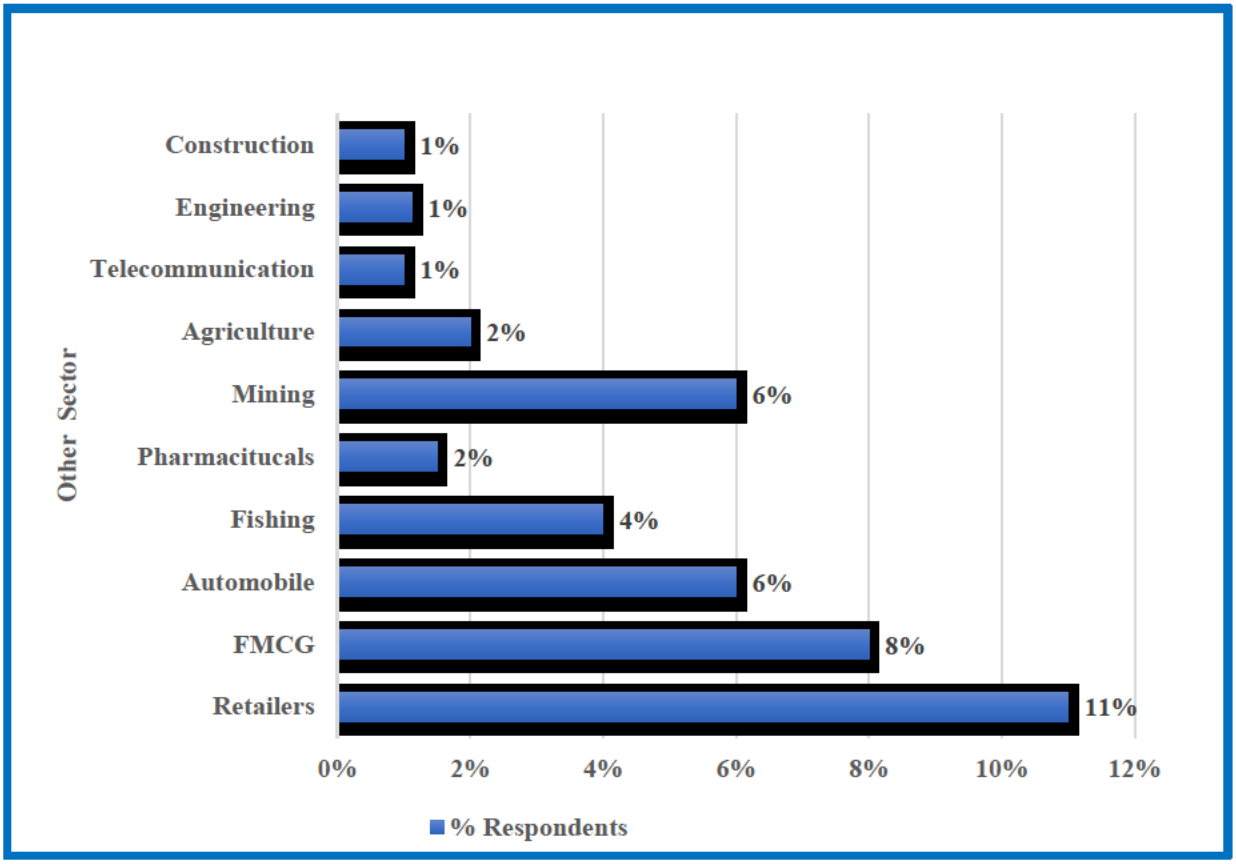


Figure 4-24: Other sector respondents' statistics

Source: Author's compilation (2022)

As reflected in Figure 4.24, most of the respondents in this sector were employed by retailers and the FMCG industry. These findings are critical as the Retail Sales Index is an excellent indicator to evaluate Namibia's economy. Furthermore, the results show significant representation of the entire sector and are not biased towards one industry.

4.3.2.2 Transport systems’ preparedness

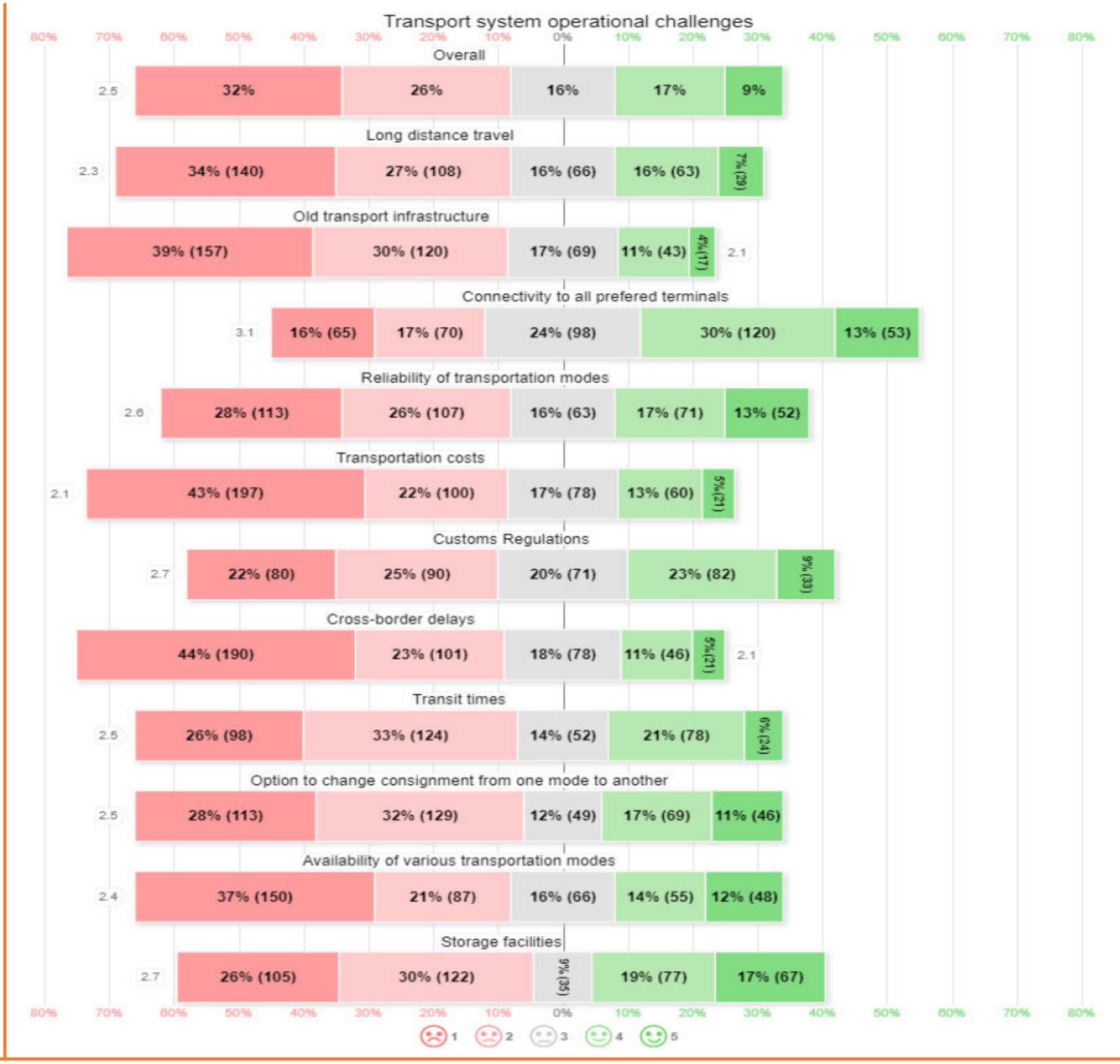
This section reports on the analysis of the responses to the questions posed by the researcher to fulfil the study’s objective, namely, to measure the preparedness of Namibia's transport systems to develop a logistics hub.

4.3.2.2.1 Transport System Challenges

A sustainable transport system is crucial for Namibia and the Port of Walvis Bay to be recognised as a world-class logistics hub connecting SADC to international markets. To date, Namibia has encountered various challenges in achieving seamless transportation. Understanding the different challenges is crucial to identify loopholes within the transport system.

a) Operational challenges

A Likert scale was used to rate the extent to which the variables in Figures 4.25 and 4.26 challenge transport and logistics operations. The following rankings were used for each variable: (1) Extremely Challenging, (2) Very Challenging, (3) Moderately Challenging, (4) Slightly Challenging, and (5) Not Challenging. Figure 4.25 provides the first part of respondents’ rankings of the identified challenges.



[redacted]

Figure 4-26: Operational Challenges (Part 1)

Source: Author's compilation (2022)

Figure 4.25 shows the first part of the operational challenges inhibiting Namibia's vision of becoming a logistics hub. The majority of the respondents (61%) considered long-distance travelling as cumbersome, ranging from very challenging (27%) to extremely challenging (34%).

Long-distance and regional freight transportation weakens resilience and sustainability, posing a challenge of not being transparent and being expensive for system users and stakeholders. Most of the respondents (69%) deemed old transport infrastructure a major setback, ranging from very challenging (30%) to extremely challenging (39%). Outdated transport infrastructure raises travel and transportation costs, discourages foreign investment, and restricts the exchange of public resources. Transport infrastructure plays a key role in industrialisation and has spill over effects on regional innovation and manufacturing productivity, which support the aggregation of industries, people, and the economy.

Many respondents (54%) described the reliability of transportation modes as very challenging (26%) or extremely challenging (28%). When transport networks suffer from insufficient capacity or dependability, they can negatively impact the economy in the form of reduced or lost opportunities and a decline in the quality of life. Transportation costs were deemed by many (61%) respondents to be high, ranging from very challenging (25%) to extremely challenging (36%). High transportation costs negatively impact the price of goods and services and supplier profitability. The majority of the respondents (47%) also felt that customs regulations were bureaucratic, ranging from very challenging (25%) to extremely challenging (22%). A lack of interconnected customs systems and delays and inconsistencies in the paper-based interchange of cross-border economic indicators between customs officials inhibits trade facilitation and regional integration initiatives. This translates into dissatisfied traders, untrustworthy trade data, disagreements over national governments' allocations from the shared income pool, and significant risk of revenue loss. Many respondents (64%) believed that cross-border delays are causing inefficiencies, ranging from very challenging (25%) to extremely challenging (39%). The ability to access global markets is crucial to the growth of an economy. Inefficient processes, needless bureaucracy, and redundant procedures increase the time and expense of border and documentary compliance.

Many respondents (59%) believed that transit time was extended, ranging from very challenging (33%) to extremely challenging (26%). Distance, the availability of various resources, and mode of transportation are the key variables influencing shipping travel times. Negative impacts on supply chain management can increase lead times and decrease productivity. Most of the respondents (60%) deemed the option to change a consignment from one mode to another as cumbersome, ranging from very challenging (32%) to extremely challenging (28%). A lack of flexibility in the transportation chain implies that transport is not smart. The bulk of the respondents (58%) considered the availability of various transportation modes as insufficient, ranging from very challenging (21%) to extremely challenging (37%). A subpar transportation system can severely influence the competitiveness of areas and their economic activities and, therefore, regional added value, economic possibilities, and jobs. The availability of storage facilities was deemed by most respondents (56%) to be insufficient, ranging from very challenging (30%) to extremely challenging (26%). The warehousing function is crucial in a supply chain because it works as a node that connects material flows between the supplier and customers. A lack of warehouses might lead to supply chains that are not streamlined.

Most of the respondents (67%) considered connectivity to all terminals as effortless, ranging from moderately challenging (24%), to slightly challenging (30%) and not challenging (13%). The ability to seamlessly connect to terminals reduces transportation costs and increases productivity.

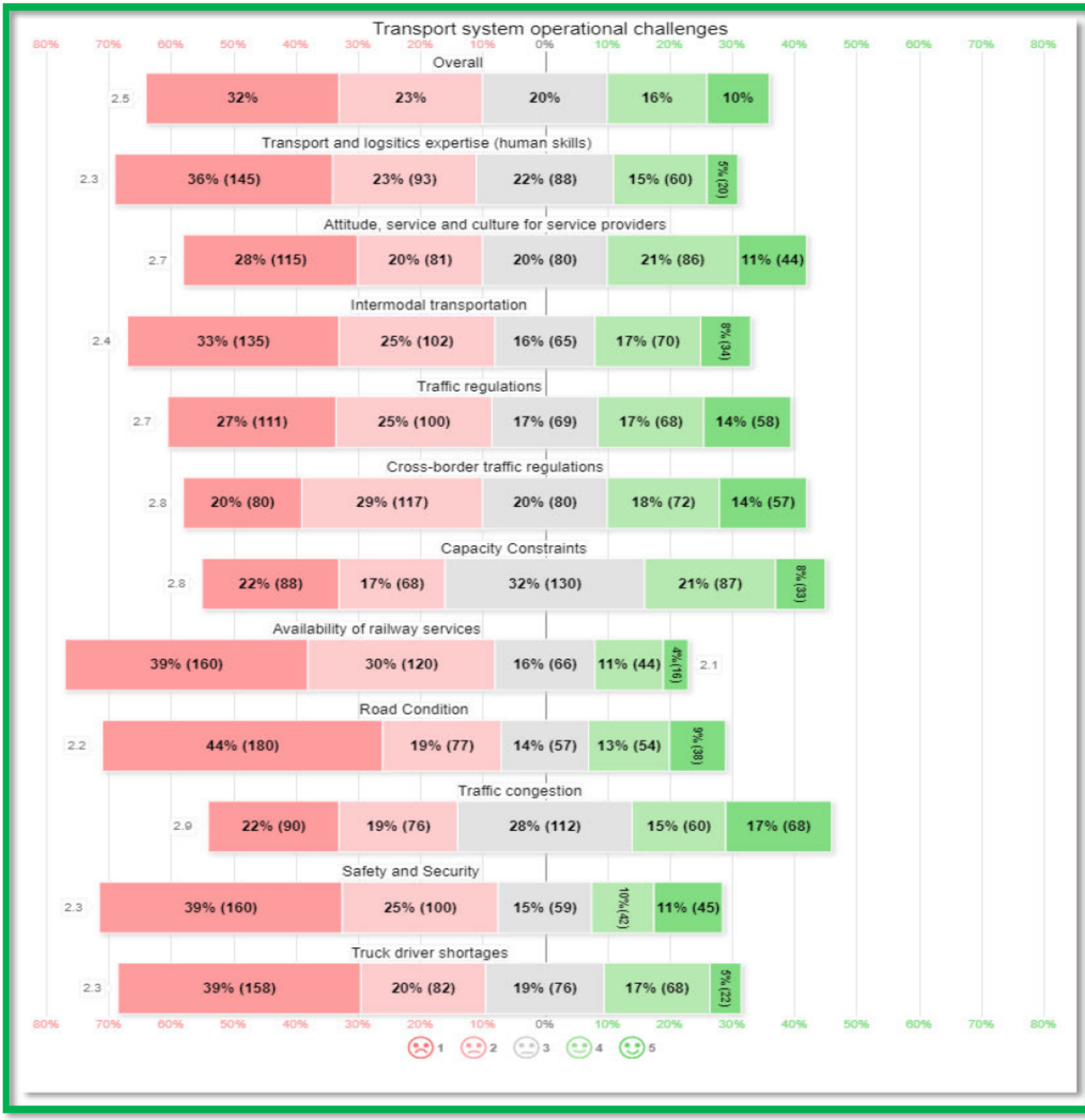


Figure 4-27: Operational challenges (part 2)

Source: Author's compilation (2022)

Figure 4.26 presents the second part of the operational challenges inhibiting Namibia's vision of becoming a logistics hub. The majority of the respondents (55%) considered transport and logistics expertise (human skills) as challenging, ranging from very challenging (23%) to extremely challenging (36%). Poverty and inequality are exacerbated by a lack of skills, making it difficult for people to find work and raise their standard of living, for businesses to increase productivity, competitiveness, and development, and for nations to realise their full potential. Most of the respondents (48%) deemed the attitude, service and culture of service providers to be taxing, ranging from very challenging (20%) to extremely challenging (28%). Understanding the cultural context of customer behaviour is essential given Namibia's rising degree of commercial globalisation. Many respondents (58%) believed that the inter-modal transportation system was inefficient, ranging from very challenging (25%) to extremely challenging (33%). Intermodal transport could provide superior flexibility, dependability, and capacity use. Traffic regulations were deemed by many (52%) respondents to be cumbersome, ranging from very challenging (25%) to extremely challenging (27%). Poor traffic management has adverse social, administrative, legal, technological, and economic repercussions. The majority of the respondents (49%) deemed cross-border traffic regulations as complex, ranging from very challenging (29) to extremely challenging (20%). Differences in opinion on the complexity of cross-border traffic regulations may arise from varied experiences, knowledge levels and exposure to cross-border operations. One of the most crucial nodes, namely border posts, significantly impacts the effectiveness of supply chains, trade competitiveness, and corridor performance.

The majority of the respondents (39%) considered capacity constraints as very challenging (17%) or extremely challenging (22%). Demand fluctuations, which are frequently tied to seasonality, can cause bottlenecks because some areas of the network cannot handle more traffic. Many respondents (69%) believed that the availability of railways was insufficient, ranging from very challenging (30%) to extremely challenging (39%). Due to its comparative economic advantages in serving specific kinds and flows of freight, rail freight is crucial to economic development. Countries with efficient freight railroads are more competitive and profit more from well-balanced transportation systems where the appropriate cargo is transported via a suitable mode. Most of the respondents (63%) deemed road conditions to be unsafe, ranging from very challenging (19%) to extremely challenging (44%). Where transportation barriers lead to a lack of market competition, transportation upgrades that enable competitiveness will result in "extra" economic gains. The bulk of the respondents (64%) considered safety and security as poor, ranging from very challenging (25%) to extremely challenging (39%). Security concerns are becoming multidimensional in today's interconnected society. New safety and security concerns emerge due to globalisation and the proliferation of networked and hyper-connected technology, affecting the local, national, regional, and global levels, and substantially increasing their complexities and scope. The shortage of truck drivers was deemed by most respondents (59%) to be a major obstacle, ranging from very challenging (20%) to extremely challenging (39%). The lack of drivers affects the economy as most freight is transported on Namibia and the region's roads.

4.3.2.2.2 Transport Key Performance Indicators

It is vital to understand Namibia's transportation system's KPIs to assess its efficiency and effectiveness. This section presents data collected to determine if the Namibian transportation system is operating as expected and its strengths and weaknesses. The KPIs were identified as road conditions, traffic regulations, cross-border control, safety and security, customs efficiency, tracking and tracing, efficient transport system, timeliness, transportation costs, congestion, cross-border truck dwelling time and railway conditions. Respondents were asked to rate the identified variables on a scale ranging from (1) Extremely Challenging, to (2) Very Challenging, (3) Moderately Challenging, (4) Slightly Challenging, and (5) Not Challenging in their assessment of transport efficiency and effectiveness.

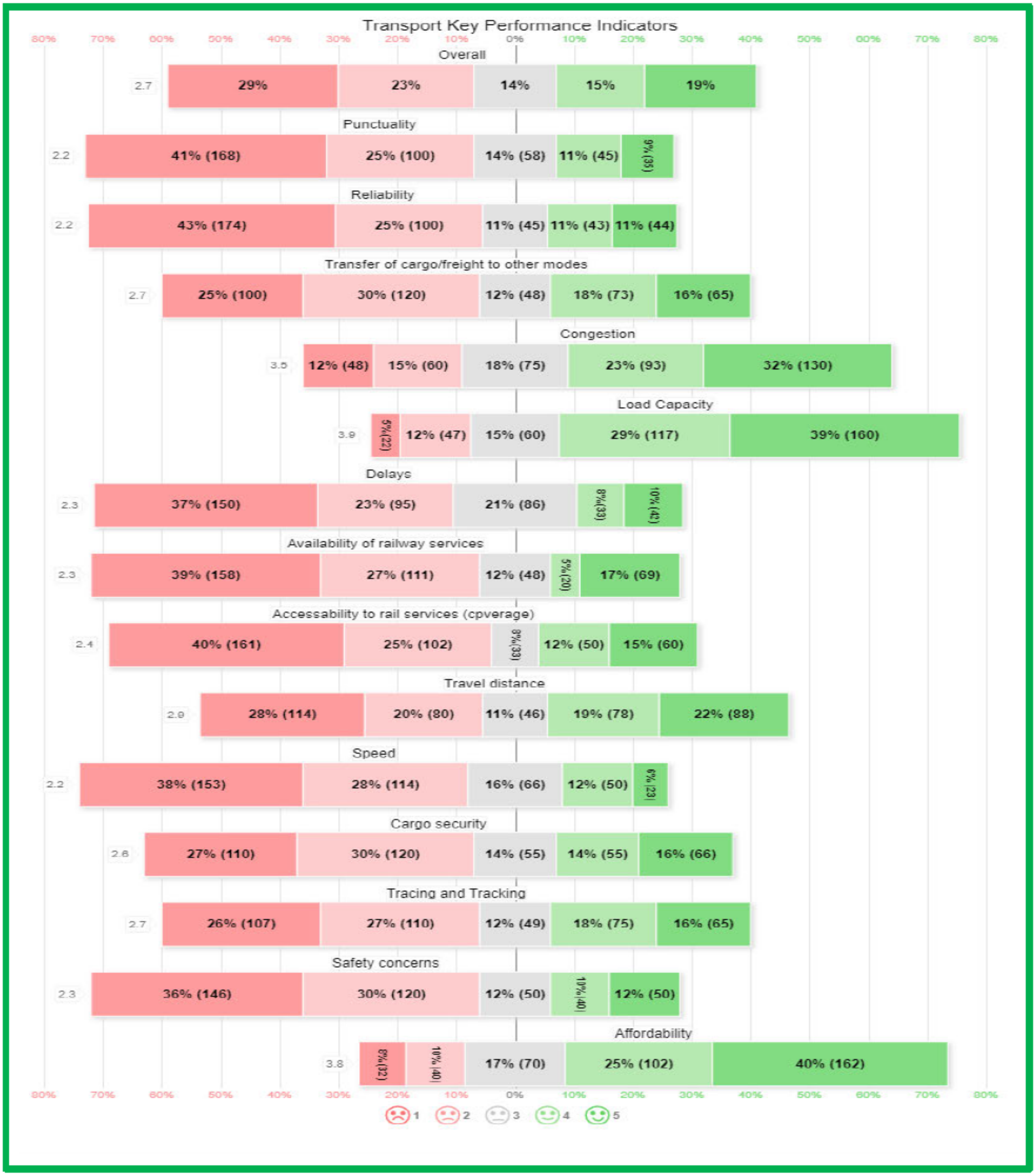


Figure 4-28: Transport system KPIs

Source: Author's compilation (2022)

The majority of the respondents (66%) rated punctuality as a drawback, varying from very challenging (25%) to extremely challenging (41%). In transportation networks, multiple stakeholders co-create value. Performance indicators are required to guide the actors and achieve the desired performance. In addition to operational capacity, punctuality as a performance metric would allow multiple actors to plan, implement, and assess their activities in relation to the expectations of transportation system participants (including their partners). Most respondents (58%) appraised reliability as low, ranging from very challenging (25%) to extremely challenging (43%). In assessing the frequency and duration of congestion on both the road and the transport networks, the reliability KPI expresses the ease of mobility, which is valued by both businesses and commuters. Transfer of cargo/freight to other modes (55%) was rated as being unreliable, varying from very challenging (30%) to extremely challenging (25%). The SADC region's logistics infrastructure lags substantially behind, impeding smooth and efficient freight flow between nations.

The respondents rated tracing and tracking as extremely unreliable (53%), varying from very challenging (27%) to extremely challenging (26%). The lack of visibility caused by the inability to track and trace leads to inadequate use of resources due to the inability to recognise them, billing conflicts brought about by a lack of service verification, resources that remain idle while not in use and maintenance difficulties, delayed response times due to siloed data/information, and the inability to monitor productivity, leading to missed goals. Many respondents (66%) considered safety concerns as significant, ranging from very challenging (30%) to extremely challenging (36%). The lack of safety in Namibia is adversely affecting its development and competitiveness. Most of the respondents (60%) rated delays as high, varying from very challenging (23%) to extremely challenging (37%). Higher transportation rates for customers and shipping businesses are associated with longer transit times. Shipment delays may have an extremely negative effect on company transactions, leading to significant financial losses.

The majority of the respondents (66%) considered the availability of railways as inadequate, ranging from very challenging (27%) to extremely challenging (39%). Rail transportation is acknowledged as the transportation with the least emissions, which may significantly reduce the transport and logistics sector's environmental impact and enable modal choice. Most respondents (65%) considered the accessibility of railway services (coverage) as being low, ranging from very challenging (25%) to extremely challenging (40%). The lack of railways as a dependable and inexpensive passenger and freight transportation system in a nation with such high unemployment and poverty rates will further exacerbate the country and region's already extreme levels of inequality. The majority of the respondents (66%) rated punctuality as unreliable, varying from very challenging (25%) to extremely challenging (41%). Timely delivery of transportation services is vital for scheduled services like trains, planes, buses, and containerised maritime cargo. Speed was rated by most respondents (66%) as challenging, varying from very challenging (28%) to extremely challenging (38%).

Most of the respondents (73%) considered congestion as low, ranging from moderately challenging (18%), to slightly challenging (23%) and not challenging (32%). Travel time can increase due to congestion, which can impact deliveries, project timeframes, the scope of work, and operational costs. The majority of the respondents (83%) felt that load capacity was sufficient, ranging between moderately challenging (15%), slightly challenging (29%) and not challenging (39%). A sizeable fraction of all logistics-related costs are related to transportation. Maximising truck routing and load planning may assist current and new clients to reduce transportation and operating expenses. The majority of the respondents (48%) considered travel distance as acceptable, ranging between moderately challenging (28%), slightly challenging (19%) and not challenging (22%). Long-distance travel accounts for a sizable proportion of total kilometres, making it critical to transportation planning. In the drive for efficiency and competitiveness, one of the most frequently stated solutions is integration of several modes of transportation, commonly known as multimodal transportation. Cargo security was generally rated as moderately challenging (57%), slightly challenging (30%), and not challenging (27%). Security measures are required to address possible risks along the cargo supply chain, focusing on ensuring that risk-based evaluation and physical screening of shipments are carried out using procedures and technology that adhere to legal and regulatory standards.

Most of the respondents (82%) considered affordability to be at an acceptable level, ranging between moderate challenging (17%), slightly challenging (25%) and not challenging (40%). In light of the logistical requirement of having the right product in the right number, at the right time, in the right condition, and at the right price, the importance of geographical distance in determining a product's value diminishes. Nevertheless, the interdependent aspects of costs and time are highly significant.

The transport system was deemed to be performing well in terms of load capacity (68%), affordability (65%) and congestion (55%). However, safety concerns, speed, the availability of railway, reliability, and punctuality were rated by 66% of the respondents as poor. Moreover, affordability and accessibility were also ranked as such. These KPIs were derived from the High-Capacity Manual (2010), which is a performance guideline for transportation. They were determined by applying the transport standard measure metrics to estimate the level of connectivity, centrality, and accessibility of the transportation system. The KPI rating results in this study provide a good indication of areas that need to be improved.

b) Namibia's Road infrastructure KPIs

Table 4.10 provides a comprehensive overview of Namibia's road infrastructure KPI ratings. It presents a systematic evaluation of various aspects related to the quality, efficiency, and performance of the country's road network.

Table 4-10: Namibia's road infrastructure KPI ratings

Source: Author's compilation (2022)

Variables	Very Good	Good	Relatively Mild	Poor	Very Poor
Road Traffic Signs	25%	22%	30%	14%	10%
Road Quality	39%	30%	17%	11%	4%
Road Coverage	25%	23%	17%	20%	16%
Cargo Security	25%	20%	23%	18%	15%
Travelling time	25%	25%	27%	15%	10%
Traffic Flow	24%	22%	26%	19%	8%
Speed	12%	20%	25%	20%	24%
Safety Concerns	10%	17%	23%	20%	30%
Travel Distance	14%	23%	25%	23%	15%
Load Capacity	17%	21%	25%	20%	17%
Connectivity to other modes	12%	15%	12%	22%	38%
Intermodal	10%	16%	15%	20%	39%
Tracing and Tracking	20%	23%	28%	19%	10%
Congestion	24%	21%	22%	17%	15%
Delays	7%	14%	27%	25%	26%

The majority of the respondents (77%) considered road traffic signs as properly designed, ranging from mild (30%), to good (22%) and very good 25%. Good traffic signs are among the most dependable control devices for directing both vehicle and pedestrian traffic. The majority of the respondents (86%) felt that road quality was acceptable, ranging between mild (17%), good (30%) and very good (39%). A significant number of respondents (65%) also rated road coverage as acceptable, ranging between mild (17%), good (23%) and very good (25%). Sound road infrastructure is a critical public asset. A sound road system is a foundation for a society's access to work, medical services, education and social connections. It is a critical component of a community's local development and a country's national and global economic growth. The majority of the respondents (68%) considered cargo security as average ranging between mild (23%), good (20%) and very good 25%. Ensuring cargo security is a delicate issue affecting both transportation users and providers. Travelling without fear of being attacked is a fundamental right. Good cargo security aims to prevent the theft of goods and containers and protects them from dangerous substances such as bombs and drugs (Closs & McGarrell, 2004). The majority of the respondents (77%) considered travelling time as fast, ranging between mild (27%), good (25%) and very good (25%). The value of reduced travel time is a monetary value used in cost-benefit analysis and traffic forecasting.

A considerable number of respondents (72%) deemed traffic flow to be satisfactory, ranging between mild (26%), good (22%) and very good (24%). Effective traffic management ensures that traffic flows seamlessly and smoothly, reducing negative externalities caused by high traffic volumes. Most of the respondents (62%) considered travel distance as manageable, ranging between mild (25%), good (23%) and very good (14%). Less travel distance equals less travel time, which implies less work that in turn denotes less labour and reduced labour costs. The majority of the respondents (63%) considered load capacity as sufficient, ranging between mild (25%), good (21%) and very good (17%). Capacity utilisation (load factor) is a crucial metric for determining the efficacy of freight transportation.

The majority of the respondents (71%) considered tracing and tracking as reliable, ranging between mild (28%), good (23%) and very good (20%). Tracking and tracing enable businesses to increase transparency and traceability throughout the supply chain to improve customer service. The bulk of the respondents (67%) considered congestion as good, ranging between mild (22%), good (21%) and very good (24%). Traffic congestion can have far-reaching effects because freight transportation affects economic productivity and growth. Alleviating such congestion is a pressing and important national priority. A significant number of respondents (57%) considered speed as acceptable ranging from mild (25%), to good (12%) and very good (12%). Road traffic speed has various significant economic consequences impacting traffic safety and operations, climate change, and air and noise pollution.

Half the respondents (50%) considered safety concerns as high, ranging from poor (20%) to very poor (30%). An increase in logistical activities or freight traffic negatively impacts road safety and could present developmental issues. The majority of the respondents (60%) felt that connectivity to other modes was unreliable, ranging from poor (22%) to very poor (38%). Transport connectivity by modes is regarded as challenging, making logistics efforts difficult to interlink and become competitive in regional and international markets. A significant number of respondents (59%) considered intermodal transportation as inefficient, ranging from poor (20%) to very poor (39%). The ability to move or transfer people or goods between a point of origin and a destination using a variety of transportation modes boosts efficiency and economic benefits, playing a significant role in the supply chain and distribution. A lack of intermodality reduces flexibility and responsiveness in the supply chain. More than half the respondents (51%) considered delays as cumbersome ranging from poor (25%) to very poor (26%). Freight delays significantly impact the entire supply chain, increasing operating expenses, forcing overtime compensation, decreasing productivity, and, most significantly, leaving consumers disgruntled and hesitant to engage with a firm again.

The results presented in Table 4.10 also show that connectivity to other modes (61%), intermodal (59%), and delays (51%) were the worst-rated road infrastructure variables, whilst road quality (69%), travelling time (50%) and road coverage were the most highly ranked. This is not surprising given that the World Economic Forum ranks Namibian roads as the best in Africa. Air and rail transportation have contributed less to freight transportation. Thus, multimodal transportation was rated low due to limited connectivity between roads and other modes of transportation.

c) Namibia's Rail infrastructure KPIs

The figure below presents a detailed depiction of the KPI ratings for Namibia's railway infrastructure. It offers a comprehensive overview of the performance and effectiveness of various aspects related to the railway network within the country.

Table 4-11: Namibia's Rail infrastructure ratings

Source: Author's compilation (2022)

Variables	Very Good	Good	Relatively Mild	Poor	Very Poor
Load capacity	30%	22%	25%	14%	10%
Affordability	39%	30%	20%	8%	3%
Congestion	44%	25%	12%	10%	9%
Cargo Security	8%	10%	18%	24%	39%
Transfer Cargo/multimodal	11%	12%	25%	27%	25%
Tracking and tracing	9%	16%	21%	25%	30%
Safety and security	7%	12%	15%	19%	47%
Reliability	5%	7%	18%	22%	47%
Travel distance	14%	15%	17%	30%	24%
Punctuality	10%	11%	25%	27%	27%
Delays	7%	12%	14%	20%	47%
Speed	5%	13%	12%	22%	47%
Accessibility to rail services (coverage)	10%	7%	19%	25%	39%
Availability of railway services	12%	15%	15%	22%	36%

The majority of the respondents (77%) considered rail loading capacity as high, ranging from mild (25%), to good (22%) and very good (30%). Rail freight load capacity is a vital component of the supply chain, increasing economic efficiency among manufacturers, retailers, and bulk traders. The majority of the respondents (79%) rated rail transportation affordability as high, ranging from mild (20%), to good (30%) and very good (39%). The rail supply sector and its cost competitiveness are vital to the economy. Freight rail provides a low-cost, low-emissions connection in freight supply networks. A significant number of respondents (81%) did not consider rail congestion as a challenge, ranging from mild (12%), to good (25%) and very good (44%).

Railways transportation benefits intercity and urban mass transit networks, reducing road congestion.

The majority of the respondents (63%) rated rail cargo security as low, ranging from poor (24%) to very poor (39%). Efficient, safe, and secure transportation services are essential for national development, collaboration, and job creation. Any land freight and passenger transit disruptions will have significant effects on economic development, territorial integrity, social growth, and the environment. More than half the respondents (52%) considered transfer cargo/multimodal as low, ranging from poor (27%) to very poor (25%). The port system is vital for overall traffic and freight flows because it links two or more modes of transportation and is responsible for sea-to-land cargo transhipment. Before moving products, it is critical to optimise routing and freight costs by combining transport operators to reduce shipment costs. The bulk of the respondents (55%) felt that tracking and tracing was poor, ranging from poor (25%) to very poor (30%). Real-time monitoring, and tracking and tracing of railway cars can increase overall rail system reliability and improve passenger and freight rail transportation by means of traffic synchronisation. A considerable number of respondents (66%) regarded safety and security as inefficient, ranging from poor (19%) to very poor (47%). Rail transport is one of the safest means of transportation in the world, providing a safe and environmentally-friendly mode of transportation. However, due to its relative safety, hazardous materials such as chemicals, petroleum, liquefied gases, and nuclear waste are regularly transported by rail. This necessitates several risk-control measures, including distinctive train formations, improved vehicle and rail track maintenance, routing away from densely populated areas, specialised handling, and increased security. Thus, poor safety and security in rail transportation can be catastrophic. The majority of the respondents (68%) considered reliability as low, ranging from poor (22%) to very poor (47%). Shippers' key concerns with rail freight have been timeliness and reliability, which is somewhat beyond the control of individual railway operators. Reliability in rail transportation rests heavily on infrastructure conditions and availability, particularly for international freight movement, posing a stumbling block to rail freight expansion.

A significant number of respondents (54%) felt that travel distance was inadequate, ranging from poor (30%) to very poor (24%). This will force organisations to transport their cargo by road instead of freight rail. The majority of the respondents (54%) also considered punctuality inadequate, ranging from poor (27%) to very poor (27%). As rail freight contributes to a more significant portion of an organisation's total volume, visibility and punctuality become more important for operations managers as it is essential to ensure timely delivery of consignments. More than half the respondents (57%) considered delays as an obstacle, ranging from poor (20%) to very poor (47%). Delays are a significant factor that discourages import and export firms from using rail and road transportation. Delays in rail transit are connected to poor punctuality, which could be caused by speed or infrastructural challenges.

The majority of the respondents (59%) felt that speed was a challenge, ranging from poor (22%) to very poor (47%). Despatching goods via rail is a more sustainable and efficient alternative for supply chain managers who value speed and reliability. However, challenges in receiving cargo on time might force them to move their cargo by road. A significant number of respondents (64%) considered accessibility to rail services (coverage) as inadequate, ranging from poor (25%) to very poor (39%). Rail transportation load capabilities enable shippers to gain supply chain benefits from a combination of rail and truck. The accessibility of rail services impacts every phase of the supply chain through a complicated network of challenges, from procurement to production and last-mile delivery. More than half the respondents (58%) considered the availability of railway services as inadequate, ranging from poor (22%) to very poor (36%). The railway system is an integral part of supply chain management. Low-cost railway networks deliver enormous quantities of freight over vast distances.

d) Rating Namibia's Port infrastructure

Table 4.12 presents a comprehensive overview of the KPI ratings for Namibia's port infrastructure. It provides a systematic evaluation of various aspects related to the efficiency, capacity, and performance of the country's ports.

Table 4-12: Namibia's Port infrastructure KPIs

Source: Author's compilation (2022)

Variables	Very Good	Good	Relatively Mild	Poor	Very Poor
Capacity	30%	22%	24%	14%	10%
Material handling services	39%	30%	20%	8%	3%
Security in the port	25%	20%	19%	20%	17%
Safety in the port	25%	20%	19%	17%	18%

Storage facilities	25%	22%	20%	18%	15%
Cargo security	24%	21%	20%	15%	20%
Throughput rate	22%	16%	20%	20%	22%
Skills and expertise	12%	10%	20%	22%	36%
Administrative services	14%	12%	15%	24%	35%
Inspections prior to customs	16%	17%	20%	20%	27%
Tracking and tracing	22%	22%	21%	17%	17%
Stay time of goods at the port	14%	15%	19%	22%	30%
Availability of specialised terminals	10%	7%	19%	27%	37%
Truck visit time	16%	17%	12%	20%	35%

The majority of the respondents (76%) considered port capacity as adequate, ranging between mild (24%), good (22%) and very good (30%). Increased port capacity could result in efficient, well-connected container ports that are supported by frequent and consistent shipping services, which are critical to reduce trade expenses such as transportation costs, connect supply chains, and encourage international trade. Thus, port performance has a critical influence on nations' trade competitiveness. A significant number (89%) of respondents considered port material handling services as fairly reliable, ranging between mild (20%), good (30%) and very good (39%). Container ports that are resourceful, well-connected, and supported by frequent and dependable shipping services are essential to decrease trade costs, including transport expenses, connect supply chains, and promote global trade.

The majority of the respondents (64%) considered security in the port as adequate, ranging between mild (19%), good (20%) and very good (25%). Significant advances in global wealth have been driven by international trade, which is handled by a vast fleet of ocean-going vessels transporting billions of tonnes of cargo via ports. A significant number of respondents (64%) felt that safety in the port was adequate, ranging between mild (19%), good (20%) and very good (25%). Port security ensures that trade will not be used as a conduit for illegal activity. A considerable percentage of respondents (67%) considered storage facilities at the port as adequate, ranging between mild (20%), good (22%) and very good (25%). The majority (65%) also considered cargo security at the port as adequate, ranging between mild (20%), good (21%) and very good (24%). Cargo security is critical to avoid theft and protect containers from damage or terrorism.

The majority of the respondents (58%) considered the throughput rate at the port as adequate, ranging between mild (20%), good (16%) and very good (22%). Increasing the efficiency of port throughput can have a significant positive impact on global supply chains and the economy. A considerable number of respondents (63%) deemed inspections prior to customs to be average, ranging between mild (20%), good (17%) and very good (16%). The majority (65%) considered the tracking and tracing of goods and services at the port as reliable, ranging from mild (21%), to good (22%) and very good (22%).

A considerable number of respondents (58%) deemed the availability of skills to be inadequate, ranging from poor (22%) to very poor (36%). Ports have evolved from ship-shore interfaces to logistical platforms and commercial hubs. Seaports are vital and indispensable to manage product and information flows in the supply chain. Thus, poor levels of skills among port staff and a shortage of expertise will undermine port efficiency and render the port an unsatisfactory supply chain partner. More than half the respondents (59%) considered the administrative services as inefficient, ranging from poor (24%) to very poor (35%). In order to increase regional cargo traffic and economic development, the port authority is expected to manage overall port operations proactively and aggressively advertise its ports to port consumers. Any challenges relating to port administrative services could impact port administrative management worldwide.

The majority of the respondents (64%) described the stay time of goods at the port as challenging, ranging from poor (22%) to very poor (30%). Worldwide, ports confront challenges relating to infrastructure, global trade, manufacturing capacity, economic factors, regulatory compliance, safety and security, sustainability, digitisation, and community support. These risks will become more evident and have more severe consequences as globalisation and maritime transport increase. A significant number of respondents (64%) rated the availability of specialised terminals as inadequate, ranging from poor (27%) to very poor (37%). As ports and terminals become more advanced multimodal hubs for the global flow of goods, the quantity and complexity of the everyday challenges they face are growing. Thus, significant investment is required in marine structures, specialised high-value equipment, storage facilities, and logistics. A considerable number of respondents (55%) considered the truck visit time as an inconvenience, ranging from poor (20%) to very poor (35%). Trucks are an unacknowledged but critical component of port logistics. The truck turnaround time can significantly impact port efficiency, affecting the entire supply chain. In port logistics, truck turnaround time is one of the most important KPIs.

4.3.2.2.3 Logistics Service Providers' KPIs

The identified logistics service providers' KPIs serve as an interactive benchmarking tool, enabling logistics hubs to determine the challenges and opportunities in trade logistics performance and what can be done to enhance performance. Logistics service providers are critical in supporting efficient and successful product delivery, necessitating a fully integrated transportation system.

Table 4-13: Logistics service providers' KPIs

Source: Author's compilation (2022)

Variables	Very Good	Good	Relatively Mild	Poor	Very Poor
Warehouse	22%	21%	19%	19%	18%
Storage facilities	24%	20%	19%	17%	19%
Dry ports	20%	18%	17%	22%	22%
Distribution centres	25%	20%	19%	17%	18%
Clearing services	22%	21%	21%	19%	16%
Bonded warehouses	24%	21%	20%	15%	20%
Efficient IT infrastructure	15%	16%	20%	22%	27%

The majority of the respondents (62%) found warehousing to be adequate, with ratings ranging from moderate (19%) to good (21%) and very good (22%). This means that the warehouses improve supply chain management by managing inventory, decreasing transportation delays, and making other operations more efficient. Many of the respondents (63%) deemed storage facilities to be good, with a minority (19%) rating them as mild, good (20%), and very good (24%). Storage facilities are utilised to optimise savings on transportation expenses as a supply chain strategy. In terms of dry ports, the majority of the respondents (55%) responded positively, with scores ranging from moderate (17%) to good (18%) and very good (20%). A dry port is of national, regional, and international importance in securing inland locations for handling, storing, inspecting, and clearing international freight. Distribution centres were given ratings of satisfactory (19%), good (20%), or very good (25%) by most respondents (63%). As part of logistics networks, logistics distribution centres serve as nodes that facilitate international commercial activities and are the essential connection between production and the market, i.e., end consumers. Many of the respondents (64%) surveyed rated the clearing services as satisfactory, with a further 21% rating them as either good or very good. Clearing agencies assist with the import and clearance of freight. Paperwork, documentation, and ancillary procedures like scheduling specialist labour and delivery save money and time.

Bonded warehouses were considered by the majority of respondents (65%) as beneficial, with ratings ranging from mild (20%) to good (21%) and very good (24%), implying that they support firms to hold products closer to international clients for faster delivery, delaying customs fees until the commodities are released. Most respondents (49%) considered efficient IT infrastructure as inadequate, ranging from poor (22%) to very poor (27%). Infrastructure contributes to economic development by increasing productivity and providing services that enhance the quality of life of the wider population. The absence or poor use of IT renders logistics services ineffective, as supply chains require intensive rapid exchange of information between transport participants.

4.3.2.3 Descriptive Statistics

Descriptive statistics includes the analysis, synthesis, and presentation of conclusions from a data set derived from a sample or the full population. They are divided into three groups: frequency distribution, measures of central tendency, and measures of variability. Descriptive statistics facilitated data visualisation and enabled the data to be presented in a meaningful and understandable manner.

4.3.2.3.1 Operational challenges computed through Measures of dispersion

The challenges identified in Figures 4.25 and 4.26 were further subjected to the measures of dispersion to establish the extent to which the respondents agreed or disagreed on the importance of such factors. Table 4.14 lists their views on significant and insignificant factors in transport operations using a Likert scale of 1 – not significant at all, to 5 – extremely significant.

Table 4-14: Descriptive statistics

Source: Author's compilation (2022)

Variables	Analysis N	Mean	Std. Deviation
Railway services	384	3.90	1.156
Transport infrastructure	384	3.88	1.160
Cross border delays	384	3.82	1.215
Transportation costs	384	3.72	1.239
Safety and security	384	3.71	1.368
Logistics and transport expertise	384	3.70	1.233
Shortages of truck drivers	384	3.70	1.285
Available modes of transport	384	3.58	1.403
Intermodal transportation	384	3.58	1.327
Distance travelled	384	3.55	1.296
Transit time	384	3.40	1.211
Behaviours of service providers	384	3.34	1.367
Reliable mode of transport	384	3.33	1.367
Multimodal transport	384	3.31	1.302
Customs regulations	384	3.27	1.242
Capacity constraints	384	3.22	1.236
Cross-border traffic regulations	384	3.13	1.308
Terminals' connectivity	384	3.00	1.272
Traffic regulations	384	2.98	1.292
Storage facilities	384	2.96	1.331
Congestion	384	2.74	1.431
Road infrastructure condition	384	2.24	1.380
Valid N (listwise)	384		

Table 4.14 shows that the respondents rated road infrastructure as the least important challenge, with a mean of 2.24. Congestion (2.74), storage facilities (2.96), traffic regulations (2.98), terminal connectivity (3.00), transit time (3.40), the behaviours of service providers (3.34), a reliable mode of transport (3.33), multimodal transport (3.31), customs regulations (3.27), capacity constraints (3.22) and cross border traffic regulations (3.13) were considered of average importance. Factors that were rated extremely important included railway services (3.90), transport infrastructure (3.88), cross border delays (3.82), transportation costs (3.72), safety and security (3.71), logistics and transport expertise (3.70), shortages of truck drivers (3.58), available modes of transport (3.58), intermodal transportation (3.55) and distance travelled (3.40).

The factors with lower mean values, such as road infrastructure, congestion, storage facilities, traffic regulations, terminal connectivity, transit time, the behaviours of service providers, a reliable mode of transport, multimodal transport, customs regulations, capacity constraints, and cross-border traffic regulations, were considered moderately important. Factors with higher mean values, such as railway services, transport infrastructure, cross-border delays, transportation costs, safety and security, logistics and transport expertise, shortages of truck drivers, available modes of transport, intermodal transportation, and distance travelled, were deemed more significant. These rankings provide insights into the priorities and perceived significance of different factors in transport and logistics.

4.3.2.3 Descriptive Statistics on Connectivity, Accessibility and Centrality

Descriptive statistics were employed to evaluate the accessibility, centrality, and accessibility of the dominant transportation system. It is important to measure centrality, accessibility, and connectivity due to their influence on numerous facets of urban life and socioeconomic development. Efficient transportation networks contribute to economic development by facilitating the movement of goods, services, and people, thereby fostering commerce, trade, and employment opportunities. In addition, well-designed and accessible transportation systems can improve the quality of life by reducing commute times, facilitating access to essential services, and fostering social inclusion. By analysing these factors with descriptive statistics, policymakers and urban planners can make decisions that result in more sustainable, efficient, and equitable transportation systems.

The descriptive statistics on centrality, accessibility, and connectivity offer invaluable insights into the transportation system's operation. They aid in the identification of vital nodes, regions with limited accessibility, and opportunities to improve connectivity. By utilising this information, decision-makers can work to improve the efficiency, equity, and sustainability of transportation infrastructure, which will ultimately benefit individuals, communities, and the urban environment as a whole.

4.3.2.3.2 Descriptive Analysis of Road and Rail Connectivity Index in Namibia

The movement of people and goods in Namibia is facilitated by two dominant transportation systems, road and rail, which connect Namibia to the region. Figure 4.28 shows the transport corridors in Namibia.

a) Road and rail transport connectivity – Transport Corridors

Figure 4.28 is a visually informative map that showcases the existing corridors that play a pivotal role in the development of the regional logistics hub in Namibia. The map serves as a valuable tool to understand the geographic layout and connectivity of key transportation routes within the country.

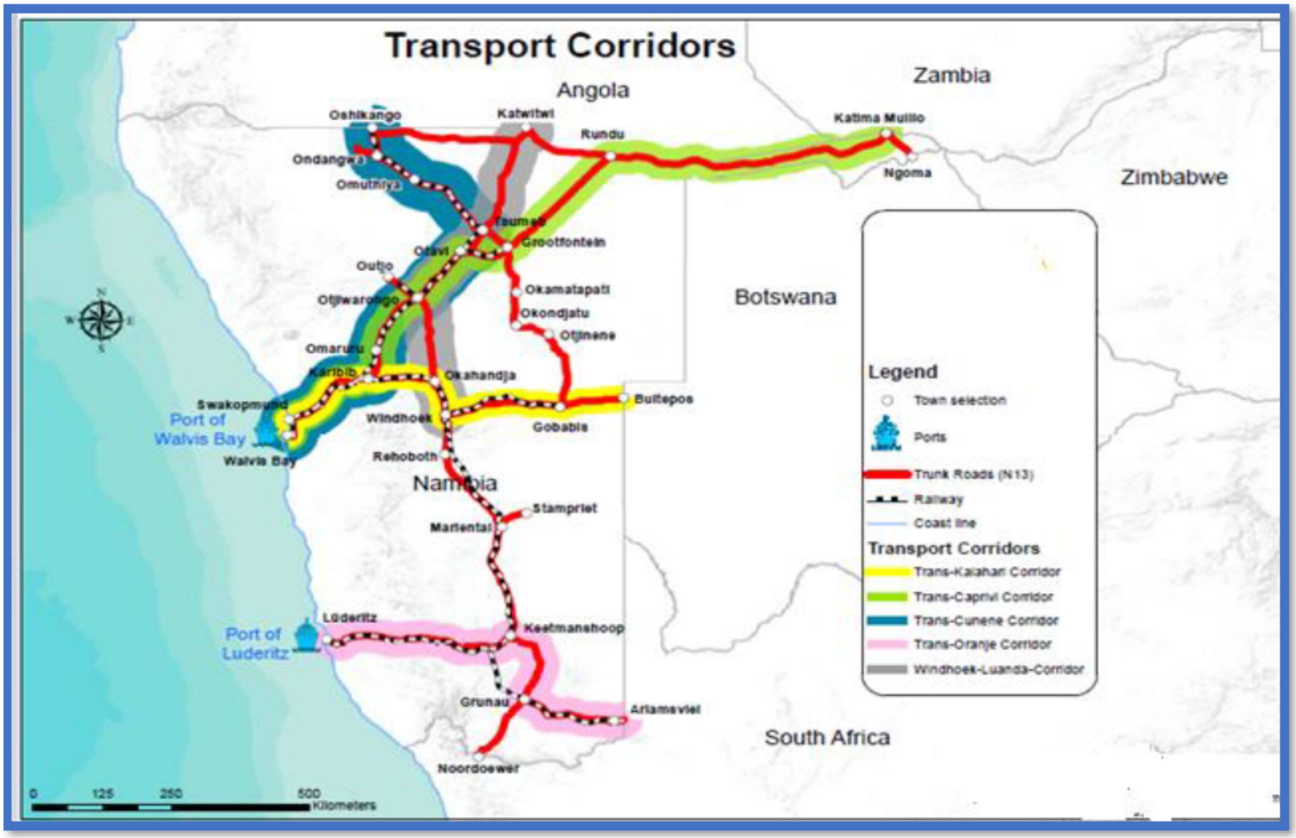


Figure 4-28: Transport Corridors in Namibia

Source: Author's compilation (2022)

Figure 4.28 illustrates Namibia's transport corridor network, including railway, town selection, ports, coastline and corridors (trunk roads). Five major transport corridors connect the Walvis Bay port: Trans-Kalahari, Trans-Caprivi, Trans-Kunene, Trans-Oranje and Windhoek-Luanda, offering trade-route alternatives to existing and new markets, and boosting regional and continental competitiveness. The port of Walvis Bay is the gateway via the Atlantic Ocean and is linked to the inland countries by four corridors. The Trans-Caprivi corridor is the longest and busiest, exporting copper and zinc from Zambia and Zimbabwe to Namibia. On this corridor, the railroad parallels the road only till Grootfontein. The Trans-Kunene corridor has the least traffic from the Oshikango border between Angola and Namibia to the Walvis Bay port. The Trans-Cunene corridor connects with the trans-Caprivi corridor in Otavi to the port. A railway was constructed alongside the Trans-Cunene corridor; however, it has never been used. The Trans-Kalahari borders Namibia, with Botswana to South Africa being the shortest corridor to the port from the border; the rail service terminates at Gobabis. The Trans-Oranje is situated south of Namibia on the route to South Africa and is also a significant corridor due to Namibia's heavy reliance on South African imports. The rail to the south and into Walvis Bay is operationally constrained due to infrastructure limitations.

b) Road and rail transport connectivity – Road/Rail network

Figure 4.29 shows the extent of rail network connectivity in Namibia to and from the port of Walvis Bay to various economic nodes. The ports are shown in blue (Walvis Bay, Cape Fria and Luderitz), the nodes (towns) are in green, and the respective road and rail links in blue and dotted yellow lines, respectively.

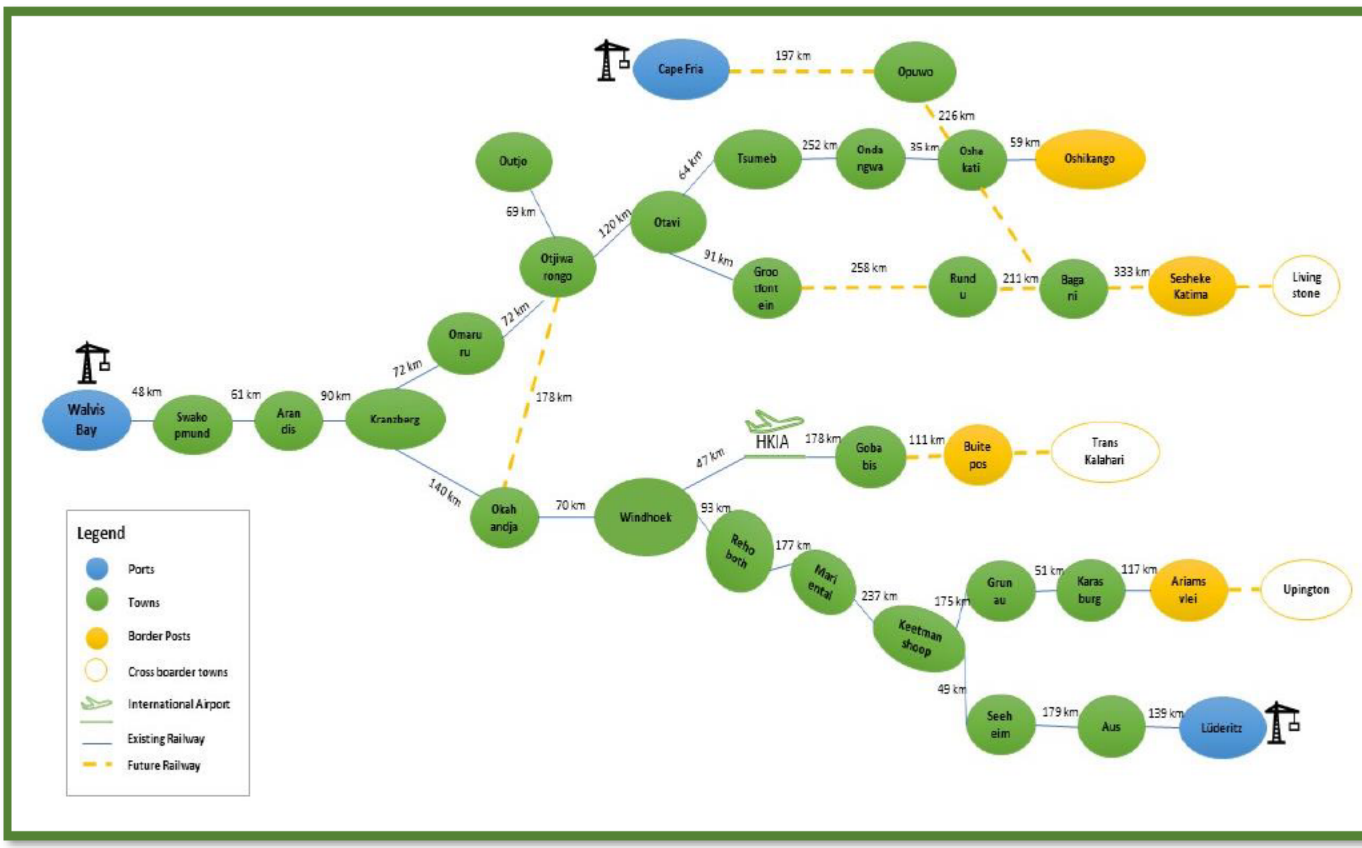


Figure 4-29: The road and rail transport network in Namibia

Source: Author's compilation (2022)

This study adopted a disaggregated approach to examine the extent to which road and rail connect each transport corridor. In order to promote effective analysis, map analysis was conducted on the road network using topological abstractions representing a series of vertices (nodes) and a set of edges (links). Furthermore, various indices were developed to describe the extent to which a network approaches maximum connectivity, which requires the existence of a direct link to each node (Kansky, 1963). All these indices were based on the link between edges and vertices in a network regarded as a topological graph. Thus, the **Beta Index, Gamma Index** and **Alpha Index** were used to determine the extent of network connectivity for road and rail. The nodes are the towns, ports and the final destination outside Namibia.

c) Beta Index (Road and Rail network)

The Beta index quantifies the degree of connection in a network as the ratio of the number of links (e) to the number of nodes (n) (v). The Beta value for tree and simple networks is less than one. A network with one cycle and one connection has a value of 1. Complex networks have a value greater than 1. In a network with a constant number of nodes, the greater the number of links, the greater the number of alternative paths, which, in general, results in greater network connectivity. Table 4.15 shows the results of the Beta index for road and rail connectivity in Namibia.

Table 4-15: Results of the Beta index for road and rail connectivity in Namibia

Source: Author's compilation (2022)

Index	**Formula**	**Road**	**Rail**
Beta	$\beta = \frac{e}{v}$	β = 38/ 34 **1.11**	β = 27/ 34 **0.79**

The results in Table 4.15 show a Beta value of 1.11 on roads leading to each node according to the Beta index. This shows that Namibia is well connected by road. However, the Beta index on Rail indicates that about 0.79 rail links led to each node. This shows that Namibia has low rail connectivity compared to the road network due to some breaks in the rail links in the towns listed in Table 4.16; hence, the rail links fall short of 11 of the road inks (38). The pending rail links are shown in Table 4.16, and they explain the low Beta index of rail connectivity in Namibia.

Table 4-16: Pending rail line links in Namibia

Source: Author's compilation (2022)

Rail link	Status
Okahandja-Otjiwarongo	Pending
Grootfontein-Rundu	Pending
Rundu-Bangani	Pending
Bangani-Sesheke	Pending
Sesheke-Livingstone	Pending
Bangani-Oshakati	Pending
Oshakati-Opuwo	Pending
Opuwo-Cape Fria	Pending
Gobabis-Buitepos	Pending
Buitepos-Botswana	Pending
Ariamsvlei to Upington	Pending

All the railway links listed in Table 4.16 were pending at the time of the study.

i. The Gamma index (road and rail network)

The Gamma (γ) index is the ratio of the actual number of edges to the maximum number of edges that could exist in the network. A planar graph depicts that it can be computed as the number of actual links divided by the maximum number of links. The Gamma index is important to compare the structure of two or more networks; for instance, Namibia's road and rail network structures. This index ranges from 0 to 1 and is calculated as shown in Table 4.17.

Table 4-17: Results of the Gamma index for road and rail connectivity in Namibia

Source: Author's compilation (2022)

Index	Formula	Road	Rail
Gamma	$\gamma = \frac{e}{3(v-2)}$	γ = 38/3(34-2) **γ = 0.39**	γ = 27/3(34-2) **γ = 0.28**

Similar to the results of the Beta index, the Gamma index for road is γ=0.39, and γ= 0.28 for rail. Again, this supports the results of the Beta index that showed higher network connectivity for road and lower rail connectivity. It highlights the need for further evaluation and potential improvements in rail connectivity to enhance the overall effectiveness and efficiency of the transport infrastructure in supporting logistics operations in Namibia.

ii. The Alpha index (road and rail network)

The Alpha(α) index, one of the critical connectivity indices, is defined as the ratio of the actual number of circuits to the maximum number of circuits in the network (Chou, 1999), where a circuit is a network loop made up of nodes and links (equation 1). This metric can be used to compare and differentiate the connection levels of different networks by evaluating network topology in terms of the number of paths that lead from one node to another. The following equation in a planar graph is used to calculate the Alpha index in a network, which ranges between 0 and 1.

Table 4-18: Results of the Alpha index for road and rail connectivity in Namibia

Source: Author's compilation (2022)

Index	Formula	Road	Rail
Alpha	$\alpha = \frac{e - v + 1}{2v - 5}$	$\alpha = \frac{38-34+1}{2(34)-5}$ **α = 0.09**	$\alpha = \frac{27-34+1}{2(34)-5}$ α = negative

The road network connectivity Alpha index is 0.09. Although the road network in Namibia shows a higher level of network connectivity based on the Beta and Gamma indices, it is deficient in terms of the number of maximum circuits that could be connected. This can be explained by the fact that the road network assumes a tree structure where it radiates from the port of Walvis Bay to various destinations (through the corridors) without branch connections. For example, the Gobabis-Otjinene-Okondjatu-Okamatapati-Grootfontein route shown in Figure 4.30 seeks to connect the eastern parts of the country to the north road. However, a gravel road that is generally not favoured by motorists is a weak link in the potential circuit. The Alpha index result for rail is negative, meaning that the rail connectivity based on this index is too low to be computed by it. Figure 4.30 shows the low level of rail connectivity.

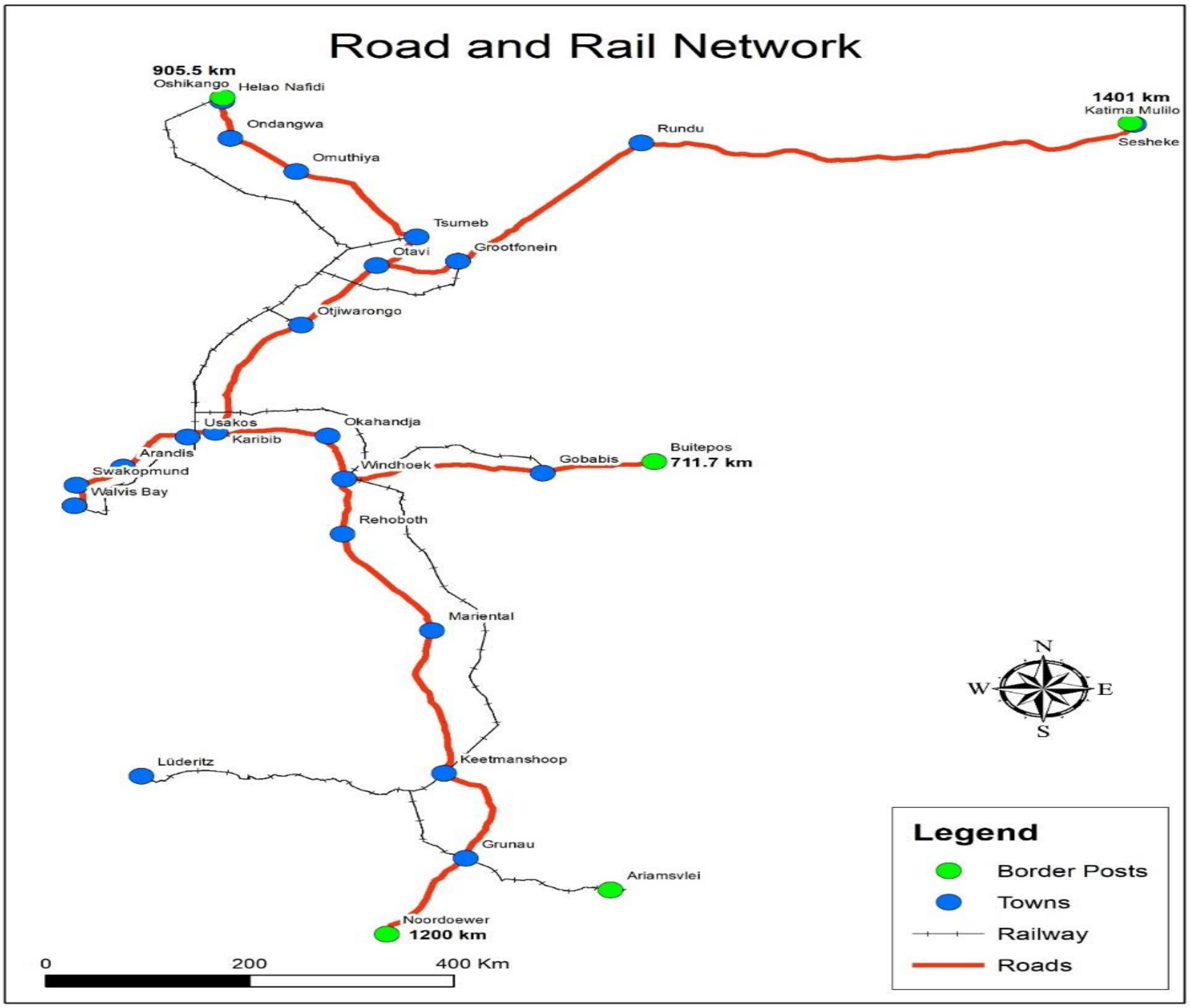


Figure 4-300: Road and Rail network structure

Source: Author's compilation (2022)

Figure 4.30 shows a map of Namibia's road and rail coverage. The country's transportation system includes a well-developed road network of 49 000 km, a 2 678 km rail network, two ports, two international and eight domestic airports, and four transport corridors connecting it to neighbouring countries. The map shows that road and rail are constructed in parallel and run from north to south and west to east. Although clearly depicted in the figure, the rail network has limited functionality as it was created for military purposes in the 1970s and is now obsolete. The current railroad infrastructure does not meet the SADC standard of 18.5 tonnes per axle (National Planning Commission, 2017, p. 9). The present axle load on the main lines is 16.5 tonnes. The Namibian rail system only links with South African rail at the Ariamsvlei border post. As a result, road transportation remains a viable alternative for the movement of passengers and freight. Except for Noordoewer, all border posts close at approximately 22:00, creating inconvenience and congestion. The shift to road led to Namibia ranking as one of the countries with the highest per capita road deaths.

Table 4.19 highlights the degree of centrality for road transport.

Table 4-19: Degree of centrality (Road)

Source: Author's compilation (2022)

	Wal	Kari	Otj	Okah	Whk	Hkut	Gob	Bui	Bot	Kee	Ari	Upi	Lud	Ota	Osha	Opu	Cap	Osh	Gro	Run	Ban	Ses	Liv	Σ	(n-1)	Degree
Wal		1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	22	0.14
Kari	1		1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	22	0.18
Otj	0	1		1	1	0	0	0	0	1	1	1	1	1	1	1	0	1	0	0	0	0	0	10	22	0.45
Okah	1	1	1		1	0	0	0	0	1	1	1	1	1	1	0	0	1	0	0	0	0	0	10	22	0.45
Whk	1	1	1	1		1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	14	22	0.64
Hku	0	0	0	0	1		1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	22	0.18
Gob	0	0	0	0	1	1		1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	22	0.18
Bui	0	0	0	0	1	1	1		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	22	0.18
Bot	0	0	0	0	0	1	1	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	22	0.14
Kee	0	0	1	1	1	0	0	0	0		1	1	1	1	1	1	0	1	0	0	0	0	0	10	22	0.45
Ari	0	0	0	0	0	0	0	0	0	1		1	1	0	0	0	0	0	0	0	0	0	0	2	22	0.09
Upi	0	0	0	0	0	0	0	0	0	1	1		1	0	0	0	0	0	0	0	0	0	0	2	22	0.09
Lud	0	0	0	0	1	0	0	0	0	1	1	1		0	0	0	0	0	0	0	0	0	0	3	22	0.14
Ota	0	0	1	1	1	0	0	0	0	1	1	1	0		1	1	1	1	1	1	1	1	1	14	22	0.64
Osha	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1	1	1	1	1	1	1	1	8	22	0.36
Opu	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1		0	0	0	0	0	0	0	2	22	0.09
Cap	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0		1	0	0	0	0	0	2	22	0.09
Osh	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0		1	0	0	0	0	3	22	0.14
Gro	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1		1	1	1	1	6	22	0.27
Run	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1		1	1	1	5	22	0.23
Ban	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1		1	1	5	22	0.23
Ses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1		1	5	22	0.23
Liv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1		5	22	0.23
Σ	3	4	6	6	10	4	4	4	4	7	7	7	6	6	8	4	2	12	7	6	6	6	6			

Cities outside Namibia | Ports | Border-post | Cities inside Namibia

Table 4.19 shows that Windhoek and Otavi have the highest centrality level for road transport, with each having a centrality value of 0.64. This means that these nodes can be accessed via many links, like a hub with many spokes. A higher level of centrality generally means higher levels of connectivity and accessibility. In contrast, Ariamsvlei, Upington, Opuwo and Cap have the lowest centrality. Table 4.20 highlights the closeness centrality for road transport.

Table 4-20: Closeness centrality (Road)

Source: Author's compilation (2022)

	Wal	Kari	Otj	Oka	Whk	HKA	Gob	Bui	Bot	Kee	Ari	Upi	Lud	Ota	Osha	Opu	Cap	Osh	Gro	Run	Ban	Ses	Liv	Σ	n-1	Closeness
Wal		3	5	4	5	6	7	8	9	8	11	12	11	6	9	10	11	10	7	8	9	10	11	180	22	0.12
Kari	3		2	1	2	3	4	5	6	5	8	9	8	3	6	7	8	7	4	5	6	7	8	114	22	0.19
Otj	5	2		1	2	3	4	5	6	5	8	9	10	1	4	5	6	5	2	3	4	5	6	96	22	0.23
Oka	4	1	1		1	2	3	4	4	4	7	8	7	2	5	6	7	6	3	4	5	6	7	93	22	0.24
Whk	5	2	2	1		1	2	3	4	3	6	7	6	3	6	7	8	7	4	5	6	6	7	96	22	0.23
HKA	6	3	3	2	1		1	2	3	4	7	8	8	4	7	8	9	8	5	6	7	8	9	113	22	0.19
Gob	7	4	5	4	2	1		1	2	5	8	9	8	5	8	9	10	8	6	7	8	9	10	129	22	0.17
Bui	8	5	5	4	3	2	1		1	6	9	10	9	6	9	10	11	9	7	8	9	10	11	145	22	0.15
Bot	9	6	6	5	4	3	2	1		7	10	11	10	7	10	11	12	11	8	9	10	11	12	166	22	0.13
Kee	8	5	5	4	3	4	5	6	7		3	4	3	6	9	10	11	10	7	8	9	10	11	140	22	0.16
Ari	11	8	8	7	6	7	8	9	10	3		1	6	9	12	13	14	13	10	11	12	13	14	194	22	0.11
Upi	12	9	9	8	7	8	9	10	11	4	1		7	10	13	14	15	14	11	12	13	14	15	214	22	0.10
Lud	11	8	10	7	6	8	9	10	11	3	6	7		9	13	14	15	13	10	11	12	13	14	209	22	0.11
Ota	6	3	1	2	3	4	5	6	7	6	9	10	9		3	4	5	4	1	2	3	4	5	96	22	0.23
Osha	9	6	4	5	6	7	8	9	10	9	12	13	12	3		1	2	1	4	5	6	7	8	138	22	0.16
Opu	10	7	5	6	7	8	9	10	11	10	13	14	13	4	1		1	2	5	6	7	8	9	156	22	0.14
Cap	11	8	6	7	8	9	10	11	12	11	14	15	14	5	2	1		2	6	7	8	9	10	175	22	0.13
Osh	10	7	5	6	7	8	9	10	11	10	13	14	13	4	1	2	3		5	6	7	8	9	158	22	0.14
Gro	7	4	2	3	4	5	6	7	8	7	10	11	10	1	4	6	7	5		1	2	3	4	110	22	0.20
Run	8	5	3	4	5	6	7	8	9	8	11	12	11	2	5	7	8	6	1		1	2	3	124	22	0.18

Ban	9	6	4	5	6	7	8	9	10	9	12	13	12	3	6	7	8	7	2	1		1	2	**138**	**22**	**0.16**
Ses	10	7	5	6	7	8	9	10	11	10	13	14	13	4	7	8	9	8	3	2	1		1	**156**	**22**	**0.14**
Liv	11	8	6	7	8	9	10	11	12	11	14	15	14	5	8	9	10	9	4	3	2	1		**176**	**22**	**0.13**
Σ	**180**	**117**	**102**	**99**	**103**	**119**	**136**	**155**	**175**	**148**	**205**	**226**	**214**	**102**	**148**	**169**	**190**	**165**	**115**	**130**	**147**	**165**	**186**			

Table 4.20 highlights that Upington has the lowest closeness centrality with a value of 0.10 for road transport. In contrast, Okahandja has the highest closeness centrality with a value of 0.24. This means that Okahandja can be accessed via many links, like a hub with many spokes. A higher level of centrality generally means higher connectivity and accessibility.

Table 4.20 highlights that Windhoek has the highest centrality level for road transport

Table 4-21: Degree of centrality (Railway)

Source: Author's compilation (2022)

	Wal	Kari	Otj	Oka	Whk	HKA	Gob	Bui	Bot	Kee	Ari	Upi	Lud	Ota	Osha	Opu	Cap	Osh	Gro	Run	Ban	Ses	Liv	Σ	(n-1)	Degree
Wal		1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	22	0.14
Kari	1		1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	22	0.18
Otj	0	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	22	0.05
Okah	1	1	0		1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	4	22	0.18
Whk	1	1	0	1		1	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	9	22	0.41
HKA	0	0	0	0	1		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	22	0.09
Gob	0	0	0	0	1	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	22	0.09
Bui	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0.00
Bot	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0.00
Kee	0	0	0	1	1	0	0	0	0		1	1	1	0	0	0	0	0	0	0	0	0	0	5	22	0.23
Ari	0	0	0	0	0	0	0	0	0	1		1	1	0	0	0	0	0	0	0	0	0	0	4	22	0.18
Upi	0	0	0	0	0	0	0	0	0	1	1		1	0	0	0	0	0	0	0	0	0	0	3	22	0.14
Lud	0	0	0	0	0	0	0	0	0	1	1	1		0	0	0	0	0	0	0	0	0	0	3	22	0.14
Ota	0	0	1	0	0	0	0	0	0	0	0	0	0		1	0	0	1	1	0	0	0	0	4	22	0.18
Osha	0	0	0	0	0	0	0	0	0	0	0	0	0	1		0	0	0	0	0	0	0	0	1	22	0.05
Opu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	22	0.00
Cap	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	22	0.00
Osh	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0		0	0	0	0	0	2	22	0.09
Gro	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		0	0	0	0	1	22	0.05
Run	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	22	0.00
Ban	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	22	0.00
Ses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	22	0.00
Liv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	22	0
Σ	3	4	2	4	6	2	2	0	0	5	5	5	5	3	2	0	0	1	1	0	0	0	0			

Table 4.21 highlights that Windhoek has the highest centrality level for road transport, with a value of 0.41. This means that Windhoek can be accessed via many rail links; it is like a hub with many spokes. Otjiwarongo, Grootfontein and Oshakati have the lowest centrality and, thus, difficult or a lower degree of accessibility.

Table 4.22 highlights that Walvis Bay has the lowest closeness centrality for road transport.

Table 4-22: Closeness centrality (Railway)

Source: Author's compilation (2022)

	Wal	Kari	Otj	Oka	Whk	HKA	Gob	Bui	Bot	Kee	Ari	Upi	Lud	Ota	Osha	Opu	Cap	Osh	Gro	Run	Ban	Ses	Liv	Σ	n-1	Closeness
Wal		3	5	4	5	6	7	0	0	8	11	12	11	6	9	0	0	10	7	0	0	0	0	104	22	0.21
Kari	3		2	1	2	3	4	0	0	5	8	9	8	3	6	0	0	7	4	0	0	0	0	62	22	0.35
Otj	5	2		0	2	3	4	0	0	5	8	9	10	1	4	0	0	5	2	0	0	0	0	55	22	0.40
Oka	4	1	0		1	2	3	0	0	4	7	8	7	2	5	0	0	6	3	0	0	0	0	49	22	0.45
Whk	5	2	0	1		1	2	0	0	3	6	7	6	3	6	0	0	7	4	0	0	0	0	48	22	0.46
HKA	6	3	0	2	1		1	0	0	4	7	8	8	4	7	0	0	8	5	0	0	0	0	58	22	0.38
Gob	7	4	0	4	2	1		0	0	5	8	9	8	5	8	0	0	8	6	0	0	0	0	68	22	0.32
Bui	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0.00
Bot	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0.00
Kee	8	5	0	4	3	4	5	0	0		3	4	3	6	9	0	0	10	7	0	0	0	0	63	22	0.35
Ari	11	8	0	7	6	7	8	0	0	3		1	6	9	12	0	0	13	10	0	0	0	0	90	22	0.24
Upi	12	9	0	8	7	8	9	0	0	4	1		7	10	13	0	0	14	11	0	0	0	0	101	22	0.22
Lud	11	8	0	7	6	8	9	0	0	3	6	7		9	13	0	0	13	10	0	0	0	0	99	22	0.22
Ota	6	3	0	2	3	4	5	0	0	6	9	10	9		3	0	0	4	1	0	0	0	0	59	22	0.37
Osha	9	6	0	5	6	7	8	0	0	9	12	13	12	3		0	0	1	4	0	0	0	0	86	22	0.26
Opu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	22	0.00
Cap	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	22	1.00
Osh	10	7	0	6	7	8	9	0	0	10	13	14	13	4	1	0	0		5	0	0	0	0	97	22	0.23
Gro	7	4	0	3	4	5	6	0	0	7	10	11	10	1	4	0	0	5		0	0	0	0	70	22	0.31
Run	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	22	0.00
Ban	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	22	0.00
Ses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	22	0.00
Liv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	22	0.00
Σ	104	65	7	54	55	67	80	0	0	76	109	122	118	66	100	0	0	111	79	0	0	0	0			

The above table highlights that Walvis Bay has the lowest closeness centrality for road transport. In contrast, Cape has the highest closeness centrality. Closeness centrality is a measure of the average shortest distance between two points. This means that the port of

Walvis Bay has the shortest distance from it to the next nodes of influence, that is, Swakopmund, Karibib and other important nodes in Namibia’s transport network.

4.3.2.3.3 Descriptive Analysis of Accessibility of the Port of Walvis Bay to Ports and Border posts

The researcher gathered information on the average speed and distance covered by operators. Tables 4.24, 4.25 and 4.26 show the operators' average speed in covering the estimated distances shown in Table 4.23. The data in Tables 4.24 and 4.25 are taken from reports confirming the distance and average speeds. Measures of accessibility in transport are usually based on the mathematical graph theory. The network is normally a simplified road network comprised of links and nodes, as shown in Tables 4.24 and 4.25. Rodrigue (2020) proposes various network properties that can be employed as relative or integral accessibility measures. These include:

i. The associated number of a node, which is the distance between it and the node furthest away in the network. The number of links measures distance.
ii. The number of other nodes reachable from a given node within a given time by travelling on the network; and
iii. The Shimbel measure, which considers the node together with all the other nodes in the network. It measures the accessibility of a node as the total travel cost to all other nodes.

The lack of robust data on travel impedance factors in terms of the actual freight costs incurred by operators meant that this study relied on accessibility measures from the fundamental relationship of distance, travel time and speed disaggregated per node and corridor, as shown below. This data was corroborated by standards on traffic flow stipulated in the Highway Capacity Manual (2000). The accessibility of the port of Walvis Bay to destination points (border posts and ports) is shown in Table 4.23.

Table 4-23: Walvis Bay port accessibility

Source: Author's compilation (2022)

From	To	Corridor	Number of nodes	Total Distance (km)
Walvis Bay Port	Oshikango Border Post	Trans-Cunene	11	873
Walvis Bay Port	Cape Frie Port	Trans-Cunene	12	1235
Walvis Bay Port	Sesheke Border Post	Trans-Caprivi	11	1356
Walvis Bay Port	Buitepos Border	Trans-Kalahari	8	745
Walvis Bay Port	Ariamsvlei Border Post	Trans-Oranje	12	1259
Walvis Bay Port	Lüderitz Port	Trans-Oranje	12	1283

Table 4.24 shows a breakdown of the distance, travel time and speed relationships per corridor (Trans-Kunene and Trans-Caprivi).

Table 4-24: Trans-Kunene and Trans-Caprivi travel time matrix

Source: Author's compilation (2022)

Corridor	**Nodal Distance-Travel Time Matrix**																					
Trans-Kunene	Walvis -		Swakop-Aran		Arandis - Kran		Krans-Oma		Omaruru-Otji		Otjiwar-Otav		Otavi-Tsu		Tsumeb-Odan		Ondang-Osha		Oshakt-Oshk		∑	
	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	**km**	**ATT**
	48	50	61	75	90	80	72	50	72	57	120	90	64	60	252	216	35	52	59	80	**873**	**810**
Av Speed	58km/hr		49km/hr		68km/hr		60km/hr		76km/hr		80km/hr		64km/hr		70km/hr		40km/hr		44km/hr		**65km/hr**	

Trans-Caprivi	Walvis - Swakop		Swakop-Arandis		Arandis - Krans		Krans-Omaruru		Omaruru-Otjiwar		Otjiwar-Otavi		Otavi-Groot		Groot-Rundu		Rundu-Bangani		Bangani -Seshek		Σ	
	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	**km**	**ATT**
	48	50	61	75	90	80	72	50	72	57	120	90	91	72	258	206	211	168	333	266	**1356**	**1114**
Av Speed	58km/hr		49km/hr		68km/hr		60km/hr		76km/hr		80km/hr		76km/hr		75km/hr		75km/hr		81km/hr		**73km/hr**	

Key: ATT=Average Travel Time

Table 4.25 shows a breakdown of the distance, travel time and speed relationships per corridor (Trans-Kalahari).

Table 4-25: Trans-Kalahari travel time matrix

Source: Author's compilation (2022)

Corridor	**Nodal Distance-Travel Time Matrix**																
Trans-Kalahari	Walvis - Swakop		Swakop-Arandis		Arandis - Krans		Krans-Okhand		Okhand-Whk		Whk-Hkia		Hkia-Gobabis		Gobabis-Buitepos		
	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Σ

																	km	**ATT**
	48	50	61	75	90	80	140	95	70	52	47	51	178	144	111	78	**745**	**625**
Av Speed	58km/hr		49km/hr		68km/hr		88km/hr		81km/hr		55km/hr		74km/hr		85km/hr		**72km/hr**	

Key: ATT=Average Travel Time

Table 4.26 shows a breakdown of the distance, travel time and speed relationships per corridor (Trans-Oranje Lüderitz and Ariamsvlei).

Table 4-26: Trans-Oranje Lüderitz and Ariamsvlei travel time matrix

Source: Author's compilation (2022)

Corridor	Nodal Distance-Travel Time Matrix																					
Trans-Oranje (Ariamsvlei)	Walvis - Swakop		Swakop-Arandis		Arandis - Krans		Krans-Okahandja		Okahandja-Whk		Whk-Rehoboth		Rehob-Mariental		Marient-Keetmans		Keetmans -Karas		Karas-Ariums		Σ	
	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	**km**	**ATT**
	48	50	61	75	90	80	140	95	70	52	93	74	177	141	237	203	226	183	117	90	**1259**	**1043**
Av Speed	58km/hr		49km/hr		68km/hr		88km/hr		81km/hr		75km/hr		88km/hr		81km/hr		74km/hr		78km/hr		**72km/hr**	
Trans-Oranje (Lüderitz)	Walvis - Swakop		Swakop-Arandis		Arandis - Krans		Krans-Okahand		Okahand-Whk		Whk-Rehoboth		Rehob-Marient		Marient-Keetman		Keetman -Aus		Aus-Lüderitz		Σ	
	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	Km	ATT (mins)	**km**	**ATT**
	48	50	61	75	90	80	140	95	70	52	93	74	177	141	237	203	228	260	139	100	**1283**	**1130**
Av Speed	58km/hr		49km/hr		68km/hr		88km/hr		81km/hr		75km/hr		88km/hr		81km/hr		53km/hr		93km/hr		**68km/hr**	

Key: ATT=Average Travel Time

Tables 4.24, 4.25, and 4.26 highlight evidence that the port of Walvis Bay is generally accessible via all the corridors based on indicators of distance, average travel time (ATT) and average speed per corridor. The minimum average travel speed for freight traffic is 65km/hr (Trans-Kunene Corridor), and the maximum observed travel speed is 73km/hr (Trans-Caprivi Corridor). Despite a generally high level of accessibility, some low speeds are experienced from Walvis Bay to Karasburg, as shown in Table 4.26 due to unfavourable weather conditions.

In order to confirm the observation that the transport corridors usually have a higher level of accessibility based on the average travel time indicator, the standard deviation was calculated, as shown in Table 4.27.

Table 4-27: Standard deviation calculation

Source: Author's compilation (2022)

Corridor	***x***	***(x−μ)***	***(x−μ)²***
Trans-Kunene	65	-5	25
Trans-Caprivi	73	3	9
Trans-Kalahari	72	2	4
Trans-Oranje (Ariums)	72	2	4
Trans-Oranje (Lüderitz)	68	-2	4
Mean *(μ)*	**70**		

$$\mathrm{SD} = \sqrt{\frac{\sum |x-\mu|^2}{N}}$$

SD = $\sqrt{9.2}$

≈ 3.025

The result of the standard deviation calculation shows that the corridors do not show a significant difference in travel time, and they all show a higher level of accessibility to the port of Walvis Bay. This finding can be used in conjunction with some qualitative measures for highways' LOS. According to the Highway Capacity Manual (2000), the LOS quantifies the quality of traffic flow in a transportation facility based on a number of user questionnaires that capture drivers' perceptions of the quality of traffic under various operating conditions. Table 4.28 depicts the service quality, or LOS (A to F), and the various operating situations.

Table 4-28: Level of Service (LOS) for a highway facility

Source: Highway Capacity Manual (2000)

LOS	Quality	Speed (km/hr)	V/C	Description
A	Free-flow	80	0.6	High level of physical and psychological comfort
B	Reasonable free-flow	70	0.7	A reasonable level of physical and psychological comfort
C	Near free-flow	60	0.8	Local deterioration is possible with blockages
D	Medium flow	50	0.85	Non-recoverable local disruptions
E	At capacity flow	40	0.9	Minor disturbances resulting in a breakdown
F	Congested flow	15	1.0	Breakdown of flow capacity drops

Key: V/C=Volume to a Capacity ratio

Thus, as shown in Table 4.28, at an average speed of 70 km/hr, all the corridors were experiencing a reasonable free-flow condition based on the LOS table. Reasonably free-flow traffic conditions translate to higher accessibility.

4.3.2.3.4 Descriptive Analysis of the Value of Speed

Table 4.29 shows that the respondents perceived speed as the second most important KPI, influencing the efficiency of all other sectors. They also indicated that speed is one of the essential indicators in safety assessment performance analysis. As more consumers turn to e-commerce, organisations compete for customer attention, resulting in a strong need to acknowledge the significance of shipping speed. Although door-to-door delivery is a necessary evil, order shipping speed has become the most critical aspect of the supply chain, accounting for the majority of corporate expenditure. Table 4.29 below shows transporters' speed on different routes.

Table 4-29: Speed on different routes

Source: Author's compilation (2022)

Descriptive Statistics			
Route	**N**	**Mean**	**Std. Deviation**
Trans-Kalahari Speed	172	102.81	22.525
Trans-Kunene Speed	151	101.25	24.224
Trans-Oranje Speed	151	99.98	23.633
Trans-Caprivi Speed	145	100.64	25.733
Other Routes Speed	153	103.92	23.185

Table 4.29 records the means and standard deviations with regard to the speeds on different corridors. The speed reflected on the interval plots of speed in different corridors in Figure 4.31 is satisfactory, considering that the legal speed limit in Namibia is 120km/hr for a sedan, 100 km/hr for trucks and 80 km/hr for heavy-duty vehicles.

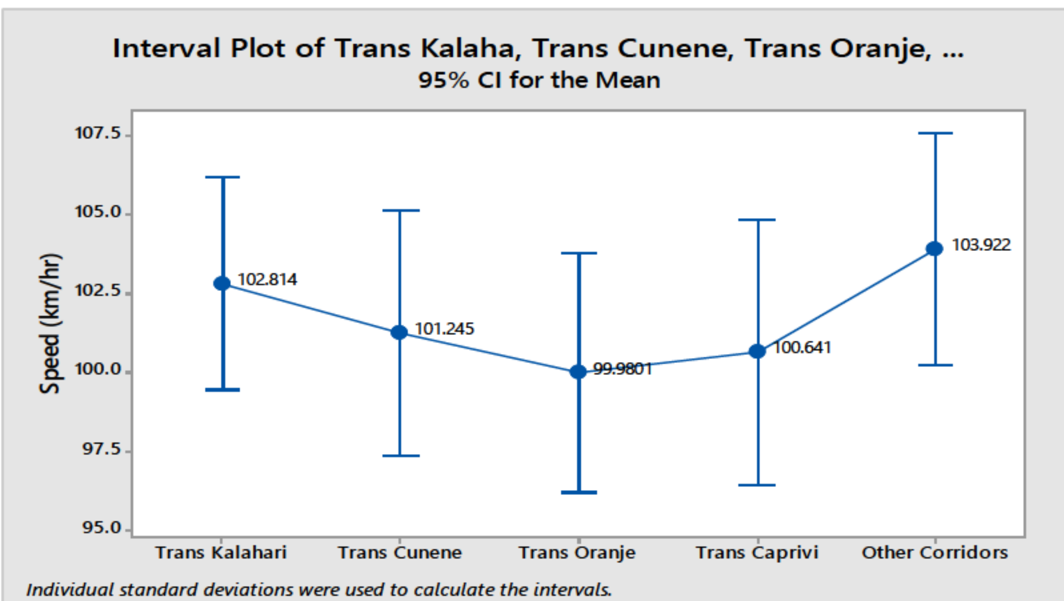


Figure 4-31: Trucks Interval plots of speeds in different corridors

Source: Author's compilation (2022)

Figure 4.31 shows that four intervals span over 100km/hr, and the highest speed reported in the survey was 107.5km/hr, while the lowest was 99.9 km/hr. The speed limit for trucks and heavy-duty vehicles is 80-100 km/hr; therefore, it is evident from Figure 4.31 that truckers are travelling above the speed limit. This is not surprising given that Namibia has an annual accident death rate of 30.4 per 100 000 people (Ambunda & Lourens, 2022, pp. 225-230.) Indeed, it is one of the most dangerous countries in sub-Saharan Africa, with an average fatality rate of 26.6 road deaths per 100 000 people; in comparison, the USA has roughly 12, and Norway has less than three annual road deaths per 100 000 people.

It emerged from the responses that railway coverage is one of the primary KPIs in the transport system; thus, its speed cannot be ignored. The current speed limit for rail transportation is 60 km/hr with no stops in between, significantly slower than the current speed limit for road transportation, between 80 and 100 km/hr. Like trucks, trains only require a single operator but may transport the equivalent of numerous trucks' worth of cargo.

4.3.2.3.5 Descriptive Analysis in relation to Connectivity, Accessibility and Centrality

In terms of connectivity, accessibility and centrality, multivariate analysis was conducted in the factor analysis section (4.3.5 Factor analysis). Table 4.30 presents the descriptive statistics generated on the main factors that determined connectivity.

a) Connectivity

Table 4-30: Connectivity – Between-Subjects Factors

Source: Author's compilation (2022)

Between-Subjects Factors			
		Value Label	n
Distance travelled	1	Not challenging	29
	2	Slightly challenging	63
	3	Moderately challenging	108
	4	Very challenging	66
	5	Extremely challenging	140
Terminals' connectivity	1	Not challenging	53
	2	Slightly challenging	98
	3	Moderately challenging	120
	4	Very challenging	65
	5	Extremely challenging	70

The frequency of responses to the questions on distance travelled and terminal connectivity is shown in Table 4.30. Regarding the distance travelled, the most common responses were extremely challenging at 140 respondents (35.5%), moderately challenging at 108 (26.6%), slightly challenging with 63 (15.5%), and very challenging at 66 (16.2%). The results show that the majority of the respondents indicated that connecting to the terminal was somewhat difficult (120; 29.6%), very difficult for (98; 24.1%), and severely difficult (70; 17.2%). As demonstrated by the other independent factors, including hub centrality and terminal accessibility, most of the respondents had difficulty connecting to the terminals. Similar responses were received in relation to the distance travelled.

Table 4-31: Connectivity – descriptive statistics

Source: Author's compilation (2022)

Descriptive statistics: Distance travelled	Mean	Std. Dev	n
Reliable mode of transport	3.33	1.367	384
Transportation costs	3.72	1.239	384
Intermodal transportation	3.58	1.327	384
Traffic regulations	2.98	1.292	384

A Likert scale was used to rate the extent to which the variables in Table 4.31 were challenging. The parameters were: (1) Extremely Challenging, (2) Very Challenging, (3) Moderately Challenging, (4) Slightly Challenging, and (5) Not Challenging. In terms of the significance of the relationship in the mean between the independent variable (connectivity to the terminal) and dependent variables (1. reliable mode of transport, 2. transportation costs, 3. intermodal transportation, 4. traffic regulations), the data shows a visible trend in the mean of the dependent variables. It can be observed that the lowest mean is in the response of “Not challenging” while the two categories that yielded the highest means are: 1. Very challenging and 2. Extremely challenging. Using the average to compare the independent and dependent variables, it can be concluded that the respondents encountered most challenges when navigating the hub's centrality across all the terminal locations, time, connectivity, and accessibility. In relation to the standard deviation of the centrality of the hub, it can be observed that the highest standard deviation was 0.609, indicating severe challenges in terms of the terminals’ connectivity and accessibility.

b) Accessibility

Table 4-32: Accessibility – between-subjects factors

Source: Author's compilation (2022)

Between-Subjects Factors			
		Value Label	n
Terminals' accessibility	1	Not challenging	49
	2	Slightly challenging	94
	3	Moderately challenging	116
	4	Very challenging	61
	5	Extremely challenging	64

Table 4.32 shows that most respondents said it was difficult to access the terminals. The table reveals that only 53 (13.1%) respondents felt that it was not difficult to access them, while 98 (24.2%) described it as slightly difficult, 120 (29.6%) as moderately challenging and 70 (17.2%) as extremely challenging to access the terminals.

Table 4-33: Accessibility – descriptive statistics

Source: Author's compilation (2022)

	Mean	Std. Dev	n
Transport infrastructure	1.68	.471	48
	3.15	.525	93
	4.18	.389	115
	5.00	.000	60
	5.00	.000	68
	3.88	1.160	384
Transportation costs	1.60	.494	48
	2.71	.454	93
	4.03	.409	115
	5.00	.000	60
	5.00	.000	68
	3.72	1.239	384
Transit time	1.55	.503	48

	2.50	.503	93
	3.48	.501	115
	4.43	.499	60
	5.00	.000	68
	3.40	1.211	384
Available modes of transport	1.09	.295	48
	2.49	.502	93
	3.97	.526	115
	5.00	.000	60
	5.00	.000	68
	3.58	1.403	384
Capacity constraints	1.38	.489	48
	2.32	.467	93
	3.18	.382	115
	4.28	.451	60
	5.00	.000	68
	3.22	1.236	384
Congestion	1.00	.000	48
	1.40	.492	93
	2.69	.464	115
	3.89	.312	60
	4.97	.168	68
	2.74	1.431	384
Safety and security	1.15	.361	48
	2.70	.560	93
	4.21	.408	115
	5.00	.000	60
	5.00	.000	68
	3.71	1.368	384

A Likert scale was used to rate the extent to which the variables in Table 4.33 were challenging and the parameters were (1) Extremely Challenging, (2) Very Challenging, (3) Moderately Challenging, (4) Slightly Challenging, and (5) Not Challenging. In considering the significance of the relationship in the mean between the independent variable (terminals' accessibility) and dependent variables (1. transport infrastructure, 2. transportation costs, 3. transit time, 4. available mode of transport, 5. capacity constraints, 6. congestion, 7. safety and security), the data showcases a visible trend in the mean of the dependent variables. A high mean of 5 was observed, with the respondents reporting that they found it very and extremely challenging to access the terminals, especially with regard to 1. transport infrastructure, 2. transportation costs, 3. transit time, 4. capacity constraints, 5. congestion, and 6. safety and security. Using the average to compare the independent variable and dependent variables, it can be concluded that the respondents encountered the most challenges when they sought to access the terminals across all the dependent variables. In evaluating the standard deviation of the centrality of the hub, it can be observed that the highest standard deviation was 5.25, indicating that it was extremely challenging to access both terminals.

Table 4-34: Accessibility – Box's Test of Equality of Covariance Matrices

Source: Author's compilation (2022)

Box's Test of Equality of Covariance Matrices [a]	
Box's M	568.494
F	19.597
df1	28
df2	149564.077
Sig.	<.001
The null hypothesis is tested, which states that the observed covariance matrices of the dependent variables are equal across groups.	
a. Design: Intercept + accessibility to all preferred terminals	

The Box's Test of Equality of covariance matrices is always tested with the alpha value of 0.001, and if the sig. value is less than 0.001, we reject the null hypothesis (which states that the dependent variables' observed covariance matrices are equal across groups) as described in Table 4.34. From the table, one can observe that the sig is less than 0.001, which means that the null hypothesis is not accepted, and that the observed covariance matrices of the dependent variables are not equal across the group. This means that the independent variables 1. infrastructure for transportation, 2. costs of transportation, 3. transit time, 4. capacity constraints, 5. congestion, and 6. safety and security have different dependence levels on the dependent variable (terminal accessibility).

c) Centrality

Table 4-35: Centrality – between-subjects factors

Source: Author's compilation (2022)

Between-Subjects Factors			
		Value Label	**n**
Centrality of the hub	1	Not challenging	44
	2	Slightly challenging	51
	3	Moderately challenging	62
	4	Very challenging	83
	5	Extremely challenging	144

As seen in Table 4.35, the majority of the respondents judged the hub's centrality to be quite difficult to navigate. Only 48 (11.8%) of the respondents indicated that the centrality of the hub was not challenging, followed by 55 (13.5%), who indicated that it was slightly challenging, and 66 (16.3%), who indicated that it was moderately challenging. Furthermore, the majority of the respondents (150; 37.0%), reported that they found it extremely difficult to navigate the hub's centrality. According to the summary of the survey data, 88.2% of the respondents reported experiencing moderate to severe difficulty in navigating the hub's centrality.

Table 4-36: Centrality – descriptive statistics

Source: Author's compilation (2022)

	Mean	**Std. Dev**	**n**
Distance travelled	1.40	.494	44
	2.20	.404	51
	3.00	.000	62
	3.64	.482	83
	4.93	.250	144
	3.55	1.296	384
Terminals' connectivity	1.00	.000	44

	1.91	.290	51
	2.27	.449	62
	3.00	.000	83
	4.37	.660	144
	3.00	1.272	384
Transit time	1.50	.505	44
	2.02	.135	51
	3.00	.000	62
	3.48	.503	83
	4.65	.478	144
	3.40	1.211	384
Multimodal transportation	1.29	.459	44
	2.00	.000	51
	2.98	.123	62
	4.00	.000	83
	4.90	.301	144
	3.58	1.327	384
Location	1.29	.459	44
	2.00	.000	51
	2.98	.123	62
	4.00	.000	83
	4.90	.301	144
	3.58	1.327	384
Terminals' accessibility	1.00	.000	44
	1.91	.290	51
	2.27	.449	62
	3.00	.000	83
	4.37	.660	144
	3.00	1.272	384

A Likert scale was used to rate the extent to which the variables listed in Table 4.36 were challenging. The parameters were (1) Extremely Challenging, (2) Very Challenging (3) Moderately Challenging, (4) Slightly Challenging, and (5) Not Challenging. In considering the significance of the relationship in the mean between the dependent variable (centrality of the hub) and independent variables (1. distance travelled, 2. terminal connectivity, 3. transit time, 4. Terminals' location, and 5. terminal accessibility), the data shows a visible trend in the mean of the dependent variables. The lowest mean is seen in the response of "Not challenging" while the two categories that yielded the highest means were: 1. Very challenging and 2. Extremely challenging. Using the average to compare the independent and dependent variables, it can be concluded that the respondents encountered the most challenges when navigating the hub's centrality across all the terminals' locations, as well as with respect to time, connectivity, and accessibility. In evaluating the standard deviation of the centrality of the hub, it can be observed that the highest standard deviation was 0.660, which was extremely challenging, for both terminals' connectivity and accessibility. This suggests wide variation among the respondents' experiences and perceptions regarding the effectiveness and ease of connecting to and accessing the terminals.

4.3.3 Bivariate Method

4.3.3.1 Annual cargo Analysis of Variance (ANOVA)

An analysis of variance (ANOVA) was conducted to determine if there was statistically significant variation in cargo means received each year for each mode of transportation. The transportation modes tested were road, rail, and sea-landed cargo. The null hypothesis would be that there was no considerable change in cargo received year-to-year for each mode of transport.

a) ANOVA on Rail cargo

This section presents the ANOVA for 2015-2019 on railway cargo. The hypotheses were:

(H_0): There is no significant difference in cargo received between 2015 and 2019

(H_2): There is at least one year with a different mean cargo from the rest

Using IBM SPSS and testing at a 5% level of significance, the results are shown in Table 4.37.

Table 4-37: Rail descriptive cargo statistics for different years

Source: Author's compilation (2022)

Descriptive statistics on Rail Cargo								
Year	**N**	**Mean**	**St. Devi**	**Std. Err**	**95% Confidence Int**		**Min**	**Max**
					Lower Bound	**Upper Bound**		
2015	12	128.16658	19.4779	5.6228		115.7909	83.375	160.931
2016	12	122.38667	10.7712	3.10937		115.543	93.909	136.842
2017	12	118.35433	15.1706	4.37938		108.7154	95.228	145.046

2018	12	123.46458	22.7493	6.56716		109.0104	98.848	162.308
2019	12	138.96325	11.291	3.25943		131.7893	121.87	155.823
Total	60	126.26708	17.5056	2.25996		121.7449	83.375	162.308

Table 4.37 shows that the mean cargo in tonnes received in 2015, 2016, 2017, 2018 and 2019 was 128.166658, 122.38667, 118.35433, 123.46458, 138.96325 and 126.26706, respectively.

i) Rail cargo Levene's test

Table 4.38 below shows the results of Levene's test, which tests for homogeneity of variance; one of the assumptions that should be met to run ANOVA. A significance value of less than 0.05 would mean heterogeneity of variance; thus, one of the assumptions of running an ANOVA would have been met.

Table 4-38: Homogeneity of variance rail cargo Levene's test

Source: Author's compilation (2022)

Test of Homogeneity of Variances			
Rail Cargo			
Levene Statistic	df1	df2	Sig
2.031	4	55	0.103

Table 4.38 shows a significance value of 0.103, which is greater than 0.05. This means that substantial homogeneity of variance exists in the data.

ii) Rail cargo ANOVA results

Table 4.39 portrays the ANOVA results for railway cargo.

Table 4-39: Rail cargo ANOVA results

Source: Author's compilation (2022)

ANOVA on Rail Cargo					
	Sum of Squares	Df	Mean Square	F	Sig.

Between Groups	3003.888	4	750.972	2.74	0.038
Within Groups	15076.326	55	274.115		
Total	18080.214	59			

Table 4.39 shows a significance result of 0.038; therefore, the null hypothesis (H_0) is rejected. A significance value of 0.038 implies that at least one year had significantly different cargo from the rest. This finding suggests that notable variation in rail cargo volumes might have been experienced in certain years. However, ANOVA is an omnibus test that does not reveal the actual years with a difference, only that a difference exists. The researcher used a Post Hoc analysis technique to determine the years with differences.

iii) Post Hoc analysis

The post hoc analysis compares each cargo's year-on-year variations. A significance value of less than 0.05 means that year's cargo differed significantly from the chosen year. The significance values for 2016, 2017, 2018 and 2019 were 0.396, 0.152, 0.49 and 0.116, respectively. When compared to 2015, none of the values is less than 0.05. Thus, 2015 was not significantly different from the rest. However, when compared to 2015, 2017, 2018 and 2019, the significance values in 2016 were observed to be 0.396, 0.553, 0.874 and 0.017, respectively. Consequently, the cargo for 2016 was significantly different from 2019. Considering the data from the document analysis, the observed tendency aligns with the findings of the post hoc analysis. The results indicate that specific years, such as 2016, exhibit significant variations in cargo volumes. This information enhances understanding of the temporal dynamics and patterns of cargo transportation in the context of the transport systems' preparedness for the regional logistics hub in Namibia.

iv) Least Significant Difference test (LSD)

Using IBM SPSS 23, the Least Significant Difference test (LSD) was calculated, and the following results were obtained:

Table 4-40: LSD post hoc analysis on rail cargo

Source: Author's compilation (2022)

Dependent Variable: Rail Cargo						
LSD					95% Confidence Interval	
(I) Year	(J) Year	Mean diff		Sig.	Lower Bound	Upper Bound
2015	2016	5.779917	6.75913	0.396	-7.76568	19.32552
	2017	9.81225	6.75913	0.152	-3.73335	23.35785
	2018	4.702	6.75913	0.49	-8.8436	18.2476
	2019	-10.796667	6.75913	0.116	-24.34227	2.74893
2016	2015	-5.779917	6.75913	0.396	-19.32552	7.76568
	2017	4.032333	6.75913	0.553	-9.51327	17.57793
	2018	-1.077917	6.75913	0.874	-14.62352	12.46768
	2019	-16.576583	6.75913	0.017	-30.12218	-3.03098
2017	2015	-9.81225	6.75913	0.152	-23.35785	3.73335
	2016	-4.032333	6.75913	0.553	-17.57793	9.51327
	2018	-5.11025	6.75913	0.453	-18.65585	8.43535
	2019	-20.608917	6.75913	0.004	-34.15452	-7.06332
2018	2015	-4.702	6.75913	0.49	-18.2476	8.8436
	2016	1.077917	6.75913	0.874	-12.46768	14.62352
	2017	5.11025	6.75913	0.456	-8.43535	18.65585
	2019	-15.498667	6.75913	0.023	-29.04427	-1.95307
2019	2015	10.796667	6.75913	0.116	-2.74893	24.34227
	2016	16.576583	6.75913	0.017	3.03098	30.12218
	2017	20.608917	6.75913	0.004	7.06332	34.15452
	2018	15.498667	6.75913	0.026	1.95307	29.04427

Table 4.40 provides a comparison of 2017 significance values, which were 0.152, 0.553, 0.453 and 0.004, compared to 2015, 2016, 2018 and 2019, respectively. The results reconfirm the post hoc analysis, as the 2019 value is again different from 2017's mean cargo. The observation for 2018 compared to 2015, 2016, 2017 and 2019 shows significance values of 0.49, 0.874, 0.453 and 0.026, respectively. Again, the same conclusion is drawn. Lastly, comparing 2019 to 2015, 2016, 2017 and 2018, the significance values are 0.116, 0.017, 0.004 and 0.026, respectively. Accordingly, 2019 is statistically different from 2016, 2017 and 2018. Other than 2019, most of the years had equal mean cargo.

The analysis reveals that 2019 stands out as a year with statistically significant differences in cargo volumes when compared to 2016, 2017, and 2018. This implies that the transport systems need to consider the specific challenges and requirements associated with the cargo volumes observed in 2019. The results highlight the need for adaptive and responsive transport systems that can effectively accommodate different years' varying demands and challenges. By considering these insights, stakeholders and policymakers can make informed decisions to enhance the Namibian transport systems' preparedness and resilience in the context of the regional logistics hub.

The statistics suggest that the alternative hypothesis (H_2) should be accepted as there is at least one year (2019) with a different mean cargo from the rest. The railway experienced an increase in cargo between 2015 and 2019.

b) ANOVA on Road cargo

This section presents the ANOVA for 2015-2019 on road cargo. The hypotheses were as follows:

(H_0): There is no significant difference in cargo received on the road from 2015 to 2019

(H_3): There is at least one year with a different mean cargo from the rest

Using IBM SPSS and testing at a 5% level of significance, the results were as follows:

Table 4-41: Road cargo descriptive statistics for 2015-2019

Source: Author's compilation (2022)

Descriptive Statistics on Road Cargo								
Year	**N**	**Mean**	**Std. Dev**	**Std. Err**	**95% Confidence Int Lower Bound**	**Upper Bound**	**Min**	**Max**
2015	12	255.5275	84.68736	24.4471	201.7198	309.3353	0.33	329.75
2016	12	262.0789	44.98186	12.9851	233.4988	290.659	221.31	359.46
2017	12	254.2593	111.6776	32.2386	183.3028	3.25.2159	37.79	386.05
2018	12	276.5891	36.49066	10.534	253.404	299.7741	218.65	321.58
2019	12	319.9152	55.55269	16.0367	284.6187	355.2117	230.55	425.82
Total	60	273.674	73.96547	9.5489	254.5667	292.7813	0.33	425.82

Table 4.41 shows that the mean cargo in tonnes received in 2015, 2016, 2017, 2018 and 2019 was 255.5275, 262.0789, 254.2593, 276.5891 and 319.9152 tonnes, respectively. The observations for 2015 and 2017 show a slight difference in the means of 255.5275 and 262.0789. Again, in 2016 and 2018, there is a slight difference in the means of 262.0789 and 276.5891. However, in 2019,

there is a large difference in the means compared to the other years. This is due to the expansion of the port that led to increased volumes of inflow cargo.

The statistics suggest accepting the alternative hypothesis (H_3) as there is at least one year (2019) with a different mean cargo from the rest. The road system experienced an increase in cargo between 2015 and 2019.

i) Road cargo Levene's test

Table 4.42 illustrates Levene's test results. However, the significance result of 0.189 renders the data invalid to contact ANOVA analysis. When the significance outcome is higher than the alpha (0.05), the null hypothesis is rejected as the data is deemed unreliable.

Table 4-42: Homogeneity of variance road cargo Levene's test

Source: Author's compilation (2022)

Test of Homogeneity of Variances			
Road Cargo			
Levene Statistic	df1	df2	Sig
1.595	4	55	0.189

Table 4.42 shows that the significance value was greater than 0.05, which meant that there was insufficient evidence to reject the null hypothesis (H_0), which stated that the mean cargos on the road were not significantly different. The different years did not yield a statistically significant difference; there was thus no need to run a post hoc analysis to explore which years were different.

c) ANOVA on sea-landed cargo

This section presents the ANOVA for 2015-2019 on sea-landed cargo. The hypotheses were as follows:

(H_0): There is no significant difference in cargo received between 2015 and 2019

(H_4): There is at least one year with a different mean cargo from the rest

Using IBM SPSS and testing at a 5% level of significance, the results are shown in Table 4.43.

Table 4-43: Descriptive statistics on sea-landed cargo

Source: Author's compilation (2022)

Descriptive Statistics on Sea-Landed Cargo								
Year	**N**	**Mean**	**Std. Dev**	**Std. Err**	**95% Confidence Int**		**Min**	**Max**
					Lower Bound	**Upper Bound**		
2015	12	273.47	128.52	37.0995	191.813	355.1237	0.35	516.35
2016	12	277.03	81.171	23.4321	225.461	328.6085	134.25	417.92
2017	12	253.25	82.33	23.7667	200.941	305.5614	115.2	396.39
2018	12	295.75	56.132	24.864	241.023	350.4741	144.46	408.83
2019	12	296.22	108.63	31.3586	227.199	365.2389	106.74	568.79
Total	60	279.14	97.025	12.5259	254.08	304.2087	0.35	568.79

Table 4.43 shows that the mean cargo in tonnes received in 2015, 2016, 2017, 2018 and 2019 was 273.4683, 277.0348, 253.2513, 295.7488 and 296.2191 tonnes, respectively. The observation for 2015 and 2016 is that there is a very minimal difference in the means of 273.4683 and 277.0348. The lowest mean was observed in 2017 at 253.251. In 2018 and 2019, the difference was not significant at 295.7488 and 296.2191; thus, over the four years, there was no significant difference in the means observed. These findings suggest consistent cargo demand and indicate the need for continued focus on maintaining efficient transport systems. Overall, these findings enhance understanding of the trends and patterns of cargo volumes within the logistics hub. They highlight the importance of considering historical data and analysing the stability or fluctuations in cargo volumes to enhance the transport systems' preparedness and efficiency. By evaluating these trends, stakeholders can identify areas for improvement and implement strategies to optimise the transport systems' performance and readiness in the context of the regional logistics hub in Namibia.

i) Sea-landed cargo Levene's test

Table 4.44 displays Levene's test results on sea-landed cargo data for 2015 to 2019.

Table 4-44: Sea-landed cargo Levene's test

Source: Author's compilation (2022)

Test of Homogeneity of Variances				
Sea landed				
Levene Statistic		df1	df2	Sig
0.414		4	55	0.797

As seen in Table 4.44, the significance value is 0.797, which is greater than 0.05. Thus, the cargo for each year is not significantly different and there is insufficient evidence to reject the null hypothesis (H_o) and hence, it is unreliable to run an ANOVA and post hoc analysis.

Table 4.45 presents the overall variance in tonnage data for the three modes of transports' cargo volume per year between 2015 and 2019, supported by the significance p-values for each mode in these years.

Table 4-45: Significance p-values for each mode of transport

Source: Author's compilation (2022)

Mode	**2015**	**2016**	**2017**	**2018**	**2019**
Rail	128.16658	122.38667	118.35433	123.46458	138.96325
Road	255.5275	262.0789	254.2593	276.5891	319.9152
Sea-landed	273.4683	277.0348	253.2513	295.7488	296.2191
Total	**657.16238**	**661.50037**	**625.86493**	**695.80248**	**755.09755**
	2015	**2016**	**2017**	**2018**	**2019**
	Mean-variance	**Mean-variance**	**Mean-variance**	**Mean-variance**	**Mean-variance**
Rail and road	-127.36092	-139.69223	-135.90497	-153.12452	-180.95195
Road and sea	-17.9408	-14.9559	1.008	-19.1597	23.6961
Sea and rail	-145.30172	-154.64813	-134.89697	-172.28422	-157.25585
	2015	**2016**	**2017**	**2018**	**2019**
	P-Value	**P-Value**	**P-Value**	**P-Value**	**P-Value**
Rail and road	-0.993713962	-1.141400693	-1.148288956	-1.240230356	-1.302156865
Road and sea	-0.070210838	-0.057066403	0.003964457	-0.069271349	0.074069941
Sea and rail	-0.531329298	-0.558226367	-0.532660523	-0.582535652	-0.530876807

Table 4.45 demonstrates that the p-value for cargo volume received by the modes of transport in 2015, 2016, 2017, 2018, and 2019 was greater than 0.05, indicating a significant difference in cargo volumes received in the respective modes of transport over these years. Such growth will lead to an increase in GDP, economic activity, and trade. There is a stronger emphasis on seamless transit in terms of transport systems, maintaining the port's accessibility, connectivity, and centrality. Alternatively, the increase in cargo could place excessive strain on the transportation systems.

4.3.4 Multivariate Method

In large-scale data, multivariate analysis identifies relationships and analyses patterns. It is essential because it enables an evaluation or assessment of the independent effects of numerous exposures on a given result while controlling for confounding factors/variables (apart from identified variables, these can be unforeseen variables that can emerge during testing). In this study, multivariate analysis was carried out to determine whether or not there is a relationship between the dependent variable and the independent variables.

4.3.4.1 Factor analysis

The primary data were further subjected to factor analysis; however, in order to satisfy the conditions for various forms of factor analysis, they were first subjected to reliability and sample adequacy tests, as follows:

4.3.4.1.1 Reliability tests

Table 4-46: Alpha and Composite reliabilities

Source: Author's compilation (2022)

Construct	Number of items	Composite reliabilities	Cronbach alpha
Inhibiting Challenges	22	0.868	0.875
Transport Infrastructure	4	0.849	0.853
Transport KPIs	11	0.807	0.808
Accessibility, Centrality and Connectivity	3	0.798	0.799
TDM	3	0.700	0.706

According to Hair et al. (2015), satisfactory composite reliabilities and alpha values range from 0.7 and above. Table 4.46 shows that the data reached the minimum accepted composite reliabilities and alpha value ranging between 0.706 and 0.875, demonstrating that the study's research questions and findings attained reliability.

Table 4-47: KMO and Bartlett's Test

Source: Author's compilation (2022)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.908
Bartlett's Test of Sphericity	Approx. C	2468.032
	Df	210
	Sig.	0.000

Before conducting various factor analyses, the Kaiser-Meyer-Olkin (KMO) and Bartlett's test for Sphericity were applied to determine whether the sample was adequate. The KMO statistic was used to assess the sample's appropriateness. The KMO statistics range between 0 and 1, with 0 representing absolute sample inadequacy and 1 absolute sample adequacy. The recommended KMO statistic is 0.5, signifying a minimum for sample adequacy, whereas Bartlett's test of sphericity statistic must be significant at p-0.05 to be considered significant (Arkkelin, 2014; Field, 2005). Furthermore, scores between 0.5 and 0.7 are considered mediocre; values between 0.7 and 0.8 are considered acceptable; those between 0.8 and 0.9 are regarded as excellent, and values beyond 0.9 are considered exceptional (Hutcheson & Sofroniou, 1999). A result of 0.908 is greater than 0.9, which means that further data analysis can be conducted and yield reliable results.

4.3.4.1 Intercorrelation factors

Intercorrelation values on operational factors, especially the independent variables, as highlighted in Table 4.43, are experienced in the transport and logistics sector. An intercorrelation matrix was established to determine how the identified transport and logistics factors work together as a system; Table 4.48 shows the intercorrelation matrix.

Table 4-48: Correlation matrix

Table 4.48 illustrates the intercorrelation values of the operational factors experienced in the transport and logistics sector.

4.3.4.1.2 Sample adequacy tests

A sample adequacy test was carried out on the quantitative sample to assess whether the sample size was good enough for the study; the results are shown in Table 4.47.

Table 4-49: Correlation matrix

Source: Author's compilation (2022)

		Distance travel	Transport infrastructures	Terminals connectivity	Reliable mode of transport	Transportation costs	Customs regulations	Cross Borders Delays	Transit time	Multimodal Transport	Available modes of transport	Storage facilities	Logistics and Transport expertise	behaviors of service providers	Intermodal transportation	Traffic regulations	Cross border traffic regulations	Capacity constraints	Railway services	Road infrastructures conditions	Congestion	Safety and security	Shortages of truck drivers
Correlation	Distance travel	1.000	.933	.917	.951	.958	.938	.940	.954	.944	.955	.931	.963	.953	.982	.923	.928	.932	.931	.849	.921	.942	.962
	Transport infrastructures	.933	1.000	.894	.935	.955	.919	.976	.912	.925	.954	.902	.950	.933	.940	.896	.945	.921	.994	.767	.860	.964	.955
	Terminals connectivity	.917	.894	1.000	.940	.917	.938	.903	.923	.936	.916	.975	.917	.938	.928	.989	.960	.945	.888	.910	.954	.900	.901
	Reliable mode of transport	.951	.935	.940	1.000	.934	.952	.932	.960	.976	.951	.936	.936	.982	.948	.937	.957	.946	.936	.862	.939	.937	.935
	Transportation costs	.958	.955	.917	.934	1.000	.920	.970	.928	.926	.969	.943	.990	.935	.965	.926	.926	.918	.951	.817	.894	.964	.979
	Customs regulations	.938	.919	.938	.952	.920	1.000	.918	.962	.972	.925	.937	.920	.951	.936	.935	.964	.985	.921	.892	.940	.915	.924
	Cross Borders Delays	.940	.976	.903	.932	.970	.918	1.000	.917	.923	.957	.917	.962	.932	.947	.903	.935	.913	.976	.780	.867	.977	.969
	Transit time	.954	.912	.923	.960	.928	.962	.917	1.000	.974	.931	.928	.931	.957	.941	.924	.940	.951	.912	.877	.935	.912	.934
	Multimodal Transport	.944	.925	.936	.976	.926	.972	.923	.974	1.000	.945	.934	.927	.972	.943	.934	.958	.958	.927	.870	.938	.933	.928
	Available modes of transport	.955	.954	.916	.951	.969	.925	.957	.931	.945	1.000	.931	.972	.947	.982	.920	.935	.920	.952	.817	.905	.971	.974
	Storage facilities	.931	.902	.975	.936	.943	.937	.917	.928	.934	.931	1.000	.943	.935	.933	.983	.958	.943	.897	.914	.957	.913	.925
	Logistics and Transport expertise	.963	.950	.917	.936	.990	.920	.962	.931	.927	.972	.943	1.000	.937	.970	.925	.925	.918	.946	.832	.902	.955	.980
	behaviors of service providers	.953	.933	.938	.982	.935	.951	.932	.957	.972	.947	.935	.937	1.000	.950	.936	.954	.945	.930	.870	.939	.936	.936
	Intermodal transportation	.962	.940	.928	.948	.965	.936	.947	.941	.943	.982	.933	.970	.950	1.000	.930	.929	.931	.938	.828	.922	.954	.968
	Traffic regulations	.923	.896	.989	.937	.926	.935	.903	.924	.934	.920	.983	.925	.936	.930	1.000	.961	.942	.891	.916	.957	.897	.909
	Cross border traffic regulations	.928	.945	.960	.957	.926	.964	.935	.940	.958	.935	.958	.925	.954	.929	.961	1.000	.970	.943	.889	.940	.933	.927
	Capacity constraints	.932	.921	.945	.946	.918	.985	.913	.951	.958	.920	.943	.918	.945	.931	.942	.970	1.000	.918	.903	.940	.908	.919
	Railway services	.931	.994	.888	.936	.951	.921	.976	.912	.927	.952	.897	.946	.930	.938	.891	.943	.918	1.000	.760	.858	.966	.953
	Road infrastructures' conditions	.849	.767	.910	.862	.817	.892	.780	.877	.870	.817	.914	.832	.870	.828	.916	.889	.903	.760	1.000	.937	.766	.817
	Congestion	.921	.860	.954	.939	.894	.940	.867	.935	.938	.905	.957	.902	.939	.922	.957	.940	.940	.858	.937	1.000	.868	.896
	Safety and security	.942	.964	.900	.937	.964	.915	.977	.912	.933	.971	.913	.955	.936	.954	.897	.933	.908	.966	.766	.868	1.000	.968
	Shortages of truck drivers	.962	.955	.901	.935	.979	.924	.989	.934	.928	.974	.925	.980	.936	.968	.909	.927	.919	.953	.817	.896	.968	1.000

The operational factors in the transport and logistics system seem to be intercorrelating at a very significant factor loading or above 0.5 (Schober, Boer, & Schwarte, 2018). This implies that the transport and logistics factors identified in the matrix work as a system with equally important elements.

4.3.4.2.1 Confirmatory factor analysis (CFA)

The data were subjected to CFA in order to determine whether i) the questions asked or the factor structure fit the study and ii) the data were appropriate for the study. Confirmatory factor analysis enables the researcher to verify the factor structure of the questions used as part of critical observable variables. It implies that the study's observable variables are correct and active, ensuring that latent variables are not used. Table 4.49 shows the components and their respective factor loading.

Table 4-50: Confirmatory factor analysis

Source: Author's compilation (2022)

	Components	Initial	CF
1	Distance travelled	1.000	.947
2	Transport infrastructure	1.000	.925
3	Terminals' connectivity	1.000	.929
4	Reliable mode of transport	1.000	.956
5	Transportation costs	1.000	.947
6	Customs regulations	1.000	.945
7	Cross border delays	1.000	.932
8	Transit time	1.000	.939
9	Multimodal transport	1.000	.953
10	Available modes of transport	1.000	.951
11	Storage facilities	1.000	.942
12	Logistics and transport expertise	1.000	.949
13	Behaviours of service providers	1.000	.955
14	Intermodal transportation	1.000	.953
15	Traffic regulations	1.000	.933
16	Cross-border traffic regulations	1.000	.955
17	Capacity constraints	1.000	.941
18	Railway services	1.000	.921
19	Road infrastructure conditions	1.000	.787
20	Congestion	1.000	.909
21	Safety and security	1.000	.929
22	Shortages of truck drivers	1.000	.945

The factor loading for each newly-developed item should be more than 0.5. Every item's factor loading for a confirmed item should be 0.6 or greater (Field, 2015). Items with factor loadings under 0.6 and R2 values under 0.4 should be eliminated from the measurement model (Awang, 2014). Table 4.50 presents the factor loadings using Principal Components Analysis. All the components present a high factor loading above 0.5, indicating that the factors are considered entirely satisfactory.

4.3.4.2.2 Multivariate analysis - Conceptual Framework variables

Table 4.50 shows the results from the multivariate test.

a) Connectivity test

Table 4-51: Connectivity – Multivariate Tests

Source: Author's compilation (2022)

Multivariate Tests [a]									
Effect		**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**	**Partial Eta Squared**	**Noncent. Parameter**	**Observed Power[d]**
Intercept	Pillai's Trace	.997	36906.745[b]	4.000	394.000	.000	.997	147626.978	1.000
	Wilks' Lambda	.003	36906.745[b]	4.000	394.000	.000	.997	147626.978	1.000
	Hotelling's Trace	374.688	36906.745[b]	4.000	394.000	.000	.997	147626.978	1.000
	Roy's Largest Root	374.688	36906.745[b]	4.000	394.000	.000	.997	147626.978	1.000
Long distance travel	Pillai's Trace	1.103	37.774	16.000	1588.000	<.001	.276	604.385	1.000
	Wilks' Lambda	.202	51.794	16.000	1204.328	<.001	.330	592.157	1.000
	Hotelling's Trace	2.563	62.878	16.000	1570.000	<.001	.391	1006.052	1.000
	Roy's Largest Root	1.942	192.766[c]	4.000	397.000	<.001	.660	771.062	1.000
Connectivity to all preferred terminals	Pillai's Trace	1.528	61.347	16.000	1588.000	<.001	.382	981.559	1.000
	Wilks' Lambda	.057	116.701	16.000	1204.328	<.001	.511	1257.741	1.000
	Hotelling's Trace	7.635	187.308	16.000	1570.000	.000	.656	2996.927	1.000
	Roy's Largest Root	6.514	646.541[c]	4.000	397.000	<.001	.867	2586.162	1.000
Long distance travel * connectivity to all preferred terminals	Pillai's Trace	.000	.[b]	.000	.000	.	.	.	.
	Wilks' Lambda	1.000	.[b]	.000	395.500	.	.	.	.
	Hotelling's Trace	.000	.[b]	.000	2.000	.	.	.	.
	Roy's Largest Root	.000	.000[b]	4.000	393.000	1.000	.000	.000	.050

a. Design: Intercept + long distance travel + connectivity to all preferred terminals + long distance travel * connectivity to all preferred terminals
b. Exact statistic
c. The statistic is an upper bound on *F* that produces a lower constraint on the level of significance.
d. Computed using alpha = .05

The multivariate test (MANOVA) was used to assess whether there is a difference in the independent variable, which provides an overview of the collapsing ANOVA test (centrality of the hub). It can be denoted under sig. (0.000) using Wilk's Lambda test, which indicates that it is statistically significant. This means that there appears to be a relationship between the independent variable and all the dependent variables (1. reliable mode of transport, 2. transportation costs, 3. intermodal transportation, 4. traffic regulations), which is further explained in Table 4.52 (tests of between-subject effects).

Table 4-52: Connectivity – Levene's Test of Equality of Error Variances

Source: Author's compilation (2022)

Levene's Test of Equality of Error Variances[a]					
		Levene Statistic	**df1**	**df2**	**Sig.**
Reliable mode of transport	Based on Mean	193.622	8	397	<.001
	Based on Median	21.638	8	397	<.001
	Based on Median and with adjusted df	21.638	8	167.550	<.001
	Based on trimmed mean	160.502	8	397	<.001
Transportation costs	Based on Mean	52.103	8	397	<.001
	Based on Median	8.402	8	397	<.001
	Based on Median and with adjusted df	8.402	8	162.210	<.001
	Based on trimmed mean	38.251	8	397	<.001
Intermodal transportation	Based on Mean	119.566	8	397	<.001
	Based on Median	14.102	8	397	<.001
	Based on Median and with adjusted df	14.102	8	125.095	<.001
	Based on trimmed mean	91.309	8	397	<.001

Traffic regulations	Based on Mean	34.968	8	397	<.001
	Based on Median	7.521	8	397	<.001
	Based on Median and with adjusted df	7.521	8	96.896	<.001
	Based on trimmed mean	23.940	8	397	<.001
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.					
a. Design: Intercept + long distance travel + connectivity to all preferred terminals + long distance travel * connectivity to all preferred terminals					

Levene's test of equality of variances tests for the homogeneity of variances to determine whether or not the dependent variables are equal across groups. Homogeneity is not violated if the significant variable is not less than 0.05 (level of significance); however, in Table 4.51, all the dependent variables (1. reliable mode of transport, 2. transportation costs, 3. intermodal transportation, 4. traffic regulations) have a sig. of <0.001, which violated the homogeneity of variance. In other words, equal variances are not assumed across the groups of dependent variables.

Table 4-53: Connectivity – Tests of between-subjects effects

Source: Author's compilation (2022)

Tests of Between-Subjects Effects									
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Noncent. Parameter**	**Observed Power** [e]
Corrected Model	Reliable mode of transport	720.021[a]	8	90.003	964.056	<.001	.951	7712.451	1.000
	Transportation costs	595.348[b]	8	74.419	1108.932	<.001	.957	8871.454	1.000
	Intermodal transportation	688.228[c]	8	86.028	1371.320	<.001	.965	10970.562	1.000
	Traffic regulations	663.209[d]	8	82.901	2623.560	.000	.981	20988.482	1.000
Intercept	Reliable mode of transport	3116.903	1	3116.903	33386.498	.000	.988	33386.498	1.000
	Transportation costs	4024.731	1	4024.731	59973.669	.000	.993	59973.669	1.000
	Intermodal transportation	3637.130	1	3637.130	57976.992	.000	.993	57976.992	1.000

	Traffic regulations	2501.034	1	2501.034	79149.878	.000	.995	79149.878	1.000
Long-distance travel	Reliable mode of transport	29.648	4	7.412	79.393	<.001	.444	317.573	1.000
	Transportation costs	25.904	4	6.476	96.500	<.001	.493	386.002	1.000
	Intermodal transportation	27.042	4	6.761	107.766	<.001	.521	431.065	1.000
	Traffic regulations	1.978	4	.494	15.646	<.001	.136	62.585	1.000
Connectivity to all preferred terminals	Reliable mode of transport	30.318	4	7.579	81.187	<.001	.450	324.747	1.000
	Transportation costs	19.923	4	4.981	74.220	<.001	.428	296.882	1.000
	Intermodal transportation	24.177	4	6.044	96.346	<.001	.493	385.383	1.000
	Traffic regulations	69.658	4	17.415	551.118	<.001	.847	2204.472	1.000
Long-distance travel * connectivity to all preferred terminals	Reliable mode of transport	.000	0	.	.	.	.000	.000	.
	Transportation costs	.000	0	.	.	.	.000	.000	.
	Intermodal transportation	.000	0	.	.	.	.000	.000	.
	Traffic regulations	.000	0	.	.	.	.000	.000	.
Error	Reliable mode of transport	37.063	375	.093					
	Transportation costs	26.642	375	.067					
	Intermodal transportation	24.905	375	.063					
	Traffic regulations	12.545	375	.032					
Total	Reliable mode of transport	5246.000	384						
	Transportation costs	6238.000	384						
	Intermodal transportation	5906.000	384						
	Traffic regulations	4270.000	384						
Corrected Total	Reliable mode of transport	757.084	383						
	Transportation costs	621.990	383						

	Intermodal transportation	713.133	383						
	Traffic regulations	675.754	383						
a. R Squared = .951 (Adjusted R Squared = .950)									
b. R Squared = .957 (Adjusted R Squared = .956)									
c. R Squared = .965 (Adjusted R Squared = .964)									
d. R Squared = .981 (Adjusted R Squared = .981)									
e. Computed using alpha = .05									

All the dependent variables have a significance value of 0.001 (1. reliable mode of transport, 2. transportation costs, 3. intermodal transportation, 4. traffic regulations), which is less than 0.05 when zoomed in on the results in Table 4.52 (tests of between-subjects) (the alpha level on which the outputs were computed). This suggests that the respondents indeed found connectivity to the terminal challenging. The researcher did not reject the null hypothesis, which states that because there is sufficient data to support it and the alpha is 0.05, which is more than the significance under the centrality of the terminal, the transport systems' preparedness in Namibia has an impact on attaining a regional logistics hub. The researcher considered the findings presented in Tables 4.50 and 4.51 to ascertain the relationship (effect) the hub's accessibility has on its dependent variables (1. reliable mode of transport, 2. transportation costs, 3. intermodal transportation, 4. traffic regulations). The majority of the responses alluded to having trouble connecting to the hub. Accessibility obviously has a negative effect on establishing a regional logistics hub. The *R squared* shows that all four dependent variables have an *adjusted variable* of above 0.5 with a minimum adjusted value of 0.950 and a maximum of 0.981, which indicates a strong relationship between the independent variable (connectivity to the terminal) and the dependent variables (1. reliable mode of transport, 2. transportation costs, 3. intermodal transportation, 4. traffic regulations).

b) Accessibility test

Table 4-54: Accessibility – Multivariate Tests

Source: Author's compilation (2022)

Multivariate Tests [a]									
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
Intercept	Pillai's Trace	.992	7315.724[b]	7.000	395.000	.000	.992	51210.068	1.000
	Wilks' Lambda	.008	7315.724[b]	7.000	395.000	.000	.992	51210.068	1.000
	Hotelling's Trace	129.646	7315.724[b]	7.000	395.000	.000	.992	51210.068	1.000
	Roy's Largest Root	129.646	7315.724[b]	7.000	395.000	.000	.992	51210.068	1.000
Accessibility to all preferred terminals	Pillai's Trace	1.999	56.785	28.000	1592.000	<.001	.500	1589.983	1.000
	Wilks' Lambda	.007	147.052	28.000	1425.615	.000	.706	3422.728	1.000
	Hotelling's Trace	23.650	332.367	28.000	1574.000	.000	.855	9306.272	1.000
	Roy's Largest Root	19.320	1098.475[c]	7.000	398.000	<.001	.951	7689.327	1.000
a. Design: Intercept + accessibility to all preferred terminals									
b. Exact statistic									
c. The statistic is an upper bound on *F* that produces a lower constraint on the level of significance.									
d. Computed using alpha = .05									

The multivariate test (MANOVA), which provides an overview of the collapsing ANOVA, can be used to evaluate whether or not there is a difference in the independent variable (terminal accessibility). Wilk's Lambda test can be used to denote it under sig. (0.000), indicating that it is statistically significant, and that all the dependent variables seem to be related to the independent variable (1. infrastructure for transportation, 2. transportation costs, 3. transit time, 4. capacity constraints, 5. congestion, and 6. safety and security) (examination of between-subject effects).

Table 4-55: Accessibility – Levene's test of equality of error variances

Source: Author's compilation (2022)

Levene's Test of Equality of Error Variances[a]					
		Levene Statistic	df1	df2	Sig.
Transport infrastructure	Based on Mean	57.414	4	379	<.001
	Based on Median	13.409	4	379	<.001

	Based on Median and with adjusted df	13.409	4	260.394	<.001
	Based on trimmed mean	53.243	4	379	<.001
Transportation costs	Based on Mean	69.702	4	379	<.001
	Based on Median	16.105	4	379	<.001
	Based on Median and with adjusted df	16.105	4	254.987	<.001
	Based on trimmed mean	64.572	4	379	<.001
Transit time	Based on Mean	2885.711	4	379	<.001
	Based on Median	22.119	4	379	<.001
	Based on Median and with adjusted df	22.119	4	234.994	<.001
	Based on trimmed mean	2334.450	4	379	<.001
Available modes of transport	Based on Mean	58.348	4	379	<.001
	Based on Median	28.100	4	379	<.001
	Based on Median and with adjusted df	28.100	4	246.145	<.001
	Based on trimmed mean	58.310	4	379	<.001
Capacity constraints	Based on Mean	75.107	4	379	<.001
	Based on Median	9.498	4	379	<.001
	Based on Median and with adjusted df	9.498	4	320.319	<.001
	Based on trimmed mean	59.820	4	379	<.001
Congestion	Based on Mean	142.404	4	379	<.001
	Based on Median	17.410	4	379	<.001
	Based on Median and with adjusted df	17.410	4	276.655	<.001
	Based on trimmed mean	124.664	4	379	<.001
Safety and security	Based on Mean	86.792	4	379	<.001
	Based on Median	18.358	4	379	<.001
	Based on Median and with adjusted df	18.358	4	254.136	<.001
	Based on trimmed mean	80.683	4	379	<.001
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.					
a. Design: Intercept + accessibility to all preferred terminals					

Levene's test of equality of variances tests for the homogeneity of variances to determine whether the dependent variables are equal across groups. Homogeneity is not violated if the significant variable is not less than 0.05 (level of significance); however, in Table 4.54, all the dependent variables (1. transport infrastructure, 2. transportation costs, 3. transit time, 4. capacity constraints, 5. congestion, 6. safety and security) have a sig. of <0.001, which violated the homogeneity of variance. In other words, equal variance is not assumed across the groups of dependent variables.

Table 4-56: Accessibility – Tests of between-subject effects

Source: Author's compilation (2022)

Tests of Between-Subjects Effects									
Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power
Corrected Model	Transport infrastructure	488.868[a]	4	122.217	871.769	<.001	.897	3487.077	1.000
	Transportation costs	569.444[b]	4	142.361	1086.417	<.001	.916	4345.669	1.000
	Transit time	510.258[c]	4	127.565	612.648	<.001	.859	2450.592	1.000
	Available modes of transport	734.875[d]	4	183.719	1189.336	<.001	.922	4757.346	1.000
	Capacity constraints	554.616[e]	4	138.654	868.930	<.001	.897	3475.719	1.000
	Congestion	772.099[f]	4	193.025	1351.774	<.001	.931	5407.097	1.000
	Safety and security	700.702[g]	4	175.175	1232.321	<.001	.925	4929.285	1.000
Intercept	Transport infrastructure	5390.845	1	5390.845	38452.669	.000	.990	38452.669	1.000
	Transportation costs	5020.801	1	5020.801	38315.851	.000	.990	38315.851	1.000
	Transit time	4284.745	1	4284.745	20578.139	.000	.981	20578.139	1.000
	Available modes of transport	4596.648	1	4596.648	29757.244	.000	.987	29757.244	1.000
	Capacity constraints	3886.367	1	3886.367	24355.430	.000	.984	24355.430	1.000
	Congestion	2902.637	1	2902.637	20327.487	.000	.981	20327.487	1.000
	Safety and security	4864.430	1	4864.430	34220.201	.000	.988	34220.201	1.000
Accessibility to all preferred terminals	Transport infrastructure	488.868	4	122.217	871.769	<.001	.897	3487.077	1.000
	Transportation costs	569.444	4	142.361	1086.417	<.001	.916	4345.669	1.000
	Transit time	510.258	4	127.565	612.648	<.001	.859	2450.592	1.000

	Available modes of transport	734.875	4	183.719	1189.336	<.001	.922	4757.346	1.000
	Capacity constraints	554.616	4	138.654	868.930	<.001	.897	3475.719	1.000
	Congestion	772.099	4	193.025	1351.774	<.001	.931	5407.097	1.000
	Safety and security	700.702	4	175.175	1232.321	<.001	.925	4929.285	1.000
Error	Transport infrastructure	56.218	379	.140					
	Transportation costs	52.546	379	.131					
	Transit time	83.496	379	.208					
	Available modes of transport	61.943	379	.154					
	Capacity constraints	63.987	379	.160					
	Congestion	57.260	379	.143					
	Safety and security	57.002	379	.142					
Total	Transport infrastructure	6655.000	384						
	Transportation costs	6238.000	384						
	Transit time	5298.000	384						
	Available modes of transport	6004.000	384						
	Capacity constraints	4839.000	384						
	Congestion	3886.000	384						
	Safety and security	6344.000	384						
Corrected Total	Transport infrastructure	545.086	383						
	Transportation costs	621.990	383						
	Transit time	593.754	383						
	Available modes of transport	796.818	383						
	Capacity constraints	618.603	383						
	Congestion	829.360	383						
	Safety and security	757.704	383						

a. R Squared = .897 (Adjusted R Squared = .896)

b. R Squared = .916 (Adjusted R Squared = .915)

c. R Squared = .859 (Adjusted R Squared = .858)

d. R Squared = .922 (Adjusted R Squared = .921)

e. R Squared = .897 (Adjusted R Squared = .896)

f. R Squared = .931 (Adjusted R Squared = .930)

g. R Squared = .925 (Adjusted R Squared = .924)

h. Computed using alpha = .05

All the dependent variables (1. transport infrastructure, 2. transportation costs, 3. transit time, 4. capacity constraints, 5. congestion, 6. safety and security) have a significant value of 0.001, which is less than 0.05 when zoomed in on the results of Table 4.55 (tests of between-subjects) (the alpha level on which the outputs were computed). This suggests that the centrality of the hub is indeed affected. The researcher is unable to reject the null hypothesis, because there is sufficient data to support it and the alpha is 0.05, which is more than the significance under the centrality of the terminal (the transport systems' preparedness in Namibia has an impact on attaining a regional logistics hub). The researcher considered the findings presented in Tables 4.53 and 4.54 to ascertain the relationship (effect) the hub's accessibility has with the dependent variables (distance travelled, terminal connectivity, transit time, terminal location, and terminal accessibility). The majority of the responses alluded to difficulties in reaching the hub. Accessibility obviously has a negative effect on establishing a regional logistics hub. The *R squared* shows that all seven independent variables have an adjusted variable of above 0.5, with a minimum adjusted value of 0.858 and a maximum of 0.930, which indicates a strong relationship between the dependent variable (accessibility to the terminal) and the independent variables (distance travelled, terminal connectivity, transit time, terminal location, and terminal accessibility).

c) Centrality test

Table 4-57: Centrality – Multivariate Tests

Source: Author's compilation (2022)

Multivariate Tests									
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
Intercept	Pillai's Trace	.993	13816.138[b]	4.000	398.000	.000	.993	55264.552	1.000
	Wilks' Lambda	.007	13816.138[b]	4.000	398.000	.000	.993	55264.552	1.000
	Hotelling's Trace	138.856	13816.138[b]	4.000	398.000	.000	.993	55264.552	1.000
	Roy's Largest Root	138.856	13816.138[b]	4.000	398.000	.000	.993	55264.552	1.000
Centrality of the hub	Pillai's Trace	1.477	58.671	16.000	1604.000	<.001	.369	938.729	1.000
	Wilks' Lambda	.018	209.680	16.000	1216.548	.000	.636	2127.198	1.000
	Hotelling's Trace	30.096	745.814	16.000	1586.000	.000	.883	11933.032	1.000
	Roy's Largest Root	29.288	2936.075[c]	4.000	401.000	<.001	.967	11744.300	1.000

To assess whether there was a difference in the independent variable, the researcher used the multivariate test (MANOVA), which provides an overview of the collapsing ANOVA test (centrality of the hub). It can be denoted under sig. (0.000) using Wilk's Lambda test, which indicates that it is statistically significant. This means that there appears to be a relationship between the independent variable and all the dependent variables (distance travelled, terminal connectivity, transit time, terminal location, and terminal accessibility), which is further explained in Table 4.58 (tests of between-subject effects).

Table 4-58: Centrality – Levene's Test of Equality of Error Variances

Source: Author's compilation (2022)

Levene's Test of Equality of Error Variances					
		Levene Statistic	df1	df2	Sig.
Distance travelled	Based on Mean	106.047	4	379	<.001
	Based on Median	18.238	4	379	<.001
	Based on Median and with adjusted df	18.238	4	259.924	<.001
	Based on trimmed mean	94.062	4	379	<.001
Terminals' connectivity	Based on Mean	146.028	4	379	<.001
	Based on Median	45.646	4	379	<.001
	Based on Median and with adjusted df	45.646	4	244.708	<.001
	Based on trimmed mean	141.430	4	379	<.001
Transit time	Based on Mean	438.484	4	379	<.001
	Based on Median	27.312	4	379	<.001
	Based on Median and with adjusted df	27.312	4	242.424	<.001
	Based on trimmed mean	373.862	4	379	<.001
Multimodal transportation	Based on Mean	64.367	4	379	<.001
	Based on Median	13.893	4	379	<.001
	Based on Median and with adjusted df	13.893	4	178.786	<.001
	Based on trimmed mean	48.093	4	379	<.001
Location	Based on Mean	64.367	4	379	<.001
	Based on Median	13.893	4	379	<.001
	Based on Median and with adjusted df	13.893	4	178.786	<.001
	Based on trimmed mean	48.093	4	379	<.001
Terminals' accessibility	Based on Mean	146.028	4	379	<.001
	Based on Median	45.646	4	379	<.001
	Based on Median and with adjusted df	45.646	4	244.708	<.001
	Based on trimmed mean	141.430	4	379	<.001
Examines the null hypothesis that the error variance of the dependent variable is the same between groups.					

a. Design: Intercept + centrality of the hub

Levene's test of equality of variances tests for the homogeneity of variances to determine whether or not the dependent variables are equal across groups. Homogeneity is not violated if the significant variable is not less than 0.05 (level of significance); however, in Table 4.57, all the dependent variables (distance travelled, terminal connectivity, transit time, terminal location, and terminal accessibility) have a sig of <0.001, which violated the homogeneity of variance. In other words, equal variances are not assumed across the groups of the dependent variables.

Table 4-59: Centrality – Tests of between-subjects effects

Source: Author's compilation (2022)

Tests of Between-Subjects Effects									
Source	**Dependent Variable**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**	**Noncent. Parameter**	**Observed Power**
Corrected Model	Distance travelled	630.741[a]	4	157.685	1275.696	<.001	.927	5102.784	1.000
	Terminals' connectivity	572.528[b]	4	143.132	695.964	<.001	.874	2783.855	1.000
	Transit time	525.074[c]	4	131.269	766.442	<.001	.884	3065.769	1.000
	Multimodal transportation	688.731[d]	4	172.183	2829.551	<.001	.966	11318.204	1.000
	Location	688.731[d]	4	172.183	2829.551	<.001	.966	11318.204	1.000
	Terminals' accessibility	572.528[b]	4	143.132	695.964	<.001	.874	2783.855	1.000
Intercept	Distance travelled	3182.952	1	3182.952	25750.519	.000	.985	25750.519	1.000
	Terminals' connectivity	2177.101	1	2177.101	10585.919	<.001	.964	10585.919	1.000
	Transit time	2969.099	1	2969.099	17335.773	.000	.977	17335.773	1.000
	Multimodal transportation	3184.492	1	3184.492	52332.048	.000	.992	52332.048	1.000
	Location	3184.492	1	3184.492	52332.048	.000	.992	52332.048	1.000
	Terminals' accessibility	2177.101	1	2177.101	10585.919	<.001	.964	10585.919	1.000
Centrality of the hub	Distance travelled	630.741	4	157.685	1275.696	<.001	.927	5102.784	1.000
	Terminals' connectivity	572.528	4	143.132	695.964	<.001	.874	2783.855	1.000
	Transit time	525.074	4	131.269	766.442	<.001	.884	3065.769	1.000
	Multimodal transportation	688.731	4	172.183	2829.551	<.001	.966	11318.204	1.000

	Location	688.731	4	172.183	2829.551	<.001	.966	11318.204	1.000
	Terminals' accessibility	572.528	4	143.132	695.964	<.001	.874	2783.855	1.000
Error	Distance travelled	49.567	379	.124					
	Terminals' connectivity	82.470	379	.206					
	Transit time	68.679	379	.171					
	Multimodal transportation	24.402	379	.061					
	Location	24.402	379	.061					
	Terminals' accessibility	82.470	379	.206					
Total	Distance travelled	5809.000	384						
	Terminals' connectivity	4315.000	384						
	Transit time	5298.000	384						
	Multimodal transportation	5906.000	384						
	Location	5906.000	384						
	Terminals' accessibility	4315.000	384						
Corrected Total	Distance travelled	680.308	383						
	Terminals' connectivity	654.998	383						
	Transit time	593.754	383						
	Multimodal transportation	713.133	383						
	Location	713.133	383						
	Terminals' accessibility	654.998	383						
a. R Squared = .927 (Adjusted R Squared = .926)									
b. R Squared = .874 (Adjusted R Squared = .873)									
c. R Squared = .884 (Adjusted R Squared = .883)									
d. R Squared = .966 (Adjusted R Squared = .965)									
e. Computed using alpha = .05									

In order to assess whether there was a difference in the independent variable, the researcher used the multivariate test (MANOVA), which provides an overview of the collapsing ANOVA test (centrality of the hub). It can be denoted under sig. (0.000) using Wilk's Lambda test, which indicates that it is statistically significant. This means that there appears to be a relationship between the independent variable and all the dependent variables (distance travelled, terminal connectivity, transit time, terminal location, and terminal accessibility), which is further explained in Table 4.58 (Tests of between-subject effects).

Levene’s test of equality of variances tests for the homogeneity of variances to determine whether or not the dependent variables are equal across groups. Homogeneity is not violated if the significant variable is not less than 0.05 (level of significance); however, as shown in Table 4.57, all the dependent variables (distance travelled, terminal connectivity, transit time, terminal location, and terminal accessibility) have a sig of <0.001, which violated the homogeneity of variance. In other words, equal variances are not assumed across the groups of dependent variables.

Zooming in on the outputs reflected in Table 4.58 (tests of between-subjects), all the dependent variables (distance travelled, terminal connectivity, transit time, terminal location, and terminal accessibility) have a significant value of <0.001, which is less than 0.05 (the alpha level on which the outputs were computed), which indicates that there is indeed an impact on the centrality of the hub.

Finally, since the null hypothesis is supported by adequate data and the alpha is 0.05, which is greater than the significance under the centrality of the hub, the researcher accepts the null hypothesis that transport systems’ preparedness in Namibia has an impact on attaining a regional logistics hub. The researcher considered the results in Tables 4.54 and 4.55 to determine the impact (relationship) the accessibility of the hub has on its dependent variables (distance travelled, terminal connectivity, transit time, terminal location, and terminal accessibility). The majority of the respondents indicated that they experienced difficulty in reaching the hub. It follows that a lack of accessibility has a detrimental impact on attaining a regional logistics hub.

4.4 Part C: Qualitative Data Analysis

Qualitative analysis was conducted on the data from the interviews, first, to explore the challenges that inhibit the regional logistics hub in Namibia; secondly, to analyse transport networks' connectivity, accessibility, and centrality in facilitating a regional logistics hub; and thirdly, to evaluate the transport systems’ KPIs in facilitating a regional logistics hub in Namibia. An interview guide was used to collect qualitative data from 12 selected interviewees using a purposive sampling approach.

Table 4-60: Demographic data

Source: Author's compilation (2022)

Participant	Gender	Position held
P1	Male	Freight Transport Executive
P2	Male	Freight Transport Executive
P3	Male	Business Development Manager
P4	Male	Supply Chain Expert
P5	Male	Director: Transport Networks
P6	Male	Senior Technician: Railway Infrastructure
P7	Male	Customs Declaring Agent
P8	Male	Operational Manager
P9	Male	Project Manager
P10	Female	Transport Regulatory Inspector
P11	Female	Retail Procurement Specialist
P12	Female	Logistics and Distribution Manager

Table 4.59 presents the demographic characteristics of the participants. Nine of the 12 participants are male and three are female. The interviewees held various positions relevant to the theme of the study and were deemed to have an adequate understanding of the subject. As shown in Table 4.59, they were employed as freight transport executives, business development managers, supply chain experts, directors of transport networks, senior technicians for railway infrastructure, customs declaring agents, operational managers, project managers, transport regulatory inspectors, retail procurement specialists, and logistics and distribution managers. The following section presents the previous analysis as a reminder of the essential findings on centrality, connectivity and accessibility.

4.4.1 Visual analysis for Transport KPIs

The researcher conducted a visual analysis using the word cloud visualisation tool in NVivo, version 12, to extract the exact words that the participants used to describe the challenges hindering the regional logistics hub in Namibia and the KPIs for the transport systems. The size of each word in the word cloud is an indication of how frequently it was used; the bigger the size, the more frequently it was used.

A rigorous process was followed to ensure the trustworthiness of the data. Qualitative data were collected from participants with expertise in the challenges and KPIs of the regional logistics hub in Namibia. Purposive sampling ensured the selection of relevant participants. The data analysis involved using NVivo, version 12, and a word cloud visualisation tool to extract and analyse the exact words used by the participants. The size of each word in the word cloud reflects its frequency of use, highlighting recurring themes. This comprehensive approach that combined qualitative data and visual analysis, aimed to enhance the credibility and accuracy of the findings, providing a robust understanding of the participants' perspectives.

Figure 4-32: Visual analysis for Transport KPIs

Source: Extracted by the author from the interviews

As illustrated in Figure 4.32, the most prominent words from the analysis of the participants' responses include challenges, infrastructure, transportation, road, transport, and systems, which are presented in orange.

4.4.2 Word Tree Analysis

Since a word cloud cannot provide detailed information, the researcher conducted a text search query in NVivo software, version 12, to visualise the words that the participants used before and after the most frequent words, using a word tree visualisation tool. The word most frequently used by the participants was challenged. This linked with the study's objective to explore the challenges inhibiting the regional logistics hub in Namibia.

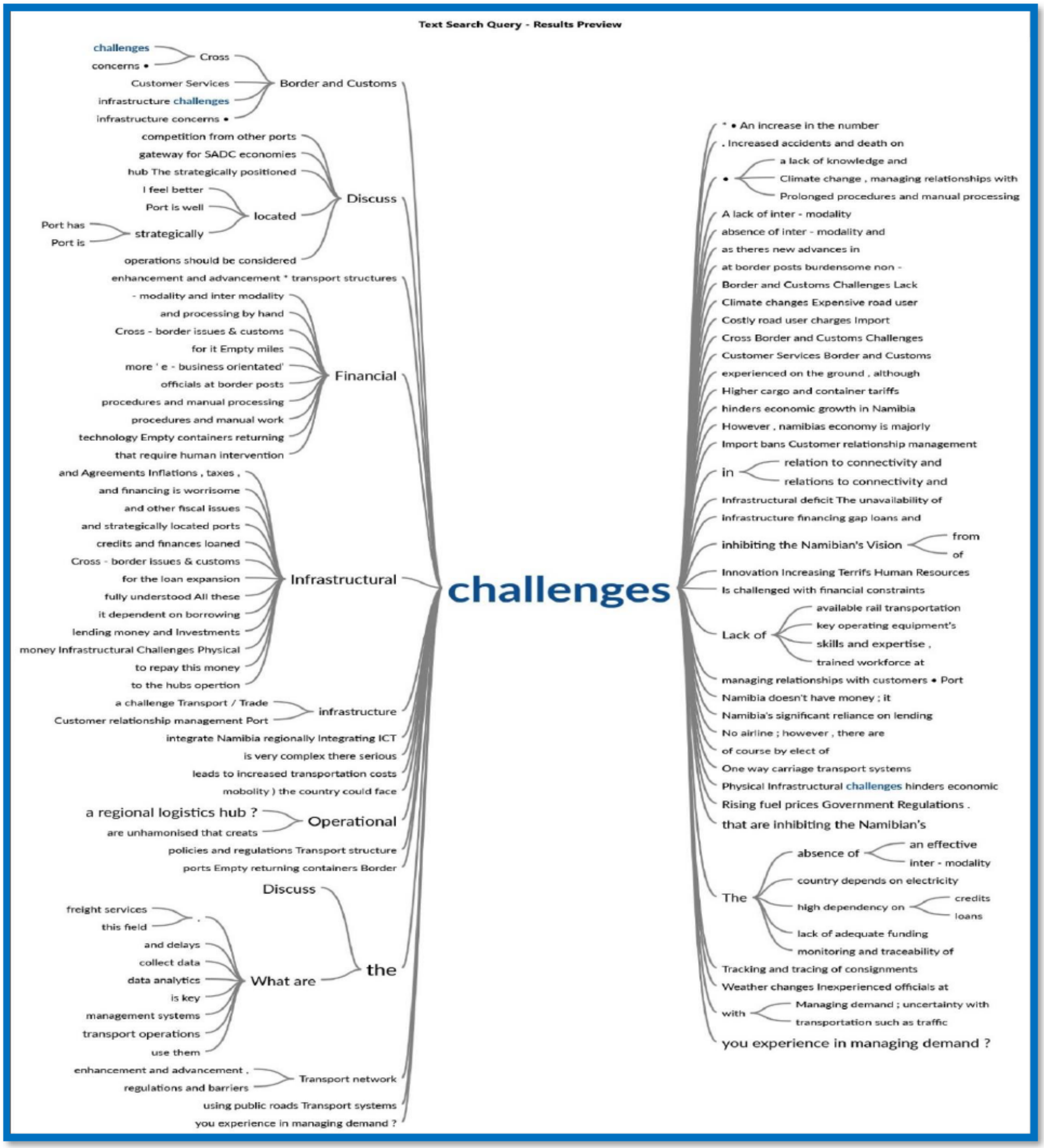


Figure 4-323: Word Tree of Challenges Visualisation

Source: Author's extraction from the analysis

In the word tree visualisation presented in Figure 4.33, the words on the left hand side of the main word (challenges) are those that the participants used before the word "challenges", while those on the right represent the words that the participants used after the word “challenges”. The bigger the word’s size, the more frequently it was used. Some keywords used before the word “challenges” included financial, operational, and infrastructure.

4.4.3 Challenges inhibiting a regional logistics hub in Namibia

Although Africa appears to be the fastest-growing economic hub globally (Leke et al., 2019), the continent confronts challenges with regard to the development of regional logistics hubs, and Namibia is no exception. This section explores the challenges that inhibit the development of a regional logistics hub in the country. Thematic analysis was employed to create themes through an inductive approach to theory development. The participants were asked to discuss the challenges that were inhibiting Namibia’s vision to become a regional logistics hub. The three main themes that emerged comprised the operational, financial, and infrastructure challenges. The following section details the operational challenges.

Theme One: Operational challenges

The respondents were asked to discuss the operational challenges that were inhibiting Namibia’s vision to become a regional logistics hub. Figure 4-35 presents a comprehensive, concise compilation of the significant hurdles and complexities encountered during the operational processes examined in this research framework. It serves as a valuable resource to comprehend the operational landscape, identify noteworthy obstacles, and facilitate informed understanding of potential avenues for enhancement and mitigation. Six sub-themes emerged under operational challenges.

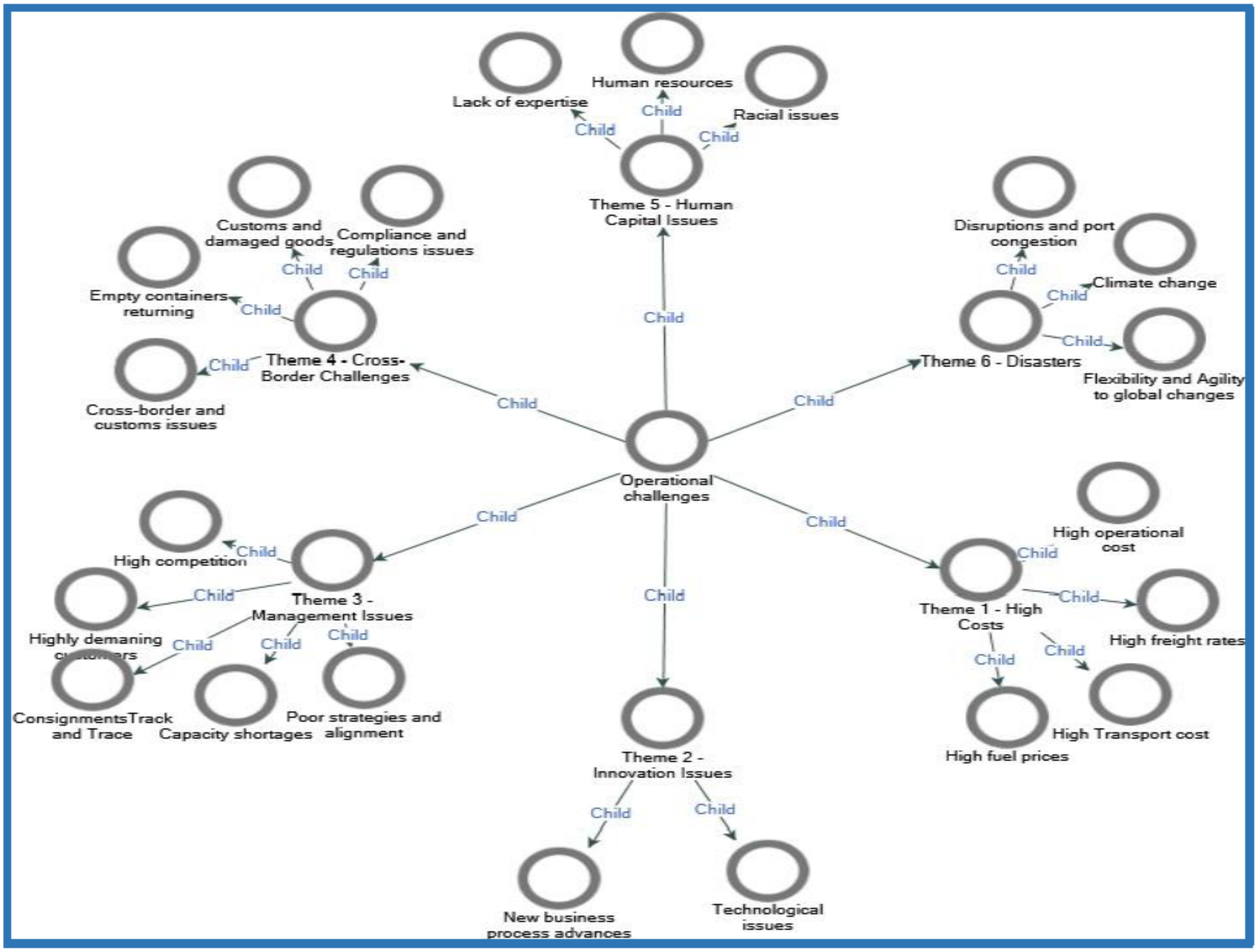


Figure 4-34: Operational challenges

Source: Extracted by the Author from the interviews

As displayed in Figure 4.34, the sub-themes encompassed high costs, innovation issues, management issues, cross-border challenges, human capital issues, and disasters. The following section delves deeper into high-cost-related challenges. As shown in Figure 4.33, these codes emerged from six participants. Participants 3 (business development manager) and 4 (supply chain expert) highlighted the challenges related to flexibility and agility in relation to global change. Similarly, Participants 1 and 2, who were both freight transport executives, cited challenges related to disruptions and port congestion, while Participants 8 (operational manager) and 9 (project manager) cited climate change issues. The following section presents some key participants' remarks on the theme of operational challenges.

Table 4-61: Operational challenges sub-themes

Source: Extracted by the author from the interviews

Theme	Sub-themes	Emerging Themes
Operational Challenges	High Cost	High freight rates
		High fuel prices
		High operational cost
		High transport cost
		High freight rates
	Innovation Issues	New business process advances
		Technological issues
	Management Issues	Capacity shortages
		Consignments track and trace
		High level of competition
		Highly demanding customers
		Poor strategies and alignment
	Cross-Border Challenges	Compliance and regulations issues
		Cross-border and customs issues
		Customs and damaged goods
		Empty containers returning
	Human Capital Issues	Human resources
		Lack of expertise
		Racial issues
	Disasters	Climate change
		Disruptions and port congestion
		Flexibility and agility in response to global change

The main theme of operational challenges produced the sub-themes when the interviewees were asked about the challenges inhibiting the realisation of the vision to establish a regional logistics hub.

P3 alluded to the sub-theme "high costs": "*It's with concern that I have noted that moving supplies within the region was more expensive than, e.g. moving goods from China. Transport in the region is extremely unreliable; hence, the cost of transport is often higher* *than the commodities being transported, making this transporting business not viable"*. **P6** stressed innovation issues: *"If Namibia and the region's supply chain industry are to avoid grinding to a halt, the country's numerous transportation organisations must become utterly compatible with technological advancement and innovation"*. Cross-border challenges prompted the observation that the region should collaborate more and remove the legacy policies and regulations hindering regional economic development and seamless logistics efficiency. **P8** remarked that, *"Namibian border posts, like other SADC border posts, have issues with how they were built and set up in the past, making it difficult for road transport to move smoothly between borders. At Namibian border posts, more than four government departments and agencies are present. Each department or agency operates independently. When crossing borders, the longest time is spent going through customs. Other transportation issues include inadequate or poorly maintained infrastructure, irregular work hours, and a lack of cooperation among domestic border officials and other stakeholders"*. By the same token, education, training and skills empowerment play a pivotal role in human capital development and a successful regional logistics hub requires competent and skilled people. **P2** identified poor human capital as a problem in relation to operational costs, and emphasised that, *"Namibian long-term economic development can be significantly influenced by the endowment, skills, and competencies of human capital among those working in the productive sectors. Investing in human capital is essential for individuals, society, and economies as a whole; this is especially true in light of changing population dynamics. Since more educated people are more likely to innovate, accept new technologies, and increase productivity, human capital is crucial to economic success"*. **P9** discussed operational costs in relation to disasters: *"A good, dependable road network is essential to Namibia's growth, as we only have road transport to depend on. However, climate change or the recent rains we have received these last few years have severely damaged transport infrastructure, particularly its roads and bridges, costing taxpayers' money to repair, additionally, delaying the delivery of freight"*.

i.Transportation Costs

The cost of transportation has a significant impact on economic activity as well as international trade. Empirical evidence suggests that increasing transportation costs by 10% deters customers and stakeholders to the extent that it resulted in diminished trade volumes of more than 20%. The participants explained that experienced pressure to keep transport and logistics costs down due to increased competition.

> **P12** concurred that *"there are challenges in keeping up with globalisation and the impact of technology"* and this was echoed by **P1, 2, 3, 4, 7, 5, 6, 9** and **11**. The participants noted that transport and logistics performance is *"a significant driver of economic growth, and this industry's lack of performance could be catastrophic for the nation. The digitisation of logistics, including enhanced tracking systems, digitalised information flows, artificial intelligence, and automation, has facilitated national, regional, and international trade expansion. However, most regional member states [have] … financial constraints [that hinder investment] … in the needed ICT infrastructure to support transport systems. Thus, SADC supply chain players frequently operate with little market knowledge. Hence, decisions made are not data-driven"*. Consequently, the participants noted that, *"lack of data results in poor town planning, inefficient tracking systems and challenges with ICT"*. They also claimed that *"traffic congestion, looting, accidents, unannounced road construction, heavy truck traffic, numerous checkpoints, and poor customs efficiency increase costs. Excessive reliance on road freight transport exacerbates the problem"* and noted that *"the primary cost driver in road freight transit is fuel, influenced by the oil price."* **P1** and **2** stated that *"poor, inadequate, and inefficient transportation infrastructure, poor national, regional, and international connectivity, insufficient logistical services, looting of goods, and supply chain disruptions affect the entire region, not just Namibia. These constraints raise the price of imports and exports, restrict consumer accessibility, and access to shipping services have been linked to increased costs and impede intraregional trade. Additionally, TransNamib as the only rail operator is typically the middle link of the supply chain network"*. TransNamib should thus serve as a crucial conduit between the port of Walvis Bay and last-mile truck transportation nationally and regionally. The lack of effective and efficient rail transportation in Namibia has led to high transportation costs.
>
> **P8** and **9** highlighted that *"the most significant challenge experienced in our business is the issue of flexibility, adaptability, responsiveness, reliability, relationships, and*

alignment that can't be achieved when information flow doesn't flow across supply-chain *nodes. All players do not want to share best practices, as the fear of competition prevails"*. **P4** and **3** believed that *"supply chain interruptions limit economic activities and trade globally. The impact is more significant in the logistics and transportation industries, leading to labour shortages, high dependency on technology, and economic activity constraints"*. **P3** suggested that *"the government should invest in intermodal and multimodal transportation modes of transport; having different options to transport cargo and passenger travel can increase competitiveness and reduce transportation costs"*. **P9** highlighted *"that Namibia is sparsely populated, with a small population, long*-distance *coverage, and no facilities along the corridors. This does not sell the idea of becoming an international logistics hub well."*

ii.Truck Driver Shortage

The demographic profile of the current workforce, particularly in terms of age and gender, is one of the most significant factors driving the shortage of the truck drivers.

P5, 4, 6, and **9** concurred with **P2** who highlighted that *"the trucking sector primarily relies on the male workforce. Professionals shun the transport industry because upwardly mobile white-collar employees view corridor management as unattractive. The issue here is the industry players must stop the stereotype that truck driving jobs are for men only. The typical lifestyle of a truck driver is not appealing, and it steers people away from considering truck driving as a career path. The salary paid to truck drivers is very minimal. Hundreds of thousands of drivers are needed in the transport industry. The scarcity has worsened for decades, and COVID-19 has aggravated the situation. Long hours behind the wheel, rising shipping prices, and increasing wait times at shipment destinations make driving a truck an increasingly unappealing job. The trucking business is struggling to find new drivers and keep the ones it already has. As a result, many drivers lack experience, and inexperience is believed to be the root cause of road accidents"*. **P4** and **6** supported **P1**, who stated: *"the revolution of industry 4.0, accompanied by the COVID-19 pandemic, rocked the world, including the realm of education. ... vocational education must link learning programmes with the high demand for skills in the industry while closing the gap in educational institutions to [serve] industrial needs"*. **P10** and **11 e**xplained, "*Women in* *the transportation industry are regularly devalued, harassed, and discriminated against. Furthermore, female employees are perceived to be less experienced than their male colleagues, resulting in frequent advancement of males above them while they remain in lower-paying positions".*

iii. Complex Regulations

According to the participants, contemporary international trade is characterised by more complex interactions between individuals, businesses, and organisations.

> **P3** observed that *"nontariff barriers and trade facilitation difficulties are among the most serious trade-related obstacles, but many of the obstacles to executing Namibia's domestic trade policy framework are non-trade-related. Such issues include infrastructure shortfalls, a lack of human capital, reduced performance, skills shortages, and energy bottlenecks. For example, the lack of energy hinders the country's capacity to realise its beneficiation objectives, as outlined in its industrial and investment policies and reduces the competitiveness of Namibian businesses. Similarly, transport and port fees in Namibia are relatively high, making it challenging for the country to market Walvis Bay as an alternative to Cape Town or Durban. The poor skills base, low productivity, lack of space for local produce in big stores, and the impact of COVID-19 negatively influence Namibia's human capital productivity."* **P7** explained that "*with several countries and regions participating in the supply chain, regulations should be harmonised, especially at weighbridges and verification of documents. There's a lot of paperwork and duplication of procedures at borders. The lack of innovation or state-of-the-art infrastructure at border posts reduces organisations' efficiency. There is a lack of skills, drivers, customer services and experts in the transport and logistics industry"*. **P10** stated that *"good trade performance requires connectivity on roads, rail, and sea, and telecommunications, financial markets, information processing, responsiveness, and agility to global changes. Adaptability to climate change for organisations is fundamental. Trade has become a 24-hour business; however, most transport companies in Namibia are being constrained by global supply chain disruptions and port bottlenecks. These disruptions cause problems for exporters and importers, particularly transporters and their drivers who are subjected to regular COVID tests, as well as an additional cost to the organisation due to the fact*

that our business is standing idle or leading to empty containers on the return leg. Inadequate transportation, logistics, and trade-related infrastructure can greatly hinder a nation's global competitiveness. Thus [there is a need for increased] … investment and funding for infrastructural development". **P2** explained that *"significant compliance restrictions enforced by the government and more than six agencies to navigate at borders make the movement of products and services across national borders extremely difficult. Unmanaged, old infrastructure, cumbersome customs regulations, manual processing, dealing with far too many customs documents and communication barriers have led to congestion, procedural delays, long transit times, lack of predictability, and high transportation and logistics costs at the border posts for our business"*.

iv. Customer Service

Customer service excellence throughout the supply network can result in on-time delivery, transportation cost savings, increased customer patronage, and a sense of security. Conversely, poor customer service and communication in logistics can lead to more significant expenses and ruined client relationships.

P8 highlighted that *"if customers are unsatisfied, it will impact market share and negatively influence firm benefits to generate value for businesses. Logistics sustainability indicators are customer satisfaction, on-time delivery, cargo damages ratio, cost performance, information transparency, skills and professionalism"*. **P4** stated that, *"ports are developed through capacity building and expansion; these advancements are dependent on country funds, which are more influenced by political desires and a lack of professionalism"*. **P6** argued that *"one of the most vital aspects of this industry sector is when your company can't provide real-time satellite cargo visibility or track trucks. The time commodities remain in transit is another difficulty in the transport and logistics sector. Customers put the business under time pressure to respond whilst you don't have an answer. Thus, service quality should be improved"*. **P7** explained that *"the essential part of customer service is the ability to switch cargo modes. The ability to adapt to changing client needs is critical. The transport and logistics sector must ensure that the correct product is delivered in the right quantities, in the best quality, at the exact place, at the right times, to the correct customer, and at the right price. Failure to adhere to these* *seven Rs could be disastrous for any organisation."* **P9** noted that *"supply chains in our industry face labour shortages, more so expertise. Businesses are failing to keep up with the customer's demand, especially if organisations are infrastructurally challenged and forced to invest to ensure that the gap is not widening between what customers want and what companies can offer"*. **P11** observed that *"the monitoring and tracing of shipments are complex, restricting visibility in the supply chain network and inhibiting importers and exporters from developing intelligent, efficient, and responsive supply chains. Customers nowadays are more informed than ever before, and if we cannot keep them informed about the status of their orders, they'll quickly turn to a competitor who can"*.

4.4.4 Financial Challenges

The participants were asked to discuss the financial challenges inhibiting Namibia's vision of becoming a regional logistics hub. Figure 4.35 depicts and analyses the major financial obstacles and limits faced by the transport and logistics industries. It provides an overview of the primary financial difficulties highlighted, and used to better understand the financial environment and potential areas for improvement and intervention. Three sub-themes emerged under financial challenges: a lack of funding, fiscal issues, and political issues.

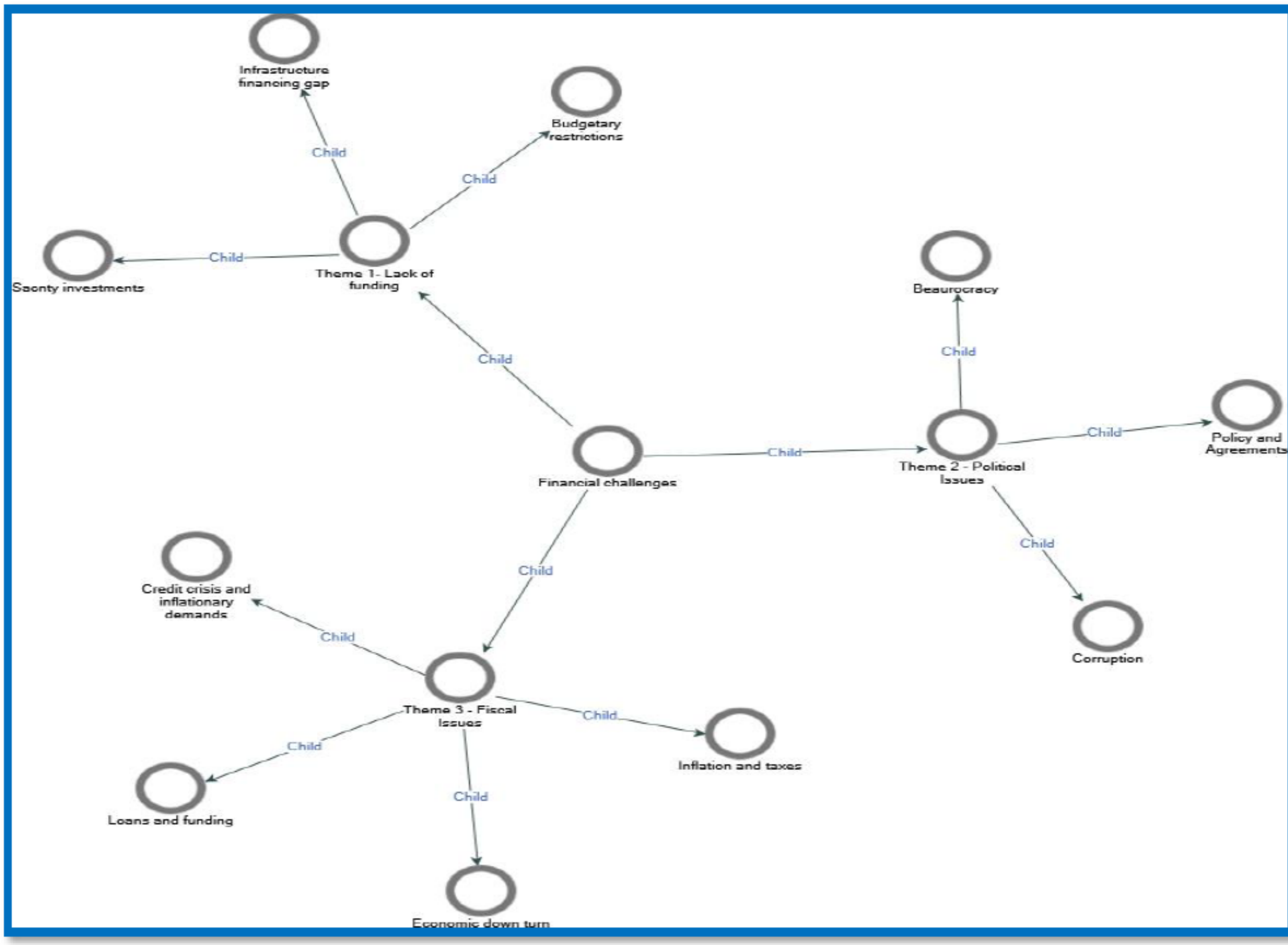


Figure 4-335: Financial Challenges

Source: Extracted by the author from the interviews

Figure 4.35 displays three sub-themes in relation to financial challenges, namely, a lack of funding, political issues and fiscal issues. The following section explores the lack of funding. The participants were asked to discuss the critical aspects of transport infrastructure for a successful regional logistics hub in Namibia, including the prevailing and projected cost composition (operating costs) of road assets, maintenance costs and service provision and the transport infrastructure cost drivers (e.g., capital, operational and maintenance costs).

Table 4-62: Financial Challenges sub-themes

Source: Extracted by the author from the interviews

Theme	Sub-themes	Emerging Themes
Financial Challenges	Lack of Funding	Infrastructure Funding Gap
		Budgetary Restrictions
		Scanty Investment
	Political Issues	Bureaucracy
		Policy and Agreements
		Corruption
	Fiscal Issues	Inflation and Taxes
		Economic Downturn
		Loans and Funding
		Credit Crisis and Inflationary Demands

4.4.4.1 Lack of funding

The first sub-theme that emerged on financial challenges was the lack of funding, which comprised of three codes, namely, the infrastructure funding gap, scanty investment and budgetary restrictions that arose from the responses of three participants. As presented in Figure 4.44 theme 3 in Appendix F 4, Participant 1 mentioned issues related to the infrastructure funding gap. Participant 2 also cited the infrastructure funding gap and scanty investment, while Participant 5 highlighted problems associated with budgetary restrictions and insufficient investment. Both Participants 1 and 2 were freight transport executives, while Participant 5 was a director of transport networks. The following section details the fiscal issues.

4.4.4.2 Fiscal issues

The second sub-theme relating to financial challenges was fiscal issues, with four codes. Figure 4.45 in Appendix F 4 illustrates the fiscal issues. The first code was the credit crisis and inflationary demands, which was mentioned by Participants 5, 7, 8, 9, 10, 12, 11, 2, and 1, who were, respectively, directors of transport networks, customs declaring agents, an operational manager, project manager, transport regulatory inspector, logistics and distribution manager, rail procurement specialist, and freight transport executives (Participants 1 and 2). The second code was inflation and taxes that was cited by Participants 1 and 2. The third code was the economic downturn, which was mentioned by Participants 10, 11, and 2. The last code associated with this theme was loans and funding issues, which were cited by Participants 1 and 2. These are unique findings. The following section describes the political issues.

4.4.4.3 Political issues

The third sub-theme that emerged from financial challenges was political issues that were associated with three codes, namely, problems related to policy and agreements, bureaucracy, and corruption.

As illustrated in Figure 4.46 in Appendix F 5, under political issues, Participants 1 and 2, who were both freight transport executives, cited policy and agreements, bureaucracy, and corruption).

Table 4-63: Fiscal Challenges sub-themes

Source: Author's extraction from the interviews

Theme	Sub-theme
Fiscal challenges	Credit Crisis and Inflationary demands
	Inflation and Taxes
	Economic downturn
	Lack of Funding
	Political Issues

The fiscal challenges produced the first sub-theme of credit crisis and inflationary demands.

> **P2** commented: *"If you follow the reports and news, it is clear that due to subpar performance in the mining and construction industries, the prolonged drought, and diminishing demand for Namibian exports, the sluggish growth in performance during the financial years 2016-2018, Namibia might just not recover from this crisis. Adding the impact of the COVID-19 epidemic, I can only anticipate the market to contract by two-digit percentage, at least 12%. The pandemic decreased tourism, retail, trade and investments, health, and education, which are fundamental"*. Economic growth and a successful regional logistics hub depend on sound fiscal decisions by the government monetary policy committee. In relation to inflationary and tax issues, **P1** commented that

"Namibia's economic growth has decreased, and we struggle with growing inflation, slowing down the country's progress in reducing poverty. As a result of high-interest rates and debt, the Namibian government is being pushed to make tough decisions to safeguard citizens' jobs, purchasing power, and development benefits from the potentially disastrous effects of economic stagnation". These challenges are not uncommon in times of global and local economic downturn. Indeed, **P3** noted that *"The worldwide recession of 2020 sparked by the COVID-19 pandemic threatens Namibia's economic pillars of trade connections, remittances, international aid, and foreign direct investment".* This puts a strain on funding. P4 concurred: *"The largest risk to Namibia's long-term growth may be insufficient infrastructure; however, this might be viewed as a big opportunity for investors to finance substantial infrastructure assets, including ports, railways, roads, and broadband ICT. The Namibian government has historically financed a sizable portion of the country's infrastructure construction on the balance sheet, and as a result, infrastructure deployment has been hampered by budgetary constraints. Additionally, it is frequently difficult for local banks to offer the length of loans required for long-term infrastructure investment. PPPs [public-private partnerships] have great potential but are also highly complicated policy tools requiring expert implementation and management if they [are to] live up to their promise".* **P11** examined the effects of political issues on macro-economic development: "*I have noted with concern that conflict and political unrest in neighbouring nations raise the risk of banking crises in a particular nation, especially nations highly dependent on countries at war (Ukraine and Russia). Political instability significantly impacts economic development, which is mostly dependent on investment and uncertainty in trade agreements."*

Generally, the participants believed that Namibia is financially and economically unstable and challenging and that its financial and economic outlook is uncertain. Financial investment is not made in implementating policies because they are overly ambitious, and there are insufficient resources to see them through. Furthermore, heavy reliance on foreign loans and funding or external financing exacercebate the challenges.

P1 and **2** highlighted that *"Namibia trades far more with the region than it does with itself. The lack of transportation infrastructure creates an economic barrier to regional* *integration and trade. The lack of rail transit in Namibia causes a slew of negative externalities. Furthermore, high transit costs caused by infrastructural challenges make the region's exports less competitive on international markets and imports more costly for consumers. Poor road and rail maintenance, and lack thereof, has resulted in most of the current infrastructure falling into disrepair, impeding economic growth and deterring new investment".* **P5** suggested that *"The government should realise that road infrastructure is crucial for the socioeconomic advancement of our nation, region, and the world as it is the predominant mode of transportation in the region. I am open to correction, but I believe that the most expensive asset in every country is its road infrastructure. Road networks connect regions' production facilities and markets for agriculture, mining, tourism, and industry. [They] promote trade by facilitating the movement of people and goods along import-export corridors connecting landlocked nations with coastal ports".* **P10** and **12** agreed that *"Namibia is faced with infrastructural obstacles to interlink regions, mostly caused by weaknesses in our transport infrastructure. It seems that to develop our ports, border crossings, and other logistical facilities, we, as private logistics and transport providers, will need significant investment. If we wait for the government, we will wait forever. The corridors developed specifically for transportation and commerce are a practical method for pooling public and private funding to improve landlocked access to global markets. However, the Trans-Kunene, for example, was a waste of money, as there's less freight moving into Angola from the port".* **P1** noted that *"due to the extensive regulatory procedures, which frequently involve customs, police, and other law enforcement agencies, truck drivers are compelled to make multiple stops. The duration of a border crossing might range from a few hours to many days; in this instance, you must know someone for things to move".* **P8** expressed the view that, *"Namibia's social and economic issues have been aggravated by the pandemic of COVID-19 , which has imposed a more severe additional burden on the strained nation's public resources".*

P4 explained: *"Implementing policies in Namibia takes on a political form when conflict levels are high, and ambiguity levels are high, with power serving as the primary factor of successful implementation. Success also depends on leadership, governance, and autonomy. Influential people are well-positioned to impose their vision. Power inequalities in our country have caused poor saving practices that have resulted in disastrous scenarios* *when oil prices are high"*. **P11** elucidated*, "I do not anticipate that we will be able to lower the public debt burden, rebuild investor confidence, and prevent overexposure to global and domestic risks if we cannot streamline our finances. The increased accidents and deaths on Namibian roads, the ridiculous prices of road charges, serious restrictions on imports, and unprofessional officials at the border posts [and] laborious processes that require skilled human intervention are just some of the key challenges that [are] leading causes [of] … the closure of businesses. These challenges would definitely have a negative impact on Namibia's GDP as well as her ability to trade"*. **P2** remarked: *"Namibia and the surrounding region are undergoing an unparalleled economic depression, which has significant adverse effects on development. Declining commodity prices, the collapse of tourism, and lower remittances – compounded by much-needed internal lockdowns and other measures to stop the pandemic's spread – have produced a severe and widespread economic downturn. Reduced fiscal flexibility, difficult financing circumstances, and mounting public debt have heightened the dangers of debt distress"*. **P6** highlighted that *"Namibia is vulnerable to various external shocks, including fluctuating raw material costs, exchange rate fluctuations and natural calamities. We have major structural flaws to blame for this, particularly a lack of export and economic structure diversity and the predominance of basic commodities. Due to their inadequate social structures and underdeveloped financial and capital markets, they lack the potential to mobilise sufficient internal resources to finance global shocks and proper means for cushioning them."*

The following section presents the infrastructural challenges.

4.4.5 Infrastructural Challenges

The last challenge that emerged in relation to preparedness for a regional logistics hub in Namibia was infrastructural challenges, which were linked to two issues, namely, modality and efficiency. The participants were asked whether the port was well connected, what the challenges were in relation to connectivity and accessibility (links, routes, density, and mobility), whether there were harmonised policies and regulations for collaborative efforts to enhance connectivity in the region and lastly, the degree of infrastructural and modal integration between road and rail in Namibia. The sub-themes included modality and efficiency issues.

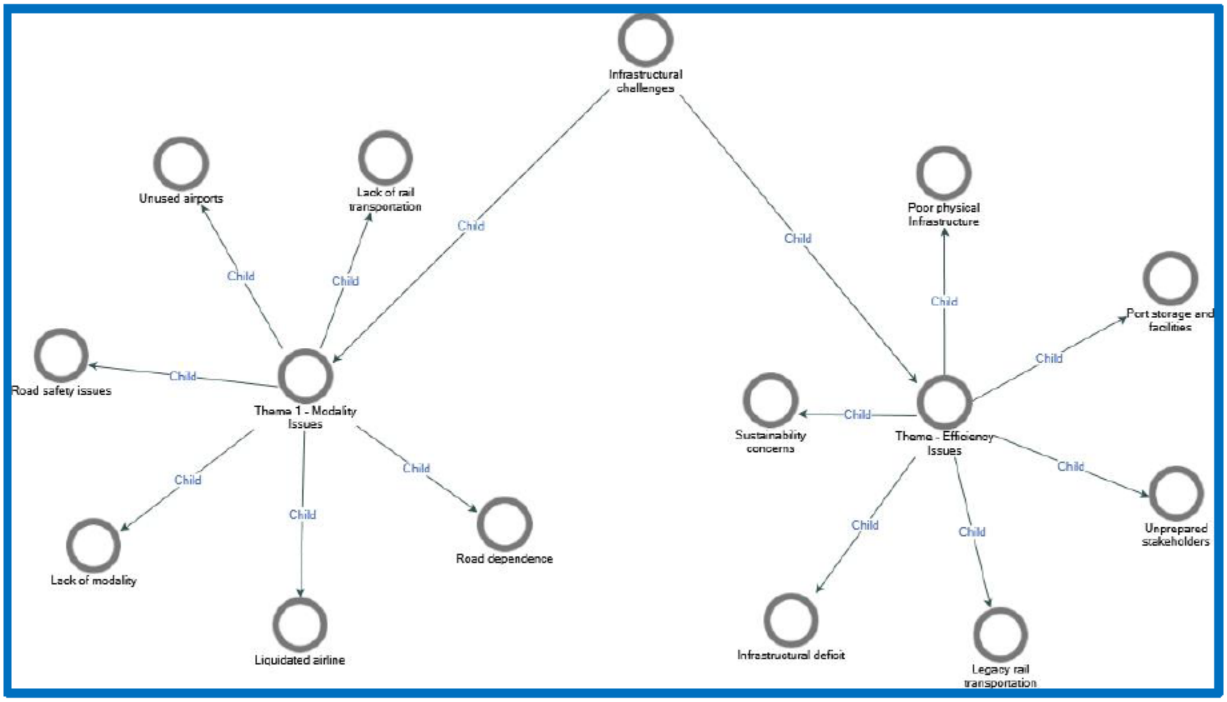


Figure 4-346: Infrastructural Challenges

Source: Extracted by the author from the interviews

4.4.5.1 Modality issues

The first sub-theme that emerged under infrastructure challenges was modality issues, which consisted of six codes drawn from seven participants' responses (Participants 10, 11, 5, 9, 6, 8, and 4). They included road dependence, a lack of modality, a liquidated airline, lack of rail transportation, road safety issues, and new airports.

As shown in Figure 4.47 in Appendix F 5, Participants 10, 11, and 8, who were a regulatory inspector, rail procurement specialist, and operational manager, all cited issues relating to heavy dependence on road transport, a lack of modality, a liquidated airline, and road safety. Similarly, Participants 5 and 9, a director of transport networks and a project manager, raised heavy dependence on road transport and a lack of modality, as well as the lack of rail transportation and road safety issues. Participant 6 (a senior technician for railway infrastructure) underscored problems related to the lack of rail transportation, while Participant 4, a supply chain expert, highlighted the lack of rail transportation, road safety, and new airports. The following section focuses on transport systems efficiency issues.

i. Road transport

Overall, all the participants highlighted that Namibia has good road/highway infrastructure linking the central nodes to the port of Walvis Bay. However, they pointed out that the country experienced challenges in maintaining and enhancing its infrastructure since its infrastructure revenue levels are inadequate to meet expansion and maintenance requirements.

> **P1** and **2** raised *"a growing regional population, lack of expertise and skills, high accident rates, restricted network coverage, funding and investments, lack of intelligent transport systems, and inadequate transportation planning"*. **P3** and **7** noted that *"additional investments are required to maintain the road's competitiveness"*. However, **P12** pointed out that *"various economic challenges, such as … COVID-19 pandemic relief, fuel charges, etc., are prioritised"*, thus reducing funding for much-needed infrastructural development projects. **P9** stated: *"The Namibian road sector is not self-sustaining, as it relies on road taxation and funding to develop the road infrastructure. The government is challenged to maintain and expand the road network, where few public income resources are allocated to several new priorities. The government also makes infrastructure upgrades that aren't economically justified as a 'public service responsibility'."* **P10** and **11** observed that, *"Although the Namibian road quality is one of the best in Africa, freight doesn't end in Namibia most of the time. We move products from one node to another or from the point of origin to the point of consumption. Our companies' greatest challenge is that Africa and the landlocked countries we service remain scattered due to poor transport infrastructure and services. … [Reducing] transport costs might boost trade by at least 20%."* **P12** added, *"There's a need to improve transport safety and accessibility to essential social and economic services, such as schools, jobs, hospitals, and the main road network to remote communities. Develop pedestrian sidewalks, cyclist lanes, heavy commercial vehicles and slow-moving truck lanes. There's a need for comprehensive public transport system linkage to different towns."*

ii. Railway

Supply chains rely heavily on railroad systems. Low-cost railway networks deliver vast quantities of freight over large distances. The participants highlighted that TransNamib management makes operational decisions and strategies for operational effectiveness, yet the failure to implement them renders the entity sluggish. Rail transportation is critical in a smart supply chain, and without it, Namibia might as well abandon its aim of becoming a regional logistics hub by 2025. Railways are often the middle link in the supply chain, connecting the port and last-mile truck service; however, Namibia's outdated railway system forces the bulk of transporters to rely on road transit. Depending on one form of transportation has resulted in significant road safety difficulties, with hundreds of people killed in traffic accidents. Furthermore, freight is frequently involved in these accidents, and consignments are plundered from trucks or at accident sites.

> **P6** noted that *"The Namibian rail infrastructure was developed for military and mining purposes in the 1890s and certain parts in the 1900s. This is vintage to me and belongs in the museum."* **P6** suggested that *"historical inadequacies extend beyond the failure to conduct maintenance on the railway lines and purchase new locomotives. Moreover, lack of expertise, skills shortage, and unsustainable HR practices render the railway operator ineffective in adapting and managing contemporary business realities. The failure to enact business strategies challenges the parastatal to adapt to changes in the current business environment."* **P3** commented: *"The Namibian rail network infrastructure is outdated and dilapidated. Thus, rail transport's safety and dependability are jeopardised, affecting the transport and logistics industry."* **P11** observed that *"Government and political realities were also indicated as contributing factors to TransNamib's present-day reality. This suggests that the government's role in a parastatal's affairs is inevitable; it must be redefined to ensure an organisation's strategic effectiveness and efficiency."* **P5** and **11** referenced *"Spoornet practices, for example, including government spending into their planning for managing future risk as an excellent practice to imitate."*

In general, all the participants revealed that they preferred road transportation due to the ripple effect of the railway's inability to deliver on time caused by old, dilapidated infrastructure.

iii. Airports

While the participants were of the view that it would be costly to revive the aviation industry, with the infrastructure for eight airports already in place, restoring it should not be too expensive. There is a dire need to address access to air transportation by building regional routes to the west, north and south, as well as into neighbouring countries, to bring Namibia up to speed with other regions.

Furthermore, acknowledging that air transport is a vital component of the logistics value chain will determine Namibia's air transportation's role in the industry.

> **P 4** asked *"How can Namibia call herself a nation if it doesn't have a flag carrier?"* **P12** highlighted that *"the current airport infrastructure is insufficient to sustain the port capacity expansion, especially in local regions"*. **P4** stated that *"the aviation industry was/is highly regulated, making this sector uncompetitive. Opening the market will increase competitiveness, affordability, and accessibility. The liquidation of Air Namibia in 2019 further presented connectivity and accessibility concerns. Air transportation is the most effective way to shorten travel time. Namibia faces a significant obstacle because accessible air services in the nation are limited and expensive, and air access into Namibia from source markets remains severely restricted. Thus, the future of transportation in Namibia remains bleak after COVID".*

iv. Sea Ports

Namibia's ports are deemed significant entry points and play a crucial part in the country's trade and logistics sector. It relies on its ports to facilitate international trade, as most of Namibia's as well as the region's exports and imports are transported by sea. The ports also play a crucial role in spatial and regional integration, both inside the nation and with the neighbouring market. Furthermore, they provide critical transit accessibility for landlocked countries.

> **P2** voiced concern over *"the Walvis Bay port expansion being the Namibian government's burden alone, although it serves the region.* Concerns were also raised about most regional ports aiming to be logistics hubs. The discussion led to the suggestion that regional member states should invest in cooperative port management. Strategic planning was also recommended for each port to best serve regional needs and avoid unnecessary competition among regional ports. **P9** expressed the view that *"the port expansion was over-ambitious. Neighbouring countries, e.g., Angola, are also developing their ports to serve landlocked countries. The port of Durban, although congested, offers lower cargo and container tariffs, making it more competitive and closely located to big traders such as China. Additionally, the African Development Bank (AfDB) loan repayment amidst Namibia's poor economic condition could worsen matters. It also doesn't make business sense to have increased the port capacity. Yet, the inland corridors or land transportation that feeds the*

port are experiencing infrastructural challenges that lead to delays, high road accidents and cost issues." **P10** highlighted that *"the port expansion resulted in a bottleneck to the rest of the transport system,"* and suggested *"expanding land-based modes for seamless transport inter-modality."* **P5** stated that *"in this ever-changing global market, logistics hubs require robust leadership and teamwork to give the port the stability it needs."* **P8** observed that *"logistical integration of port activities is a challenge, for example, the current storage facilities management experienced at the port. Management should look into expanding the port storage facilities in Arandis rather than in Walvis Bay if they would like to reduce traffic congestion."*

4.4.5.2 Efficiency issues

Another sub-theme under the infrastructure challenge was efficiency issues, which comprised six codes that emanated from seven participants (Participants 3, 2, 1, 5, 7, 8, and 6). They aligned with issues relating to sustainability concerns, infrastructural deficits, outdated rail transportation, poor physical infrastructure/corridor challenges, the shortage of port facilities, and stakeholders' under-preparedness. As displayed in Figure 4.48 in Appendix F 6 Participants 3 (a business development manager) and 2 (a freight transport executive) cited sustainability concerns and outdated railway transportation, respectively. Participant 1, also a freight transport executive, underscored the issues associated with the infrastructural deficit, outdated rail transportation, and a shortage of port facilities. Participants 5 and 7, a director of transport networks and customs declaring agent, respectively, cited challenges relating to poor physical infrastructure. Participant 8 (an operational manager) also noted challenges with regard to a shortage of port facilities. Finally, Participant 6, a senior technician for railway infrastructure, raised challenges associated with a shortage of port facilities, as well as stakeholders' under-preparedness.

i. Trans-Kunene

The Walvis Bay Corridor Group (WBCG) operates the Trans-Kunene Corridor, which connects the Port of Walvis Bay to the southern area of Angola via Tsumeb and Ondangwa to Oshikango (in Namibia) and the Santa Clara border station in Angola. The Trans-Cunene Corridor is ideally located to provide two-way traffic between Angola, Namibia, South Africa, Europe, the Americas, and the Far East.

P1 and **2** explained that this corridor conveyed the highest freight volumes relative to the other four routes. *"With the leadership change in Angola in 2018, the corridor's freight traffic declined dramatically."* They added that *"the Angolan market lapsed in 2018 due to diminishing foreign exchange reserves. Therefore, the economic conditions significantly impacted the volume of freight transported along this corridor constructed to service Angola and the northern market"*. **P6** noted that *"the rail transport construction to the border post was performed by civil servants with little knowledge of rail construction. As we speak, this railroad is an albatross."* **P7** observed that *"the border station closes at 7 p.m.; if a truck arrives after that time, it will be required to spend the night in Namibia."* In addition, participants highlighted communication difficulties between border control agents and drivers due to language barriers. **P8** highlighted *"challenges on this corridor related to animals on the road, shebeens established next to roads, people crossing the highway, unroadworthy vehicles, unlicenced drivers and uninsured vehicles, creating severe financial challenges for transporters."*

ii. Trans-Caprivi

The corridor was first known as the Zambezi Corridor, then Trans-Caprivi and now the WBNLDC.

The WBCG operates the Trans-Caprivi Corridor, the shortest route between the Namibian west coast ports of Lüderitz and Walvis Bay and the vital transport centres of Livingstone, Lusaka, and Ndola in Zambia, Lubumbashi and Zimbabwe.

P12 and **1** agreed that the Trans-Caprivi route is one of the busiest. *"Most raw resources are exported from the DRC, Zambia, and Zimbabwe to the port of Walvis Bay.* They added that the *"roads from the Democratic Republic of the Congo, Zambia, and Zimbabwe to Katima Mulilo are in poor condition. The roads are riddled with potholes, requiring drivers to go at speeds of up to 30 km/hr. The speed at which the transporters travel causes delays and have significant financial consequences. The road conditions post-Namibian borders increase fleet maintenance costs due to the poor transport infrastructure"*. **P1, 2, 7,** and **11** agreed that *"border delays and corruption raise the cost and [reduce the] profitability of freight operations for import and export players. This border's functioning hours are also limited, causing congestion. Another issue is the outdated infrastructure at weighbridges and the region's disparate fees. There is no dedicated parking place for* *trucks, reducing safety and efficiency"*. **P8** and **12** also stated that *"the distance between Katima Mulilo and Rundu is around 500km, with no resources along this route."* The participants also observed that the rail only runs until Grootfontein, reducing the ability to transfer cargo to other modes of transport. *"Furthermore, if a truck is involved in an accident, items are plundered by other drivers, and it takes roughly 5 hours to receive help if you are halfway"*.

iii. Trans-Kalahari

The WBCG also operates the Trans-Kalahari Corridor, which connects the Port of Walvis Bay to Botswana's capital, Gaborone, and South Africa's industrial hub, Gauteng. The Trans-Kalahari Corridor is ideally situated to facilitate two-way trade between South Africa, Botswana, Europe, the Americas, and the Far East.

P1 and **2** claimed that *"port holdups cause epic congestion and significant obstacles for truck drivers and transporters, causing a ripple effect in issues of visa expiration and an increase in all related expenditures"*. **P11, 1, 2** and **12** agreed: *"Border transit delays are another nightmare, with many importers for time-sensitive products incurring high costs"*. **P7** highlighted that *"SADC member states lack harmonised customs procedures involving duties, taxes, levies, fines, and weights. Transporters also face complex cargo clearance processes, which cause significant distress and delays,"* pointing to inadequate infrastructure. The participant added: *"Moreover, impediments due to the COVID protocols have resulted in potentially severe supply chain disruptions"*. **P1, 2,** and **11** concurred that *"SADC routes lack digital connectivity, and manually processing paperwork leads to errors, excessive charges, and conflicts between organisations, drivers, and officials"*. **P2** claimed that *"trucking companies face trade imbalances due to transporters failing to secure return-trip loads"*. **P6** suggested that *"the routes highly depended on the road as the rail system network only connects to Gobabis, thus offering one mode of transport to the final destination"*.

iv. Trans-Oranje

This corridor connects to the southern Namibian port of Lüderitz, and its paved road network is supplemented by rail. Its road and rail network are ideally situated to facilitate trade in both directions between Angola, Namibia, South Africa, Europe, the Americas, and the Far East.

P3 highlighted that *"the Namibian market depends on South Africa as the major import market, and the two nations are politically and economically intertwined. This corridor is Namibia's lifeline. However, this route is highly dependent on road transportation as the railway system is incompatible with the South African system.* The participant further claimed that *"labour unrest and looting are common on the South African side"*. **P1** *stated that "the Trans-Oranje corridor is one of Namibia's busiest trade and transit corridors, handling most of the nation's regional and international trade from and to South Africa".*

v. Walvis Bay "Corridor" (Walvis Bay – Karibib)

The Walvis Bay corridor is not a corridor as such, and although most goods transported to and from the port travel along Walvis Bay and Karibib, participants referred to this part of the road as the Walvis Bay corridor.

According to **P1** and **2**, *"traffic congestion is the most challenging obstacle on this route. This is because Swakopmund is a popular tourist and holiday destination for people from all over the world. Congestion from trucks delivering and transporting merchandise from and to the port adds to Namibia's major issues. There are only two routes/links into Walvis Bay, one of which is gravel and is never used due to safety and security issues, leaving the Swakopmund route, which leads to congestion"*. **P10** highlighted that *"Namibia is one of the countries in the world with a high frequency of traffic accidents, resulting in a high per capita fatality rate because commercial cars compete with private automobiles on this corridor. On the other hand, Namibia was recognised as one of the countries with the best routes in Africa, a very contradictory finding that [needs] … researchers to unpack this issue"*. **P1** stated that *"this is the only corridor where transporters can currently use train and road transportation in Namibia. However, most accidents are experienced on this route. The road is too narrow and only has dual lanes, one lane in the opposite direction. Our trucks are losing mirrors on this route regularly. When rail transportation is en route to deliver cargo, you should expect one of the following challenges: if it doesn't derail, if it arrives after the deadline for delivering a shipment, or if it just doesn't take off. The highest volumes of trucks are found on this road, following each other close to avoid security issues"*. **P4** stated that becoming an international logistics hub for the SADC region would come at a high cost to the country and its citizens, as increased logistical activities are expected to severely impact road safety. **P4** and **12** argued that *"while the corridor's transportation infrastructure has improved, it still faces issues from road accidents due to long travel distances. The corridor requires rest areas for drivers and passengers, such as hotels, restaurants, and recreation; ICT services and banking facilities; specialised services, such as medical centres."* The participants suggested safety training before driving on Namibian roads and connecting corridors to SMEs to help local economies and develop businesses. **P12** stated that *"the port volumes are rising, posing more challenges to the already constrained transport systems"*.

4.4.6 Transport System Key Performance Indicators in facilitating a regional logistics hub

A further objective of the study was to explore the KPIs that could facilitate a regional logistics hub in Namibia. This objective was achieved by gathering qualitative data from 12 interviewees and using an inductive approach to theory development. Thematic analysis was conducted using NVivo software, version 12. Five themes emerged: efficiency, cost, mobility and safety, multimodal, and society. The participants were asked to discuss the transport systems' KPIs that are crucial in facilitating a regional logistics hub.

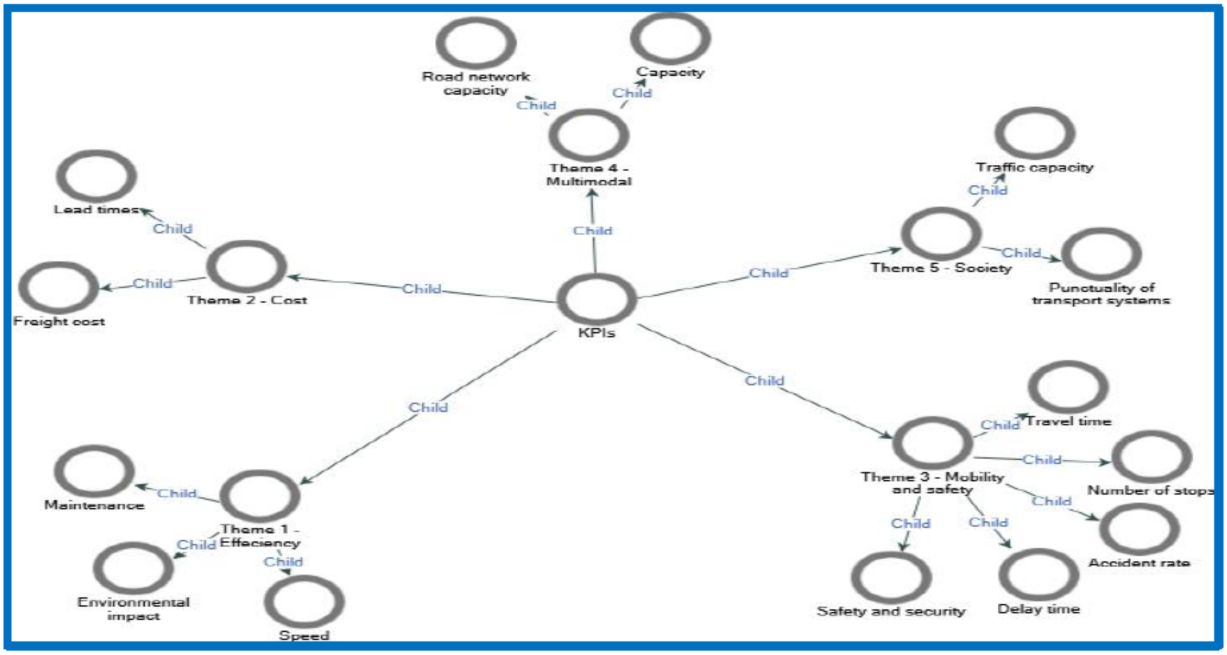


Figure 4-357: Key Performance Indicators

Source: Author's extraction from the analysis

The following section discusses efficiency in detail as a KPI measure.

4.4.6.1 Efficiency

The first theme of the KPIs was efficiency, which consisted of three codes, including speed, maintenance, and environmental impact.

As displayed in Figure 4.49 sub-theme 1 – KPI efficiency in Appendix F 6, these codes emerged from the experiences of four participants (Participants 2, 3, 4, and 12). Participants 2 and 3, a freight transport executive and business development manager, cited speed, while Participant 4 (supply chain expert) cited maintenance in addition to speed. Lastly, Participant 12, a logistics and distribution manager, cited environmental impacts.

4.4.6.2 Cost

The second theme of the KPIs was cost. As illustrated in Figure 4.50 sub-theme 2 – KPI cost analysis from extraction in Appendix F 7, the codes that emerged from this theme were freight cost and lead times, which emerged from Participant 6's responses. The following section explores mobility and safety as a KPI.

4.4.6.3 Mobility and safety

Mobility and safety was a further theme that emerged as a KPI in facilitating the regional logistics hub in Namibia. This was associated with five codes: travel time, accident rate, number of stops, delay time, and safety and security. As presented in Figure 4.51 sub-theme 3 – mobility and safety in Appendix F 7, Participant 12, a logistics and distribution manager, cited travel time, the accident rate, the number of stops, and delay time. Similarly, Participant 6, a senior technician for railway infrastructure, cited accident rates, while Participant 11 (a rail procurement specialist), Participant 10 (transport regulatory inspector), and Participant 2 (freight transport executive) all pointed to safety and security. The following section focuses on multimodal as a KPI.

4.4.6.4 Multimodal

The fourth theme was multimodal, which was associated with two codes, namely road networks and capacity. These codes arose from the responses of Participants 4, 9, 10, and 11, who were a supply chain expert, project manager, transport regulatory inspector, and rail procurement specialist. As illustrated in Figure 4.52 sub-theme 4 – multimodal analysis from extraction, Participant 4 mentioned both road networks and capacity, while the rest only cited capacity.

4.4.6.5 Society

The last theme that emerged as a KPI in facilitating a regional logistics hub in Namibia was society, which was aligned with two codes, traffic capacity and the transport system's punctuality. These codes were based on the views of Participant 12, a female logistics and distribution manager (see Figure 4.53 sub-theme 5 – society analysis in Appendix F 8). The following section delves deeper into overlooked KPIs.

4.4.7 Overlooked key performance indicators in facilitating a regional logistics hub

The study sought to determine the KPIs that were overlooked based on the experiences of the 12 interviewees. The participants were asked to discuss KPIs which were overlooked on the different modes of transport. Two codes emerged, namely, safety and capacity. The analysis in Figure 4.54 in Appendix F 9 shows that the participants, who were freight transport executives, business development managers, supply chain experts, directors of transport networks, senior technicians for railway infrastructure, customs declaring agents, operational managers, project managers, transport regulatory inspectors, a rail procurement specialist, and a logistics and distribution manager, cited safety issues. As seen in Figure 4.54, Participants 4, 11, and 12 also noted capacity as an overlooked KPI. These are unique findings of the study.

Table 4-64: Transport system KPIs' sub-themes

Source: Extracted by the author from the interviews

Theme	Sub-themes
Transport Systems KPIs	Road transport
	Railway
	Airports
	Sea Ports

i.Road Network

In general, the participants felt that the well-developed road network was contributing to socioeconomic advancement in Namibia. A well-connected road network is the most critical factor in determining the country's prosperity. The major challenge in relation to road transportation was the road network's inability to accommodate the increasing volume of traffic.

> **P12** observed that *"The quality of our road is excellent; however, with the increased number of trucks on the road, and the increased second-hand dankie Botswanas, the increase in the seven-seaters that are illegally used as public transport is a recipe for disaster. Narrow single-lane roads also impede vehicles on Namibian roads at key port areas."* **P10** concurred that *"Namibia is challenged with inadequate maintenance, rapid deterioration of the gravel road network, and the expensive cost of gravel road upgrading pose significant obstacles."* It was also noted that *"there is an enormous funding vacuum for road improvements and maintenance, which is detrimental to automobile owners and the economy".* **P5** considered *"climate change as one of the critical issues negatively affecting the serviceability of road networks, the quality of networks, congestion, road safety [and] environmental impacts, leading to increased maintenance costs and no or fewer funds for new road network projects".* **P4** and **12** noted that *"Namibia has the highest number of road fatalities globally, unprecedented urbanisation, increased imported second-hand cars, new drivers travelling long distances, [poor] driver behaviours, high*

speed, and single narrow lanes." The respondents further highlighted that the road network is the only transport mode that links Namibia with all neighbouring countries and is the preferred mode of transport.

ii.Rail Network

The participants noted that the national network consists of lightweight railway tracks, the bulk of which have reached the end of their economic lifespan, making it difficult to operate the system safely. The railroad does not comply with SADC-mandated regulations, resulting in speed limits that impede rail's capacity to move more freight more quickly.

P2 indicated that *"The persistent deficit in terms of infrastructure and equipment, human capital and financial investment requires an urgent need for targeted intervention in these areas; failure to redress these in the most immediate term may have a detrimental effect on the measures for transformational change herein envisaged over the longer-term future of the rail company - TransNamib. The rail transportation systems require a total overhaul".* **P6** revealed that *"desert dunes cover train tracks and reduce the lifespan of track materials while keeping railways operational during sandstorms is costly and extremely difficult. Corrosion severely deteriorates sleepers and rails, and unusually high temperatures in the country's interior necessitate intensive monitoring and timely action to prevent track collapse".* **P12** suggested that *"given the current state of the Namibian railway system, significant volumes of freight move on the road."* The participants added that, in order *"to compete with road transportation, railways need an effective and dependable rail infrastructure".* **P1** asserted that *"the national railway network has decayed dramatically, resulting in severe speed constraints and accident rates. The highest speed that [a] ... train can operate at is 40 km/hr, and the challenges experienced are caused by deferred maintenance and components of the rail system that is past the point at which they are still useful. Each track component has a different lifespan and degradation rate, which affects the quality and operability of the railway track."* The participants also maintained that trains' safe passage could not be assured on some sections of the railway. They highlighted that *"the rail only links South Africa via Upington to Johannesburg, south of Namibia. This sad state of affairs requires immediate intervention to enable Namibia to serve as a regional logistics hub".* **P8** was of the view that *"TransNamib needs* *a multi-pronged, multi-sectorial, and multi-dimensional approach to the transformation it desperately needs. The lack of plasticity in TransNamib is caused by distorted perceptions, dulled motivation, failed creative response, political deadlocks and action disconnects"*. **P4** highlighted that *"TransNamib is an anachronistic entity, amid a dynamic organisational and industrial environment within which it is expected to contribute towards the envisaged logistical hub for Namibia. Its strategic inertia, as symptomatically demonstrated by its many organisational challenges, and the resistance of these to change, however, render it ineffective. Transformational change at the most radical/fundamental (root) level is required to unlock this inert immunity to change"*. **P5** stated that although the rail system was also designed to be used for travel purposes, few people use the train services. *"The unreliability of train performance against schedule and the degradation of regional rail infrastructure are highly correlated issues. Degraded networks lead to variable train speeds along corridors, resulting in unreliable train arrivals (particularly late trains due to speed restrictions) at terminals (freight or regional passenger services)"*.

iii.Walvis Bay Port

Overall, the participants believed that, as a point of connection between two or more modes of transport and a means of cargo transhipment from sea to land transit and vice versa, the port system is vital to the overall traffic and cargo flows. It plays a crucial role in developing economies, as the global economy calls for increasingly efficient transfer of cargo and other resources from relatively low-efficiency regions to relatively high-efficiency destinations. The participants further highlighted that the geographical location of the port of Walvis Bay, the quality of transportation infrastructure, specific roads, expansion of free trade agreements, the quality of service, and IT are the driving factors for increased logistics activities in Namibia.

P9 stated that a series of questions of questions need to be asked with regard to the vision of becoming an international logistics hub. The first is whether this vision is not overly-ambitious: *"With the level of vessels going down due to COVID, this being the key indicator for the viability of the port, will we ever recover? With the country experiencing an economic … downturn, will we be able to repay the AfDB loan? With the development of other regional ports, will we achieve the gateway status? The Kazungula Bridge constructed between Zambia and Botswana, creating a shorter path into South Africa,* *could be catastrophic for Namibia."* According to this participant, *"the answer is NO, not now and not in the next five years"*. **P12** stated that *"cargo would leave the Walvis Bay Port via one of the transport corridors because the rail is nearing the end of its life. As a result, an increase in trade volume at the port implies a significant increase in goods transported on our national roads. The heavy reliance on road transportation services for essential mobility, particularly in rural areas, contributes to adverse development outcomes in terms of a significant burden of injuries and death, many of which affect young people of prime working age."* The participants also indicated that *"development pressures such as increased commercial traffic and a more significant number of private vehicles increase the burden of road accidents. ... as trade volume increases, it creates bottlenecks if efficient multimodal systems do not support it"*. **P1, 4, 5, 10** and **12** argued that *"It doesn't make business sense to have increased the port capacity, yet the inland corridors or land transportation that feeds the port are experiencing infrastructural challenges that lead to delays, high road accidents and cost issues. How can Namibia call herself a nation if it doesn't have a flag carrier?"*

4.4.8 Summary of findings

Table 4.64 presents a comprehensive summary of the key obstacles and barriers that impede the realisation of the envisioned regional logistics hub. It provides valuable insights into the various challenges such as inadequate infrastructure, regulatory constraints, limited technological capabilities, and logistical bottlenecks. These findings underscore the complexity of establishing a successful regional logistics hub and highlight the crucial areas that require attention and strategic interventions to overcome the identified challenges and achieve this vision.

Table 4-65: Challenges inhibiting the vision of becoming a Regional Logistics Hub

Source: Author's compilation (2022)

Operational challenges	Financial challenges	Infrastructural challenges
Theme 1: *High Costs*	**Theme 1: *Lack of funding***	**Theme 1: *Modality Issues***
High freight rates	Budgetary restrictions	Lack of modality

High fuel prices	Infrastructure financing gap	Lack of rail transportation
High operational costs	Scanty investment	Liquidated airline
High Transport costs	**Theme 2: *Fiscal Issues***	Road dependence
Theme 2: *Innovation Issues*	Credit crisis and inflationary demands	Road safety issues
New business process advances	Economic downturn	Unused airports
Technological issues	Inflation and taxes	**Theme 2: *Efficiency Issues***
Theme 3: *Management Issues*	Loans and funding	Infrastructural deficit
Capacity shortages	**Theme 3: *Political Issues***	Outdated rail transportation
Consignments track and trace	Bureaucracy	Poor physical infrastructure
High levels of competition	Corruption	Port storage and facilities
Highly demanding customers	Policy and agreements	Sustainability concerns
Poor strategies and alignment		Under-prepared stakeholders
Theme 4: *Cross-Border Challenges*		
Compliance and regulations issues		
Cross-border and customs issues		
Customs and damaged goods		
Empty containers returning		
Theme 5: *Human Capital Issues*		
Human resources		
Lack of expertise		
Racial issues		
Theme 6 – Disasters		
Climate change		
Disruptions and port congestion		
Flexibility and agility to respond to global change		

Table 4.65 presents an overview of the main primary findings on the identified KPIs and the supplementary KPIs that were neglected or underutilised in this research. It underscores the importance of considering a comprehensive range of KPIs to obtain an in-depth understanding of

performance. It also identifies the potential advantages of integrating overlooked KPIs into the evaluation of transport systems' performance.

Table 4-66: Key Performance Indicators (KPIs) and overlooked KPIs

Source: Author's compilation (2022)

Key Performance Indicators (KPIs)	Overlooked KPIs
Theme 1 - Efficiency	**Codes**
Environmental impact	Capacity
Maintenance	Safety
Speed	
Theme 2 - Cost	
Freight costs	
Lead times	
Theme 3 - Mobility and safety	
Accident rate	
Delay time	
Number of stops	
Safety and security	
Travel time	
Theme 4 - Multimodal	
Capacity	
Road network capacity	
Theme 5 - Society	
Punctuality of transport systems	
Traffic capacity	

Table 4.64 comprehensively assesses the key hindrances and barriers that obstruct the realization of the intended regional logistics hub. The table offers valuable insights into various challenges, including insufficient infrastructure, regulatory limitations, limited technological proficiencies, and logistical bottlenecks. These findings underscore the intricate nature of establishing a prosperous regional logistics hub and emphasise vital focal points that necessitate concentrated efforts and strategic measures to surmount the identified obstacles and attain the envisioned goal. In a similary, Table 4.65 furnishes an overarching depiction of the primary findings related to the designated Key Performance Indicators (KPIs), along with supplementary KPIs that were either

overlooked or underutilised within this study. The table highlights the significance of encompassing a comprehensive array of KPIs to comprehend performance thoroughly. Furthermore, it pinpoints the potential benefits of assimilating these neglected KPIs into evaluating transportation systems' effectiveness.

4.4.9 Overlap between quantitative and qualitative results

The study's qualitative findings confirm and reinforce several key findings from the quantitative research. It was established that Namibia's geographic positioning provides a favourable opportunity for it to become a regional logistics hub within SADC. However, the qualitative data also highlights fundamental challenges that must be addressed to ensure the sustainability and competitiveness of the hub. Furthermore, underperformance in relation to KPIs in the transport systems is evident, negatively impacting the overall efficiency of the transportation networks. The qualitative insights emphasise the significance of factors such as accessibility, connectivity, and centrality in improving port performance. Moreover, critical operational and financial challenges hinder the realisation of the vision to become an international logistics hub. Integrating the quantitative and qualitative findings facilitated comprehensive understanding of the issues, enabling the formulation of effective strategies and solutions to address the identified challenges and optimise Namibia's potential as a regional logistics hub.

4.5 Chapter Summary

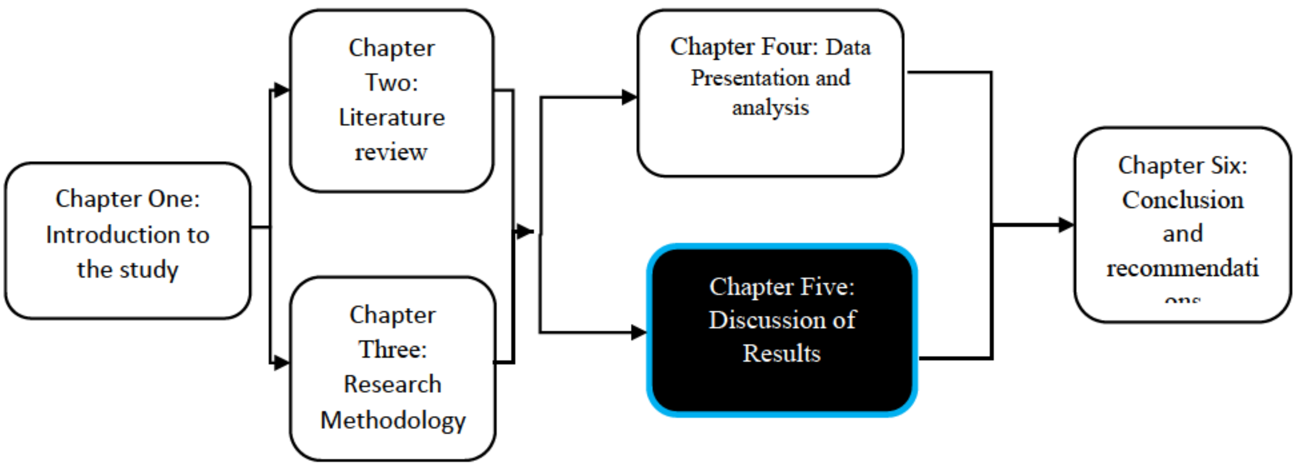
This chapter presented and analysed the data obtained from the document review, the questionnaire administered using SurveyMonkey (containing both open-ended and closed-ended questions) and the interviews that were analysed using thematic analysis and NVivo computations. It covered the response rate analysis, socio-demographic analysis, and exploratory factor analysis applied to investigate the fundamental issues underlying the challenges experienced in the road, ports and rail transport systems. Explorative analysis was used to identify the variables that were challenging and correlated with one another. The correlated variables made up a cluster with five sets that represented the five underlying challenges when grouped. Descriptive statistics, reliability statistics, and construct validity using the KMO from data was used to run factor analysis and test hypotheses in the quantitative analysis phase (SPSS, MS Excel, and Minitab). In the qualitative phase, NVivo was used to generate the emerging themes presented in Tables 4.64 and 4.65 and word cloud analysis. The chapter tested the proposed hypotheses, among other statistics. It ended with a qualitative presentation of challenges on the themes of transport infrastructure, transport systems challenges, complex regulations and operational challenges based on the responses to the open-ended qualitative questions and a brief discussion on the overlap between the qualitative and quantitative results. The following chapter discusses the research findings. The objective was to develop a TDM framework from the data collected. The chapter proposes an empirical framework for the Namibian transport network. The variables included were tested and confirmed as positively influencing the development of a regional logistics hub. A software application was developed based on the empirical evidence on the variables collected to demonstrate the aspects that should ideally be covered to enhance the development of a regional logistics hub.

CHAPTER FIVE:

DISCUSSION OF RESULTS

"Victory is the beautiful, bright-coloured flower. Transport is the stem without which it could never have blossomed." ~ Winston Churchill

5.1 Introduction



This chapter interprets and discusses the study's results. The research aimed to examine the extent of transport systems' preparedness towards the attainment of a logistics hub in Namibia that will enable it to become a trade gateway for the Southern African region. Achieving this vision calls for a seamless transportation system, notably rail transportation that is capable of carrying heavy loads destined for final consumers. Namibia's geographical placement in the Southern African region places it in a favourable position to serve the region's landlocked countries, the African continent, and the world.

The discussion is categorised into four sections based on the study's objectives and broken down into documentary analysis (content, frequency and time-series), the quantitative results (frequency distribution, descriptive statistics, inferential statistics, and factor analysis) and the qualitative analysis (thematic analysis) to measure the extent to which identified challenges inhibit a regional logistics hub in Namibia.

5.2 Restating the research problem and objectives

This study captured insights into the transport systems' preparedness towards a regional logistics hub in Namibia. The research problem hinged on the observation that there is a mismatch between port infrastructure expansion and increased traffic on the one hand, and under-investment in core infrastructure, resulting in an old and dilapidated rail network and deferred road maintenance plan on the other hand. The transportation industry is also highly reliant on imported electricity and suffers from inadequate ICT infrastructure (Zietsman et al., 2014). Furthermore, Namibia's low population density (World Bank, 2019) presents challenges in achieving transport economies of scale. Based on this research problem, the study examined Namibia's transport systems' preparedness in support of a regional logistics hub. The findings of this study and the discussion hereunder are based on the following objectives:

i. To analyse the extent of connectivity, accessibility, and centrality of transport networks in facilitating a regional logistics hub;
ii. To evaluate the Key Performance Indicators (KPIs) of the transport system in facilitating a regional logistics hub in Namibia;
iii. To identify the challenges inhibiting the logistics hub; and
iv. To develop a TDM framework for a regional logistics hub.

A fundamental finding that emerged was that the lack of infrastructural investment, the failure to sustain the institutional framework, and strategic inertia experienced in the rail sector is felt at all levels and sectors. It is also deepening, entrenching itself and intensifying the anachronistic system TransNamib has become. In the absence of urgent fundamental redress, TransNamib risks not only deepening its operational ineffectiveness and inefficiency, but also the possibility of eroding Namibia's Vision 2030 goal of becoming the logistical hub and gateway of the SADC region. Furthermore, the country's reliance on road transport as the primary mode of transportation leads to fragmentation due to a lack of transportation infrastructure and inefficient transportation services.

5.3 Objective One: To analyse the extent of connectivity, accessibility, and centrality of transport networks in facilitating a regional logistics hub in Namibia

Somuyiwa (2022) posits that any transportation mode promotes spatial interaction, generates locational changes, and integrates multiple regional locations. The relationship between economic development and transportation is theoretical, particularly when examined through the lens of classical and neo-classical conceptions. In other words, transportation is the path, if not the hallmark, of economic progress in ensuring that these functions are met. The author adds that supply chain management is comparable to a well-rounded and skilled relay squad. When each player understands how to position him/herself for a hand-off, the team will be more competitive. The connections between players who immediately pass the baton are the strongest, but the entire team must work together to win the race. Namibia's transportation system includes a well-developed road network of 49 000 km, a 2 678 km rail network, two ports, two international and eight domestic airports, and four transport corridors connecting it to neighbouring countries. The following sections analyse the extent of connectivity, centrality and accessibility of this extensive road network.

5.3.1 Connectivity

A key finding that emanated from this study is that the road network in Namibia shows a high level of network connectivity based on the Beta and Gamma indices. The Beta value of 1.11 on road and 0.79 on rail supports how well the road network is connected. The Gamma index was computed to verify the effectiveness of transportation links, and similar results to the Beta index were obtained; the Gamma index for road was γ=0.39, and for rail, γ= 0.28, meaning a high level of road connectivity and lower for rail. The low level of rail connectivity is due to a number of pending rail projects which would make significant capacity available in the future and improve rail network connectivity. Despite this relatively high level of connectivity, especially for roads, the transport system remains deficient in terms of the number of maximum circuits that could be connected. This can be rationalised by the road network assuming a tree structure where it radiates from the port of Walvis Bay to various destinations (through the corridors) without branch connections. For example, the Gobabis-Otjinene-Okondjatu-Okamatapati-Grootfontein route seeks to connect the eastern parts of the country to the north road. However, there is a gravel road that is generally not favoured by motorists, and it becomes a weak link that dampens the potential circuit. The Alpha index result for rail was negative, meaning that rail connectivity based on this index was too low to be computed by the index.

Two implications can be deduced from these findings. First, the road network connectivity Alpha index is 0.09, which is high; however, there is low south-north nodal connectivity, especially nodes that are non-linearly connected. This negatively affects inter-regional trade between the northern and southern parts of Namibia. It is due to low spatial interactions among the nodes (towns) except for those that are linearly connected. Inter-zonal (town to town) trade might be negatively affected as there is no direct link, especially in the northern and southern zones. Kumar et al. (2016) demonstrated that the link/node with the lowest connectivity causes longer travel time because drivers will have to take longer routes to reach a particular node; this contributes to increased logistical costs.

For rail connectivity, the results showed a negative result based on the Alpha index, meaning that the rail network density and connectivity in Namibia is too low to be computed by this measure. The implication is that more road-based freight traffic can be anticipated in the future. There is an inverse relationship between road and rail transport infrastructure. This finding is supported by the intercorrelation statistics that show that logistics and transport systems are intercorrelated at a very significant factor loading of above 0.5. High rail network connectivity coupled with good operational performance is likely to lead to low levels of road-based freight traffic; this would indirectly reduce negative environmental externalities, such as traffic accidents and air and noise pollution generated by heavy trucks. Gnap et al.'s (2021) research on the correlation between the length of railway infrastructure and the performance of rail freight transport supported the need for a balanced modal split between road and rail transport infrastructure. The authors noted that the European Union supports investment in rail transport infrastructure in order to alter the modal split between road freight and rail freight. They found a statistically strong relationship between investment in infrastructure and the services achieved within rail transport in the case of Denmark, Norway, the United Kingdom, Luxembourg, France, and Japan. In the case of Denmark and Norway, strong-to-medium direct dependence between the variables was observed, which means that investment in infrastructure affects the performance of rail transport in these countries.

5.3.2 Accessibility

The results from Chapter four on the accessibility of the Port of Walvis Bay showed that it is generally accessible via all the corridors based on the indicators of distance, average travel time (ATT) and average speed per corridor. The minimum average speed for freight traffic was 65km/hr (Trans-Kunene Corridor) and the maximum was 73km/hr (Trans-Caprivi Corridor). The average speed of 70km/hr across all the corridors means a reasonable free-flow condition based on the LOS (Table 4.28). Reasonably free-flow traffic conditions translate to higher accessibility. A standard deviation value of ≈ 3.025 on differences in accessibility to Walvis Bay via the transport corridors further confirmed that the corridors did not show a significant difference in travel time, and they all showed a higher level of accessibility to the port of Walvis Bay.

Only 53 (13.1%) of the respondents were of the view that accessing the terminal was not difficult, with 24.2% saying that it was slightly difficult; 29.6% that it was moderately difficult; and 17.2% said that it was extremely difficult to access the terminal. Despite a generally high level of accessibility, low speeds are experienced from Walvis Bay to Karasburg due to unfavourable weather conditions.

Port access channels and landside access have been singled out as some of the determinants of port performance (Kong, 2014). Other factors include labour relations, the number and type of cargo handling equipment, the quality of backhaul area, port access channel, land-side access and customs efficiency. The statistical data on the volumes of cargo supported the alternative hypothesis (H_3) given that there was at least one year (2019) with a different mean cargo than the others. Between 2015 and 2019, road saw an increase in cargo. An increase in freight volumes can be interpreted as an increase in the flow of goods and services to customers in lieu of monetary payment. Inadequate transportation infrastructure or congestion results in increased travel times and costs. Transport systems that are well-established and efficient provide high levels of accessibility, whilst those that are less developed provide lower levels (Cruz & Sarmento, 2020). As a result, while accessibility is associated with a variety of economic and social benefits, congestion can have a detrimental influence on mobility (Litman, 2017). This indirectly lowers a region's productivity because transportation expenses are directly proportional to selling prices. Therefore, infrastructure improvements are crucial to enhance the SADC region's competitiveness.

The difficulty with such investment is that it is time-consuming and expensive (Jubiz-Diaz, Saltarin-Molino, Arellana, Paternina-Arboleda, & Yie-Pinedo, 2021). Therefore, it is imperative for the Namibian government to prioritise this type of investment.

5.3.3 Centrality

5.3.3.1 Rail

The centrality variable was used to measure the degree to which the towns and cities (nodes) were central in terms of being served by both road and rail networks. The results for centrality are shown in Figure 5.1.

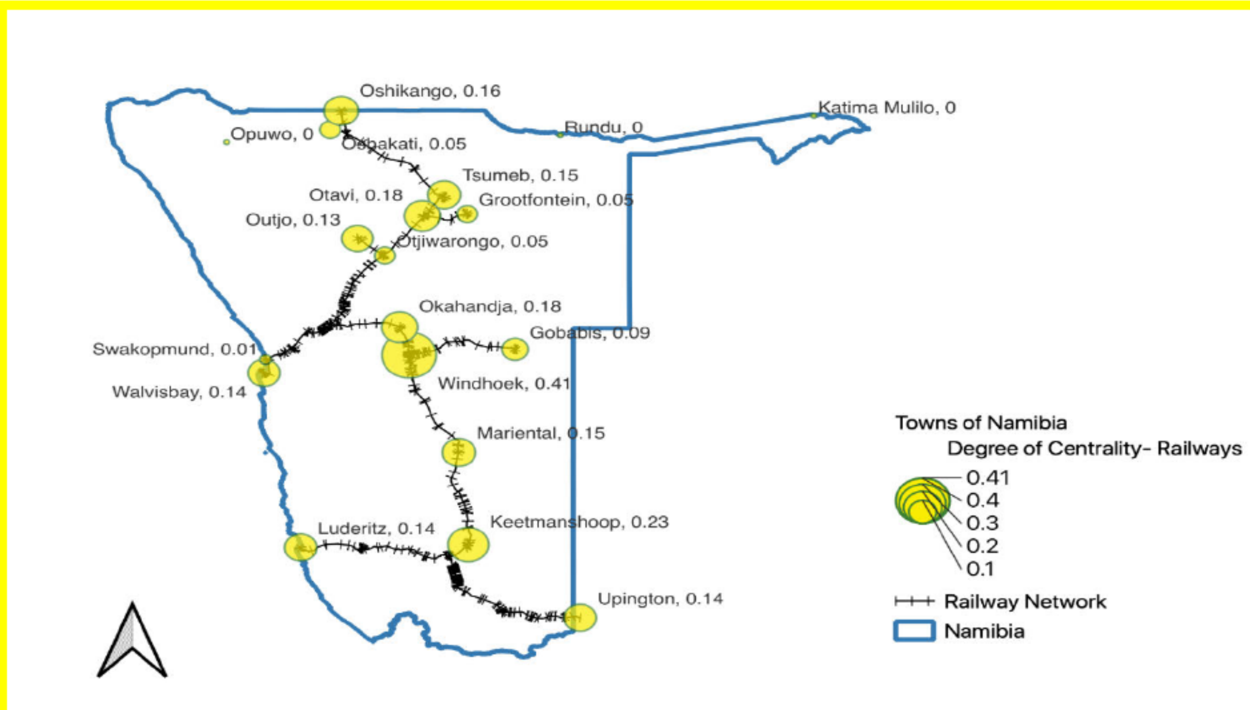


Figure 5-1: The extent of Rail Centrality in Namibia

Source: Study, 2022

Figure 5.1 depicts the degree of centrality of railways in Namibia. Windhoek has the highest degree of centrality, with a rating of 0.41 degrees, while Otjiwarongo, Grootfontein and Oshakati have the lowest degree of centrality. The map also shows that there is no rail system from Otjiwarongo; thus, a company transporting consignments destined for the south must first travel to the east coast before there is a link to Windhoek in Karibib. Furthermore, Figure 5.1 shows high rail centrality to three towns. Mountains and rivers in Namibia prevent the construction of rails to connect countries.

The West Coast of Namibia has a severely corrosive environment and desert sandstorms, while the interior is very dry and hot. A railroad network in such a setting confronts unique difficulties. It is costly and difficult to keep railway lines operating during sandstorms, and desert sand dunes block train tracks and reduce the lifespan of track material. Extremely high inland temperatures and corrosion rapidly weakening sleepers and rails, necessitating constant, meticulous track monitoring and prompt repairs to prevent buckling. More than half the country's rail system comprises lightweight railway tracks, most of which have reached the end of their economic lifespan, making it difficult to keep the system in a safe operating state. These findings were supported by the statistics run on ANOVA for annual rail cargo received between 2015 and 2019 that indicated that the railways experienced a significant increase in cargo in one of the years; thus, the alternative hypothesis (H_2) was accepted.

This study's findings imply that a substantial backlog in the repair, restoration and development of rail infrastructure is becoming increasingly apparent as TransNamib faces regular operational issues and risks. One of the operational challenges is that the current railroad infrastructure does not meet the SADC standard of 18.5 tonnes per axle. The current axle load on the main lines is 16.5 tonnes. The Namibian rail system only links with the South African railway at the Ariamsvlei border post. As a result, road transportation remains a viable alternative for the movement of passengers and freight.

This highlights the need for Namibia's railway infrastructure to be expanded and further developed. The railway network only connects Namibia to one of its neighbours, South Africa. Freight between Namibia and South Africa is transhipped at the Ariamsvlei border, as per the bilateral agreement between the two countries. The transhipment of consignments from Namibian locomotives to South African ones causes delays and depends on the type of product moved. The new railway line extension from Tsumeb to Oshikango in northern Namibia is not linked to the Angolan railway network. However, it should be noted that this segment of the railway network is underutilised due to low demand from the Angolan market. Poor railway management has also resulted in high levels of inefficiency and poor train infrastructure over the decades. Many consumers prefer road trucks as a more effective and dependable means of transportation. Low revenue due to capacity restrictions, a tight and inefficient tariff structure, excess staffing levels, and poor asset utilisation were linked to the losses, which mainly reflected poor management and the impact of government control on business decisions and pricing.

5.3.3.2 Road

Figure 5.2 illustrates the degree of centrality of roads in Namibia. Windhoek and Otavi have the highest degree of centrality, with a rating of 0.64 degrees, while Opuwo, Swakopmund and Upington have the lowest degree of centrality.

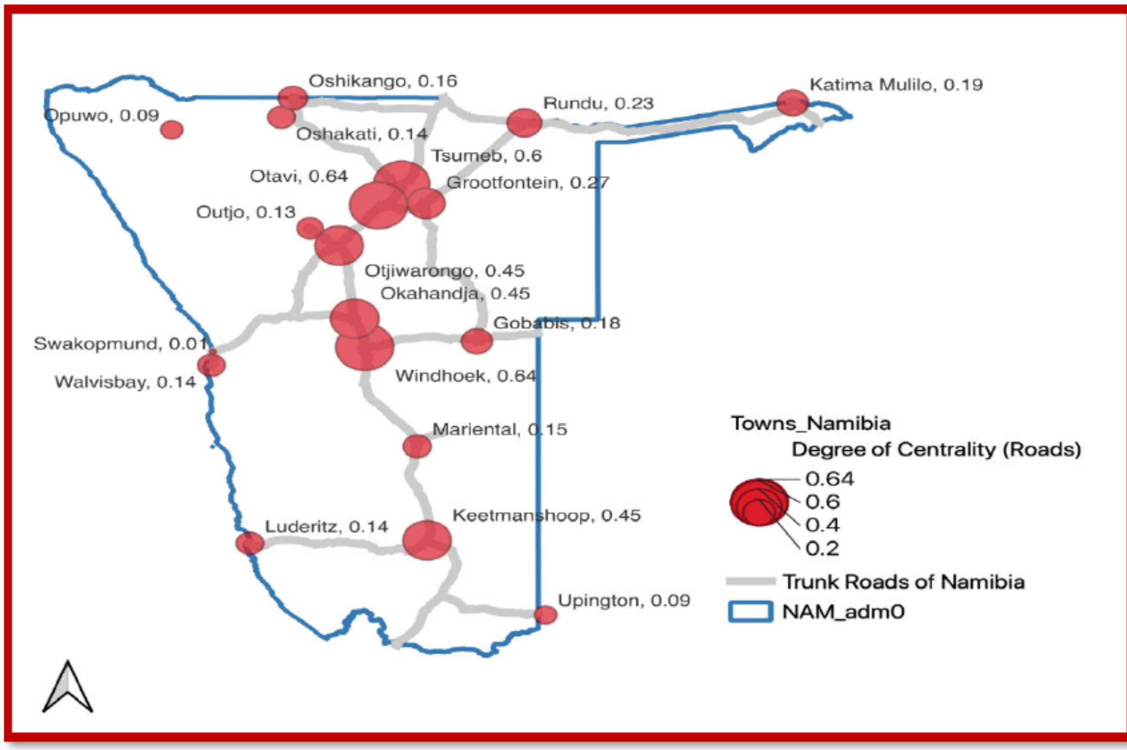


Figure 5-2: The extent of nodal centrality in Namibia (road)

Source: Study, 2022

Figure 5.2 shows that Namibian towns and cities have a higher degree of centrality in terms of the road network. This implies that the government needs to prioritise rail infrastructure investment since towns and cities are highly central to the road network.

This key finding is supported by the maps in Figures 5.1, 5.2 and 5.5 on the issues of centrality, accessibility and connectivity, and the summarised findings from the data gathered from the interviews. Figures 5.1 and 5.2 show that the Walvis Bay port can only be reached via road from Karibib, a gravel road from Henties Bay, and another gravel route behind the dunes. Carriers rarely utilise the gravel road behind the dunes because it is in an isolated location with no activities (Roads Authority, 2020). The gravel road from Henties only extends to the north-western section of Namibia, where there are almost no commercial operations. Most transport and logistics firms convey cargo via a single road node through (Karibib). Rail also connects all Karibib areas to the port. Figure 5.5 shows the 190km road between Karibib and Walvis Bay, which is narrow and unforgiving. On this stretch, trucks follow each other in close proximity. When overtaking on the narrow lanes, drivers have to overtake five or more trucks at once and hope there is no oncoming car. On asking why the truckers travel in such close proximity, the researcher was informed that it is the only way they can protect their cargo and themselves from being hijacked and attacked.

5.4 Objective Two: To evaluate the Key Performance Indicators of the transport system in facilitating a regional logistics hub in Namibia

The transport systems' performance was measured in relation to the following seven indicators/areas:

i. Road quality
ii. Rail performance
iii. Port infrastructure quality
iv. Average vehicle speed
v. Traffic congestion
vi. Transit time
vii. Cargo security

5.4.1 Road quality

Based on a qualitative assessment of the quality of the road transport infrastructure, the majority of interviewees (77%) considered road traffic signs as well-designed, ranging between mild (30%), good (22%) and very good 25%. Good traffic signs are among the most dependable devices for directing both vehicle and pedestrian traffic. The majority of the participants (86%) considered road quality as satisfactory, ranging between mild (17%), good (30%) and very good (39%). A significant number of participants (65%) rated road coverage as satisfactory, ranging between mild (17%), good (23%) and very good (25%). The document analysis supported this finding based on the road quality indicator published annually by the World Economic Forum, which confirmed that Namibia had a high road quality index of 5.3 as at 2019 on a scale of 1 (low quality) to 7 (high quality). Figure 4.15 outlined the country's road quality from 2012 to 2019. The implication of this finding is that Namibia is well-prepared to achieve the vision of becoming a logistics hub from a road infrastructural asset point of view. Current road maintenance plans and programmes should continue to be appraised to maintain this standard.

5.4.2 Rail performance

The participants were asked to rate rail's performance based on their user experience in relation to the following: load capacity, affordability, congestion, cargo security, cargo transfer, cargo tracking and tracing, and reliability. The key finding was that rail offers very high cargo-carrying capacity at a lower cost per tonne per kilometre (affordability) than road-based freight services. However, this was achieved at the expense of increased delays due to slower speeds. This has negative implications for delivery of consignments, with 47% of the participants confirming that rail deliveries experience significant delays. This means that rail becomes an unreliable transport option.

Furthermore, the majority of the participants (63%) considered rail cargo security as inadequate, ranging from poor (24%) to very poor (39%), and more than half (52%) considered transfer cargo/multimodal as inefficient, ranging from poor (27%) to very poor (25%). Another issue observed with regard to rail transport was poor cargo tracking and tracing. The majority of the participants (55%) considered tracking and tracing as unreliable, ranging between poor (25%) and very poor (30%). This means that customers are not able to track and trace their goods in order to estimate the time of arrival. It raises the serious conundrum of the dearth of innovation and technological investment given the diffusion of 4th industrial revolution concepts.

It is assumed that modern technologies can achieve efficient and effective intelligent logistics performance. By the same token, intelligent logistics can facilitate the security and safety of cargo in transit and the process on inbound and outbound operations. The implication of this study's finding on rail performance is that the utility of rail services is sub-optimal due to its low levels of service quality. Despite being a low-cost carrier per km per tonne of consignments, it remains the least favourable due to other parameters such as delays, poor cargo safety and security and poor cargo transfer facilities either from road to rail or vice versa.

5.4.3 Port infrastructure and service quality

The participants were asked to rate the quality of the infrastructure at the port of Walvis Bay based on *inter alia*: port capacity, materials handling infrastructure, safety and security, skills and expertise, administration, inspections prior to customs, cargo tracking and tracing, etc. The key finding was that the port was rated favourably in the areas of port capacity, cargo handling and safety and security. However, it was rated low in relation to port administration, 21st century skills, cargo inspections and technology to improve administrative efficiency. Corridors are entangled and crippled by delays caused by administrative inefficiency. Emerging technologies like the IoT, blockchain, biometrics, data analytics, and machine learning have created new threats and opportunities, necessitating a swift and inventive response from industry experts.

As shown in Figure 4.15, over the years, the port of Walvis Bay has maintained a relatively high ranking (5.20 to 5.30) on a scale of 1 (low) to 7 (high) of its infrastructure quality. A major drop in the quality of port infrastructure was observed in 2018/19, presumably due to COVID-19's impact on port operations. These findings were confirmed by the themes that emerged from the qualitative data on the challenges impeding Namibia's aim of becoming a regional logistics hub. The implication is that port staff's lack of skills and the shortage of expertise lead to inefficiencies. Reskilling the existing workforce and inculcating the new skills required in the 21st century should thus be a key element in improving preparedness for a regional logistics hub. Furthermore, challenges related to port administrative services could impact port administrative management worldwide.

5.4.4 Average vehicle speeds and safety

The sound road network has resulted in a trade-off of speeds higher than the stipulated 100km/hr for small vehicles. The study's findings revealed that, the highest speed reported for road-based traffic was 107.5km/hr, while the lowest was 99.9 km/hr. The speed limit for trucks and heavy-duty vehicles was 80-100 km/hr. However, the study found that truckers were travelling over the speed limit. This is not surprising given Namibia's annual accident death rate of 30.4 per 100 000 people (Jones, Odero, & Adanu, 2020). The country is one of the most dangerous in sub-Saharan Africa, with an average fatality rate of 26.6 per 100 000 people; by comparison, the USA has roughly 12, and Norway has less than three annual road deaths per 100 000 people (WHO, 2013). However, excessive speeding is not the leading cause of accidents when it comes to Heavy Goods Vehicles (HGVs); rather, it is driver fatigue due to the long distances travelled by trucks to and from Walvis Bay to various regional destinations. The minimum distance that truck drivers traverse along the transport corridors within Namibia is 745km (Trans-Kalahari corridor) from Walvis Bay to Buitepos Border Post with Botswana and the maximum is 1 356km (Trans-Caprivi corridor) to the Sesheke Border post with Zambia. Chatukuta (2020) found that trucks were rated third in terms of accidents, mortality rates and injury rates per 100 reported accidents (see Table 4.4). Speeding and driver fatigue, coupled with narrow road widths along certain sections of the highway between Walvis Bay and Usakos, contribute to road traffic accidents. The narrow road widths are illustrated in Figure 5.3.

Figure 5-3: Narrow Road widths due to the lack of road shoulders

Source: Author (2022)

In terms of rail, in general, the freight train services offered by TransNamib were found to operate at slow speeds averaging 40km/hr. The implication of this finding is more related to delays in cargo or consignment delivery as opposed to safety concerns. Participant 6 mentioned that *"the poor maintenance of the country's railway lines contributes to about 60% of train accidents, while 20% is attributed to the public not complying with regulations, and the rest is due to internal matters"*. This suggests that train speed has no effect on rail accidents in Namibia. However, the Namibian rail system is a less favourable business partner in the freight and logistics industry. This infers that the road mode is preferred over rail transportation. The increase in road traffic accidents could be attributed to rail transport's failure to offer a viable alternative.

5.4.5 Traffic congestion

In terms of traffic congestion along the five corridors, the study revealed that roads along all the corridors were experiencing a reasonable free-flow condition (averaging 70km/hr). Based on the LOS traffic flow measures, 70km/hr represents a LOS of C. This is a result of the declining vehicle population in Namibia shown in Figure 4.18. Figure 4.17 shows the annual growth in vehicles in the country from 2013 to 2018 (Tjikotoke, 2022). The average annual growth for those years was 5%, with the highest annual growth of 9% in 2014-2015, 2015-2016 (8.2%) and 2013-214 (7.1%). The data on the spatial distribution of the vehicle population in Namibia supported the conclusion of relatively free flow traffic conditions along the transport corridors. Forty-four per cent of the vehicles were in Windhoek, and 56% of the traffic was distributed across the country's 48 899 89 km of main roads, district roads and trunk roads (see Figure 4.18) (Tjikotoke, 2022). This indicates that Namibia has low vehicle density per kilometre, facilitating the free flow of traffic and leading to minimal site-specific congestion.

5.4.6 Transit time

Another important indicator investigated in this study on Namibia's transport system was performance in relation to the transit time for commercial traffic to and from Walvis Bay's port. Transit time data was gathered from interviews with truck drivers, and data on comparative transit time between Walvis Bay port and other ports in the region were gathered through a review of secondary data. Many participants (59%) were of the view that transit time was challenging. They identified the primary factors impacting trip times as distance, the availability of various resources, and mode of transportation. According to Praveen and Arasan (2013, p. 302), one of the main challenges faced by the Southern African transportation sector is drivers having to drive long distances. This has resulted in many experienced drivers having to retire early due to the strain on their bodies. This research study also found that long-distance travel was one of the challenges impacting operations. When the challenges were ranked against one another, it was ranked sixth, after availability of railway services, old transport infrastructure, cross boarder delays, transport costs, and the option to change a consignment from one mode to another. This indicated that companies confronted more severe challenges than long-distance travel. A key informant reported that although long-distance travel was reported to be a draining experience for drivers, many unemployed drivers were available. Although inexperienced, they were more than willing to drive these long journeys (The Namibian, 2022).

The trucking industry has emerged as one of the most severe bottlenecks in a supply chain that nearly disintegrated due to the COVID-19 pandemic, aggravating supply shortages across industries, stoking inflation, and endangering economic recovery. In recent news coverage, oblique reference was made to a critical shortage of drivers, particularly truck drivers (Duggan & McMurtrey, 2021). The USA has begun hiring South African drivers. Foreign drivers are also a major contributor to the challenges experienced in some African countries, with many South Africans believing that trucking firms hire too many foreigners, often without the required documentation. The disadvantage of young, inexperienced drivers is that they lack the knowledge that more experienced drivers accumulated over time of unsafe areas and routes that are not documented. Another key informant pointed to the need to capture such places and routes to enable drivers to avoid crises or hazards. In summary, although the literature identified long distance travel as one of the primary challenges, it was moderated by the influx of young drivers; however, this led to the challenge of inexperienced drivers who are unable to detect danger as well and as early as more experienced ones.

Long distance transportation negatively impacts supply chain management by increasing lead times and decreasing productivity. Long distance and regional freight transportation weakens resilience and sustainability, posing a challenge with regard to transparency and system users and stakeholders' costs. However, innovations such as self-driving trucks, once the stuff of science fiction, are becoming part of everyday life and significant to the transport industry. The trucking sector has embraced cloud platform technology such as Infrastructure as a Service' (IaaS), 'Platform as a Service' (PaaS), and 'Software as a Service' (SaaS) due to their economic and operational benefits (Ali, Jaber, Abd, Alkhayyat, & Albaghdadi, 2022). IaaS can mimic most hardware functionalities, reducing the need for on-site computer updates. These technologies enable trucks and vehicles to interact over the cloud to avoid accidents and access the latest traffic statistics and maps, allowing truckers to identify congested regions and find the fastest route to their destination (Zolkin, Domracheva, Losev, & Avdeev, 2021). PaaS enables trucking companies to use high-level cloud databases without worrying about truck/warehouse capacity (Axbrink, 2022). Finally, cloud platform technology contributes to the reliability and security of electronic logging device (ELD) systems to keep track of each driver's Hours of Service (HoS). This method, known as a telematics transfer, allows supervisors and drivers to communicate and exchange data in real time, even while en route. It is an efficient approach for organisations to streamline their logistics. ELD systems like self-driving technologies greatly improve the efficiency of the transportation business. Table 4.5 shows that Walvis Bay Port has a time advantage regarding exports to Asia and North America. The port also seems to have a cost advantage. However, it should be noted that this preliminary calculation only applies to “one way” traffic. It is quite easy to get return cargo at Durban, unlike at Walvis Bay; therefore, the total trucking cost is much lower for the Durban route. This makes the Durban route the most preferred. Empty haulage is thus a critical factor that Namibia needs to address to reduce land transport costs in preparation for the logistics hub.

5.4.7 Port and Cargo Security

According to information obtained from Namport officials, cases of illegal goods smuggling, and theft have been reported at the port of Walvis Bay. The interviewees also confirmed that rail cargo security is poor.

Namibia has been severely affected as a source and transit for trafficking in wildlife and forest products. Monthly exports of raw timber (logs) from Walvis Bay's port to China averaged between 250 and 300 containers in 2017 (Ceesay et al., 2018). Almost all of these logs originated in southeast Angola, south-eastern Zambia, and the eastern DRC, all of which have strict regulations prohibiting the export of raw logs. Illegal trade in pangolins, one of the world’s most trafficked animals, has been identified in Namibia. Furthermore, Rodrigue and Slack (2020) point to road safety and security issues including worker safety, burning of freight trucks on national roads, theft, hijacking, and robbery.

Since the commencement of the Container Control Programme at the port of Walvis Bay in 2021, there has been a considerable drop in the number of such incidents. The programme is believed to have enhanced the port's capacity to intercept illegally imported goods, such as wildlife and forest products. According to the UN (2021), up to 90% of global cargo movement occurs in shipping containers, but less than 2% is physically inspected by customs authorities to verify the contents. Partly for this reason, containers are used on a large scale for illegal activities.

5.5 Objective Three: To identify the challenges inhibiting the attainment of a regional logistics hub

The study’s key findings on the challenges inhibiting the attainment of a logistics hub in Namibia were grouped according to the themes that emerged, namely, operational, financial, and infrastructural challenges (see Table 5.3). The data from the face-to-face interviews and questionnaires revealed critical challenges.

5.5.1 Socio-economic profile of respondents

Section one of the survey instrument was designed to gather the respondents' demographic data and evaluate the performance of the logistics sector from the industry's perspective. Around 11.33% of the respondents held top management positions, while 17.24% were in middle management, and 24.44% in lower management positions. The remaining 46.56% held other non-portfolio positions. In terms of service, 38.92% of the respondents had held their positions for 0 to 2 years and 31.03% for 3 to 5 years. This suggests high employee turnover, resulting in minimal work experience. In turn, it implies that there may have been challenges relating to knowledge retention, skills development, and institutional stability within the logistics sector. It is essential to address these issues to ensure a well-prepared, capable workforce that can effectively support the operations and growth of the regional logistics hub. Strategies such as retention programmes, training and development opportunities, and fostering a positive work environment could mitigate the impact of high turnover and promote the accumulation of valuable work experience in the industry. Only 16.01% of the respondents had served their organisation for 11+ years, while 14.04% had served for 6 to 10 years. Most respondents had a degree (53.45%), followed by those with secondary education (20.44%). Furthermore, 1.23% of the respondents reported that they had not gone beyond the primary level of education, while 72.67% had achieved a tertiary-level qualification. The presence of experienced individuals with long-term service suggests valuable insights and expertise. At the same time, a high percentage of tertiary-educated respondents indicates a well-educated workforce capable of innovation and complex logistical operations. The findings highlight the potential to enhance efficiency and competitiveness in the transport systems, emphasising the significance of experienced professionals and a knowledgeable workforce in shaping the research field and contributing to the development of a robust regional logistics hub in Namibia.

The study also found that 57.88% of the respondents worked in the logistics and transportation sectors. Thus, key stakeholders within these sectors were fairly represented, while 42.12% of the respondents worked for "other" industries.

Table 5-1: Summarised challenges inhibiting the attainment of a logistics hub

Source: Author's compilation (2022)

Operational challenges	Financial challenges	Infrastructural challenges
Theme 1: *High Costs*	**Theme 1: *Lack of funding***	**Theme 1: *Modality Issues***
High freight rates	Budgetary restrictions	Lack of modality
High fuel prices	Infrastructure financing gap	Lack of rail transportation
High operational costs	Scanty investment	Liquidated airline
High transport costs	**Theme 2: *Fiscal Issues***	Road dependence
Theme 2: *Innovation Issues*	Credit crisis and inflationary demands	Road safety issues
New business process advances	Economic downturn	Unused airports
Technological issues	Inflation and taxes	**Theme 2: *Efficiency Issues***
Theme 3: *Management Issues*	Loans and funding	Infrastructural deficit
Capacity shortages	**Theme 3: *Political Issues***	Outdated rail transportation
Consignments track and trace	Bureaucracy	Poor physical infrastructure
High levels of competition	Corruption	Port storage and facilities
Highly demanding customers	Policy and agreements	Sustainability concerns
Poor strategies and alignment		Under-prepared stakeholders
Theme 4: *Cross-Border Challenges*		
Compliance and regulations issues		
Cross-border and customs issues		
Customs and damaged goods		
Empty containers returning		
Theme 5: *Human Capital Issues*		
Human resources		
Lack of expertise		
Racial issues		

5.5.2 Operational challenges

Five sub-themes emerged under operational challenges: high operational costs, management issues, a lack of innovation, customs and border inefficiencies, and critical skills shortages, as shown in Figure 5.4.

Figure 5-4: Key operational challenges

Source: Author's compilation (2022)

5.5.2.1 High operational costs

The first sub-theme under operational costs was high costs. The four codes were high operational costs, high fuel prices, high transport costs, and high freight rates. These findings align with earlier studies (Amin et al., 2021; Elentably, 2017; Çelebi, 2019) that found that several costs, such as facility utilisation rates and operational charges, *inter alia*, negatively influence the ease of arranging competitively priced shipments. Similarly, uncertainty at border crossings leads to unpredictability and delays, increased transactional costs, and even the loss of business and opportunities (Hodzi et al., 2020). The results also support Kingombe (2014), who highlights high transport costs in Africa, estimated at an average 14% of export value, and even higher in countries like Malawi (56%), Chad (52%), and Rwanda (48%). Lastly, high related costs push the government to postpone road maintenance and development (Habiyaremye, 2020). Therefore, high costs inhibit the creation of a regional logistics hub in Namibia. The following section focuses on management issues.

5.5.2.2 Management issues

The second challenge that emerged from this study was management issues. The respondents identified several key issues, including poor strategies and alignment, high levels of competition, capacity shortages, consignment tracking and tracing, and highly demanding customers. These areas of concern need to be addressed for effective management of a regional logistics hub. The identification of poor strategies and alignment suggests a need for strategic planning and coordination within the logistics sector. It implies that there might be a lack of clear objectives, goals, and synchronisation among different stakeholders, which can hinder the overall performance and effectiveness of the transport systems. Addressing this challenge requires the development and implementation of robust strategies that align with the goals of the regional logistics hub.

The reported high levels of competition in the logistics sector in Namibia can have both positive and negative implications. On the one hand, this drives innovation and efficiency as companies strive to differentiate themselves and attract customers. On the other, it can lead to price wars, reduced profit margins, and compromised service quality. Managing competition requires a balanced approach that fosters healthy competition while ensuring fair business practices and customer satisfaction. Capacity shortages also emerged as a management challenge, implying that there might be insufficient resources and infrastructure to meet the growing demands of the logistics sector. This can hinder the smooth flow of goods and services and result in delays and inefficiencies. Investment in infrastructure development and capacity-building initiatives is crucial to enhance the overall readiness and preparedness of Namabia's transport systems.

Consignment tracking and tracing was noted as a further management challenge. In an era of increasing customer expectations and demands for transparency, effective tracking and tracing mechanisms are essential. This challenge highlights the need for advanced technologies and systems that enable real-time monitoring and visibility of consignments throughout the supply chain. Overcoming it could enhance operational efficiency, customer satisfaction, and overall competitiveness. Lastly, the fact that the logistics sector is under pressure from highly demanding customers highlights the need for a customer-centric approach, proactive communication, and tailored solutions. It calls for the sector to build strong customer relationships, understand their requirements, and continuously improve service offerings.

The identified management challenges highlight the importance of strategic planning, effective management of competition, infrastructure development, advanced tracking systems, and customer-centric approaches to ensure preparedness for and success of the regional logistics hub in Namibia. By addressing these challenges, stakeholders can work towards optimising the transport systems' performance, enhancing competitiveness, and facilitating seamless movement of goods and services within the region.

5.5.2.3 Lack of innovation

Innovation was the third operational challenge that emerged. While Serrano (2018) underscores that information technology and its associated networks are essential to enable remote access to, and control and management of transport systems, the study found that innovation was associated with new business process advances and technological issues. Most respondents identified challenges in relation to business process advances, while some focused on those with regard to technological issues.

These findings are in line with those of Manda and Ben Dhaou (2019), who concluded that complex interconnected corporate information networks are vulnerable to hacking and disruption, and that Industry 4.0 technology should serve as a solution that promotes a seamless transport system (Yava & Ozkan-Ozen, 2020). However, adopting Logistics 4.0 hinders transport systems and hubs from adapting to new technological developments (Manda & Ben Dhaou, 2019). The study's results also concur with Deloitte (2020) that notes that a lack of technology is one of the most significant developmental challenges facing sub-Saharan Africa (Manda & Ben Dhaou, 2019).

The findings align with Ghaderi and Burdett's (2019) study that found that it is crucial to determine each consignment's exact location and route throughout the transportation process. Feng et al. (2020) also state that improved traceability leads to more reliable distribution channel processes, a more effective risk management system, and an improved transport system. Similarly, multiple and contradictory documentation requirements or lengthy inspection procedures by various government agencies such as customs, immigration, the health and sanitary authorities, police, and other security agencies can contribute to such unpredictability (OECD, 2015). Cumbersome and time-consuming administrative and customs clearance procedures also negatively impact global shippers and clients (Liutkevičius et al., 2020).

5.5.2.4 Customs and border clearance inefficiencies

The fourth theme was cross-border challenges, which was associated with four codes: compliance and regulations, cross-border and customs issues, customs and damaged goods, and empty containers returning. Many participants (47%) perceived customs regulations to be challenging, ranging from very challenging (25) to extremely challenging (22%). The findings revealed compromised capacity at the ports of entry amidst an exponential increase in cargo volumes. Cross-border volumes increased by 10% from 2020-2021 to 2021-2022, rising from 1 464 000 gross tonnages to 1 606 984 gross tonnages. However, complex customs processes and the numerous border agencies cause delays at the borders, reducing compliance and delaying goods clearance. Most Namibian border posts lack the infrastructure required to manage growing trade volumes as well as ICT infrastructure, while unharmonised policies increase traders' costs. A lack of facilities and resources creates challenges for traders, and poor customer service reduces transparency in the supply chain. Border operating hours were deemed to be restricting; worldwide, countries experienced severe challenges at their borders as COVID-19 struck in 2020. Furthermore, a lack of interconnected customs systems and delays and inconsistencies in the paper-based exchange of cross-border economic indicators between customs officials inhibited trade facilitation and regional integration initiatives. This translates into dissatisfied traders, untrustworthy trade data, disagreements over national governments' allocations from the shared income pool, and a significant risk of loss of revenue.

These results align with the OECD’s (2015) observation that lengthy cross-border procedures and barriers are a significant challenge and that revamping the complex regional administrative systems should be a priority. Moreover, global trade poses customs and border control challenges (Konstantinus, Zuidgeest, Christodoulou, Raza, and Woxenius, 2019; Bell, 2017). Different countries, including developing states, have distinct and stringent customs regulations (Bell, 2017), calling for a paradigm shift to improve regional customs efficiency (OECD, 2015).

5.5.2.5 Human capital issues

The fifth theme under operational challenges was human capital issues, with three codes: racial issues, a lack of expertise, and a lack of experience. The lack of experience was evident in the proportion of respondents (38.92%) who had held their respective positions for 0 to 2 years, with 31.03% having served for 3 to 5 years. This implies a high employee turnover rate, resulting in minimal work experience.

A shortage of skills hampers Namibia's economic progress and the skills development system has not met expectations. Although the education sector is trying to build capacity by running transport, logistics, and other programmes, many graduates are unemployed, and COVID-19 worsened the situation as many up-and-coming big businesses had to close. Due to financial, economic and social constraints, Namibia’s unemployment rate stood at 46.1% in 2018 (Bobek, Moritz, & Horvat, 2019). It is impossible to forecast what will happen to logistics globally or in Namibia until more is known about the duration and after-effects of COVID-19. Policy directives suggests that the skills gap should be filled by hiring international experts for Namibians to learn from. This could lead to xenophobia-related challenges, where nationals feel that jobs meant for Namibians are given to foreigners.

5.5.3 Financial challenges

Three sub-themes emerged under financial challenges: a lack of funding for transport infrastructural investment and fiscal and political issues (see Figure 5.5).

5.5.3.1 Lack of funding

The lack of funding was explained in three dimensions; the infrastructure funding gap, scanty investment and budgetary restrictions. P1 and P2, both freight transport executives, cited issues related to the infrastructure funding gap, with P2 also referring to scanty investment, while P5, a director of transport networks, highlighted the problems associated with budgetary restrictions and insufficient investment. Habiyaremye (2020) also highlights that the government has tended to postpone road maintenance and development due to budgetary constraints. According to Diemer and Dittrich (2019), infrastructure adaptation to new mobility patterns and the mobilisation of sustainable infrastructure present significant challenges that require new investment and a new approach to designing network and business models. However, these findings reveal an infrastructure funding gap. Thus, the transportation system needs to conclude formal partnerships with regional governments and other entities to boost investment in transportation infrastructure (Lam & Yang, 2020).

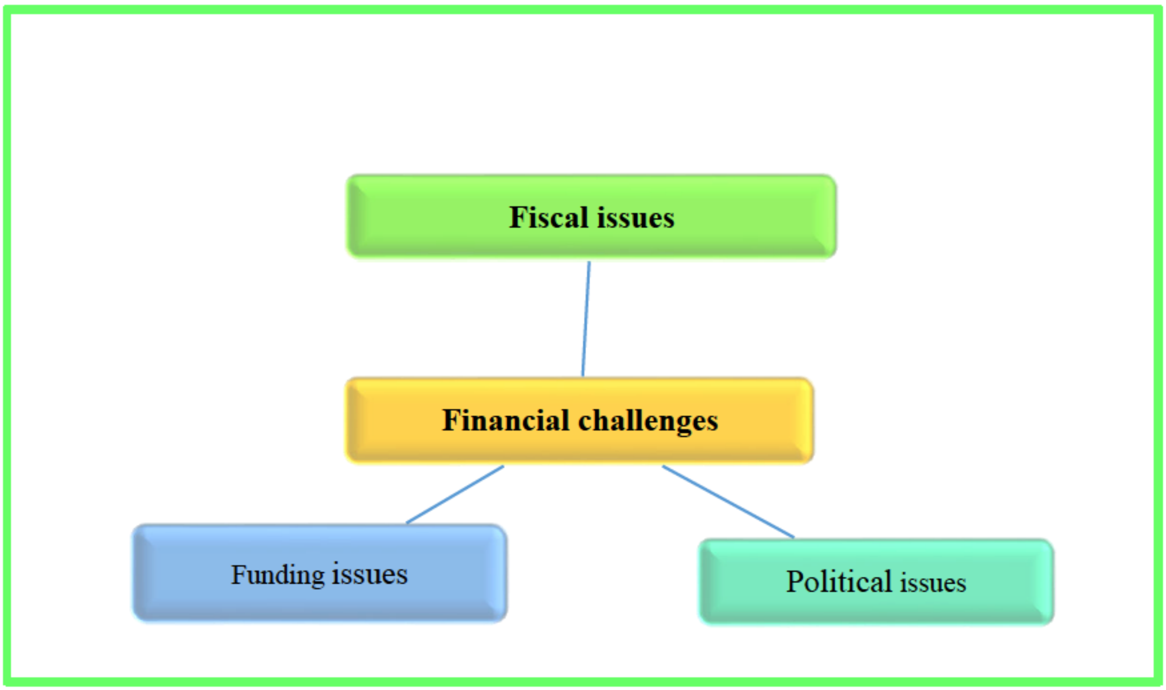


Figure 5-5: Financial challenges and their associated sub-challenges

Source: Author's compilation (2022)

5.5.3.2 Fiscal issues

The first code under fiscal issues was the credit crisis and inflationary demands, which was raised by P 5, 7, 8, 9, 10, 12, 11, 2, and 1, who were, respectively, directors of transport networks, customs declaring agents, an operational manager, project manager, transport regulatory inspector, logistics and distribution manager, rail procurement specialist, and freight transport executives (Participants 1 and 2). The second code was inflation and taxes, cited by Participants 1 and 2. The third, economic downturn, was highlighted by Participants 10, 11, and 2. The last code associated with this theme was loans and funding issues that was cited by Participants 1 and 2. These are unique findings of the study. The government has implemented a fiscal consolidation strategy since FY 2015/2016, reducing government spending across all sectors, including transport. The year-on-year reduction in the total budget allocation to road infrastructure was 15%, from N$ 1 456 360 825 in FY 2019/2020 to N$1 245 433 325 in 2020/2021 (Petrus, 2018).

Furthermore, the road charges collected by the Road Fund Administration are comprised mainly of the fuel levy of N$1.14, constituting 60% of the revenue collected by the Road User Charges (RUCs). However, the optimal levy required to maintain Namibia's road network in a sustainable state is estimated at N$4.00; the current levy is thus a quarter of that required (Medium-Term Expenditure Framework, 2021). Therefore, the fiscal budget allocation and road user charges are insufficient to fund road infrastructure development.

In the rail sector, the year-on-year reduction in the total budget allocation to infrastructure was 57%, from N$489 131 865 in FY 2019/2020 to N$283 204 760 in 2020/2021. At the time the study was conducted, no reliable data was available on the maritime sector's budget expenditure. Namibia has an aged, dilapidated railway network which the state-owned entity is struggling to maintain and develop. The government borrowed N$2.4 billion from the AfDB to rehabilitate key sections of the network (Mid-Term Expenditure Framework, 2021). However, the funding model for this subsector, including fiscal budgetary allocations and concession loans from the state, is insufficient. Thus, the government should explore options to liberalise the railway network to capture private sector efficiencies, capital and technology to improve the sector.

Sobják (2018) observes that when international investors co-invest in transport infrastructure projects with a domestic government institution, they perceive this as a risky scenario. In the absence of comprehensive due diligence, the power matrix connecting this investor to the government might be overlooked. Consequently, implementation of the project is susceptible to improper political involvement, inflated costs and the accompanying wrongdoing used to conceal this state of affairs. The following section describes the political issues.

5.5.3.3 Political issues

Political issues revolved around policy and agreements, bureaucracy, and corruption. While government policies are critical in promoting economic efficiency in a transportation system (Mi & Coffman, 2019), the study’s results reveal that Namibia faces challenges associated with policies and agreements. Sobják (2018) notes that corruption hinders the development of the transportation market. The author adds that the cost of corruption in Africa is projected to exceed 25% of the continent's GDP. It is a significant impediment to the creation of a reliable transportation system and a significant source of inefficiency. Due to market distortion, corruption in the road transportation sector (such as overloaded vehicles and tax evasion) directly affects the growth of this sector. These results are in line with Otu and Ani (2018) who noted that corrupt practices among security and safety authorities through the abuse of roadblocks and checkpoints, especially in relation to road freight trucks departing from Namibian and South African ports to other neighbouring countries such as corridors to Eswatini, Botswana, Zambia, Zimbabwe, Mozambique, and others, can impede the implementation of road safety policies. This renders the road transport system’s implementation more ambiguous, with high insecurity experienced in moving goods and commuters between regional borders (Vourgidis et al., 2020). Lastly, designing operational and administrative procedures to improve services has become more challenging due to extensive customs bureaucracies (OECD, 2015).

5.5.4 Transport infrastructural challenges

Two sub-themes emerged from transport infrastructure-related challenges: ageing and dilapidated rail infrastructure and a lack of inter-modality.

5.5.4.1 Ageing and dilapidated rail infrastructure

The key finding that emerged on the transport infrastructure’s preparedness to support a regional logistics hub was that of ageing and dilapidated rail infrastructure. Indeed, 69% of the respondents deemed this to be an obstacle, ranging from very challenging (30%) to extremely challenging (39%). In support of this, documentary evidence showed that most of the rail infrastructure is more than 100 years old, as shown in Table 5.2.

Table 5-2: Rail network coverage and age of selected rail tracks in Namibia

Source: TransNamib, 2019

i. Windhoek-Kranzberg: 210 kilometres long and completed in 1902 ii. Kranzberg-Walvis Bay: 201 kilometres long. An expansion to Walvis Bay was commissioned in 1914, with tracks constructed close to the Atlantic Ocean's coastline iii. This stretch was replaced in 1980 by a new path behind the dunes that allowed for a higher axle load iv. Kranzberg-Otavi: 328 kilometres (204 miles) long and completed in 1906 v. Otavi-Grootfontein: 91 kilometres long and completed in 1908.

The implication of ageing rail infrastructure is increased rail accidents in the form of derailments. The participants who were interviewed revealed that ageing rail infrastructure and equipment, as well as the government's inability to provide capital for it, has left the country's railway company limping from one disaster to the next. The CEO of TransNamib had this to say:

"About 20% of train accidents are due to the public not adhering to the rules and regulations, and 60% is the old rolling stock as well as the railway infrastructure that has not been maintained at the level it was supposed to."

This is a major obstacle to Namibia's vision of becoming a logistics hub by 2025. Rail infrastructure plays a key role in ensuring a state-of-the-art logistics hub. The Master Plan sets objectives for 2025 based on predicted potential demand and supply capacity and future cargo volume by kind of transport group. One of its projections, is that:

"In 2025, the railway is expected to have a higher modal share than the road. In this railway-oriented instance, future rail cargo demand is expected to be 6.0 million tonnes in 2025, based on TransNamib's predicted average growth rate from 2018 to 2020. In this case, the share of rail cargo transport will rise from 12% in 2013 to 15% in 2025. This move in cargo volume to rail will improve traffic conditions on the highways, particularly between Swakopmund and Okahandja."

Given the ageing rail network infrastructure and equipment, this projection of the Logistics Hub Master Plan is highly unlikely to become a reality, hampering Namibia’s vision of becoming a regional logistics hub. Capacity will be lacking to cater for the projected increase in demand for bulk cargo in Namibia. Within the SADC region, statistics show that countries such as Zimbabwe, Zambia and Botswana use the port of Walvis Bay for imports and exports. The DRC is at the top of the list, with approximately 60% of bulk cargo. A breakdown of the type of cargo ferried to and from the port of Walvis Bay revealed that copper, manganese ore, granite, charcoal and wooden items are key SADC exports through Namibia. This type of cargo has a higher axle weight loading on trucks and contributes significantly to road deterioration and damage. Respondents who transported goods via the Trans-Caprivi corridor noted that the road on one side from the Namibian border post to the port of Walvis Bay is in poor condition. They noted that the leading cause is the heavy mining of raw materials imported from the DRC. Trade in international goods is crucial to Namibia's economic development because it connects producers and consumers from various countries in a global economic system.

Dufour et al. (2018) and Brdulak and Brdulak (2021) found that the lack of consistent transport policies, regulations, and standards results in significant inefficiencies and commercial transaction costs. Less-developed countries, such as East African states, incur substantially greater transportation expenses than affluent economies. Road safety is another dilemma in developing countries (Dufour et al., 2018) that suffer high rates of accidents and fatalities. Inadequate enforcement of road safety legislation and low infrastructure standards contribute to the high accident rate. Modernisation of infrastructure facilities, such as the railway network, development of the central communication port, and investment in road terminals are required. Delays in upgrading road and rail transportation are among the infrastructural difficulties confronting nations like Poland (Brdulak & Brdulak, 2021). Edmond and Show (2020, p. 201) state that Africa’s dilapidated railway system hinders the continent’s economic growth as it results in the use of more expensive means of transportation. Research suggests that rail should be established as a new product offering to restore consumers' faith in the system's dependability and efficacy (Aritua, 2019). Utilising the capabilities of computer software to create statistical models for risk assessment is adding an increasingly preventative, proactive edge to safety. These programmes continuously identify risks and aid in designing a system that forecasts where errors will occur and how to eliminate them (Markarian & Staniforth, 2020).

5.5.4.2 Imbalanced freight modal share

Under modality issues, specific issues singled out by the participants included heavy dependence on road-based conveyance, a lack of intermodality, liquidated airlines, a lack of rail transportation, road safety issues, and unused airports. The majority of the respondents (58%) considered the availability of various transportation modes as inadequate, ranging from very challenging (21%) to extremely challenging (37%). In terms of the freight modal split by imports and exports, 57% of exports were transported via sea. Air and road transportation accounted for 25% and 18.4% of total exports, respectively. In contrast, transport by road accounted for 70% of imports. Sea transportation accounted for 25%, while air only accounted for 5%. The data highlights a highly road-dependent transport system. In terms of types of cargo ferried, mining commodities accounted for 52%, which is vital, as mining products are characterised as heavy. Yet, TransNamib only carried 1.6 million tonnes of freight in 2021, which is not even half the projected cargo for 2020. While rail transport would be the ideal mode of transport due to its economies of density and scale, this is not the case due to operational challenges at TransNamib.

This finding is in line with Okyere et al.'s (2019) research that noted that most developing nations depend entirely on road transport infrastructure to connect airports and seaports, overlooking other transportation modes. This practice is fraught with cost-inefficiencies, greenhouse gas emissions, traffic congestion, accidents, and high maintenance and service deficiencies. Chenikwi and Wang (2019) confirmed that the most popular means of travel in Africa is by road, followed by air, sea, and rail. Road-rail, road-maritime, road-air, and different additional intermodal combinations are available. To avoid connectivity issues, it is essential to ensure high connectivity and integration in a transportation system. Moyo, Kibangou and Musakwa (2021) emphasised that nodes or interlinks with significant spreading ability are influential ones in a regional transportation system. It is therefore vital to identify and rank these influential nodes based on spreading capabilities as this will ensure a solid connectedness in the transportation system. Many developed countries have integrated transportation systems to improve accessibility and minimise commuting times (Moyo et al., 2021).

Li et al. (2020) also expressed the view that a transportation system that is heavily reliant on roads incurs high maintenance costs, congestion, negative environmental impacts, and road safety costs. Similarly, Pyrgidis (2021) underscores that rail is intrinsically competitive in heavy haul, high-speed intercity and intermodal transport. In contrast, the current study found evidence of a lack of railway transportation. These results are consistent with those of Lesmin et al. (2017) that found that trucks account for up to 98% of freight transportation in Africa, while railways account for less than 2%. The increase in heavy commercial vehicles, imported second and now third-hand cars, inexperienced drivers, long-distance drivers, and narrow single lanes, for example between Swakopmund and Karibib to the port, create delays and, at times, congestion, leading to alarming road safety concerns.

Limiting the transport modality of land-based modes and linking them to the port can constrain transport systems' efficiency and effective development, as railways and ocean shipping are economically efficient and environmentally-friendly (Kumar & Anbanandam, 2020). Wang et al. (2018) suggest that improving the sea-road-rail intermodal transportation system results in improved service quality and increased intermodal transportation frequency; economies of scale achieved by centralising activities at the intermodal hub; and increased market share and competitiveness of a given region.

5.5.4.3 Road safety issues

Road safety is closely linked to the modal imbalance due to the transportation of hazardous material (HAZMAT). The interviewees expressed concern over road safety on Namibian roads; the majority (64%) rated safety and security as low, ranging from very challenging (25%) to extremely challenging (39%).

The study found that the port of Walvis Bay handled more than three million tonnages of cargo (Namport, 2020). Petroleum averaged 39% of the freight received in volume, followed by copper/lead and concentrates, accounting for 9% of total cargo landed. Motor vehicles came in third, accounting for 8%, followed by fish and fish products representing 6%. This analysis was supported by statistical analysis that resulted in the alternative hypothesis (H_1) being accepted as there was a significant increase in cargo on the road. The railway experienced an increase in cargo between 2015 and 2019. This finding was supported by the statistical results that showed that volumes increased on all modes of transport, with a p-value of greater than 0.05. The increase in cargo could place further excessive strain on the road transportation system.

Comparing these statistics with the active modes of transportation within the Namibian transport systems raises new concerns about safety and security related to the transportation and storage of HAZMAT. HAZMAT accidents have a high impact risk if they occur; hence Moradi and MirHassani (2015) suggest that a pipeline is the preferred mode of transportation for petroleum. However, this mode is close to non-existent within the Namibian transport system.

5.6 Objective Four: To develop a transport demand management framework for a regional logistics hub

Objective four of this study aimed to develop a comprehensive framework to manage freight transport demand within a regional logistics hub in Namibia. One of the significant findings was the need to comprehend transport demand in the context of Namibia's transportation infrastructure. Trade patterns, supply chain dynamics, economic growth, and demographic trends all influence demand for transportation services. Another important result was the need for multimodal integration in Namibia's logistics centre. Integrating several means of transportation, such as road, rail, air, and sea, allows for the smooth movement of products while reducing congestion. This requires fast multimodal transfers and excellent coordination among transport operators, suggesting that Namibia should create robust infrastructure and operational procedures to support smooth multimodal connectivity.

A further significant concern is the lack of road infrastructure and connectivity, which is compounded by the large number of trucks and traffic accidents. The country's road network is strained by the large number of commercial vehicles, resulting in congestion, increased wear and tear, and safety concerns. The high rate of traffic accidents adds to the difficulties, posing risks to both drivers and other road users. Addressing these difficulties calls for not only expenditure on road infrastructure, but also the implementation of comprehensive road safety measures such as increased enforcement, driver education, and infrastructure upgrades. This would improve the Namibian transportation system's overall efficiency, safety and sustainability.

The ideal solution to the transport system's challenges in Namibia is the implementation of the proposed LOC Truck Smart, a novel and inventive strategy that revolutionises freight transportation and reduces the number of commercial vehicles on the road. It offers significant potential to overcome the specific transport challenges faced by the country.

By adopting LOC Truck Smart, Namibia can leverage the sharing economy concept and innovative technology to optimise the utilisation of transport resources. This solution allows customers to actively participate in the sharing economy and reduce transportation costs. It provides an efficient platform to connect shippers and carriers, enabling them to collaborate and optimise truck capacity utilisation. LOC Truck Smart's integration into Namibia's transportation system would address significant concerns such as limited capacity, high transportation costs, and inefficient resource utilisation. It would improve visibility and transparency in the logistics process by employing advanced technological capabilities such as real-time tracking and automated scheduling. This would enhance overall productivity and customer satisfaction by streamlining operations and reducing administrative burdens.

Implementing LOC Truck Smart has the potential to revolutionise freight transportation, optimise resource use, and reduce the environmental effect of logistics operations. Namibia could resolve its transportation issues, improve the efficiency of its transportation system, and encourage long-term economic growth in the logistics sector by embracing innovative techniques and using the sharing economy concept.

5.7 Chapter Summary

This chapter discussed the study's findings in line with its research objectives and hypotheses. Its conclusions were also compared with the relevant literature. The chapter identified the key difficulties in developing a seamless transport system that could accommodate increased cargo volumes at the port of Walvis Bay. It was noted that a logistics hub is crucial for national and regional economic growth. Large-scale facilities such as logistics hubs enable logistics service providers to collaborate and provide services with added value by pooling their resources. Such hubs influence the performance of transportation systems due to their direct impact on the movement of commodities. An accessible, central and well-connected hub with a seamless transport system is essential for increased efficiency. The lack of multimodal options and, more specifically, the obsolete rail infrastructure that requires a complete overhaul renders the aim of becoming a regional logistics hub impractical or unfeasible. The analysis indicated that Namibia's reliance on foreign investment and funding results in subpar performance. High transportation costs, challenging cross border and customs requirements, and a lack of expertise in the transport and logistics sector are fundamental findings that need to be addressed for the vision of becoming a regional logistics hub to be realised. The development of infrastructure in neighbouring countries might reduce Namibia's competitiveness as stakeholders might opt for other routes, e.g., to South Africa's ports for trade. Based on these discussions, the following chapter presents the study's conclusions and recommendations as well as its limitations and suggestions for future research.

CHAPTER SIX:

CONCLUSIONS, RECOMMENDATIONS, AND LIMITATIONS

"The key word for transportation in the 21st is 'choice'."

Anthony Foxx

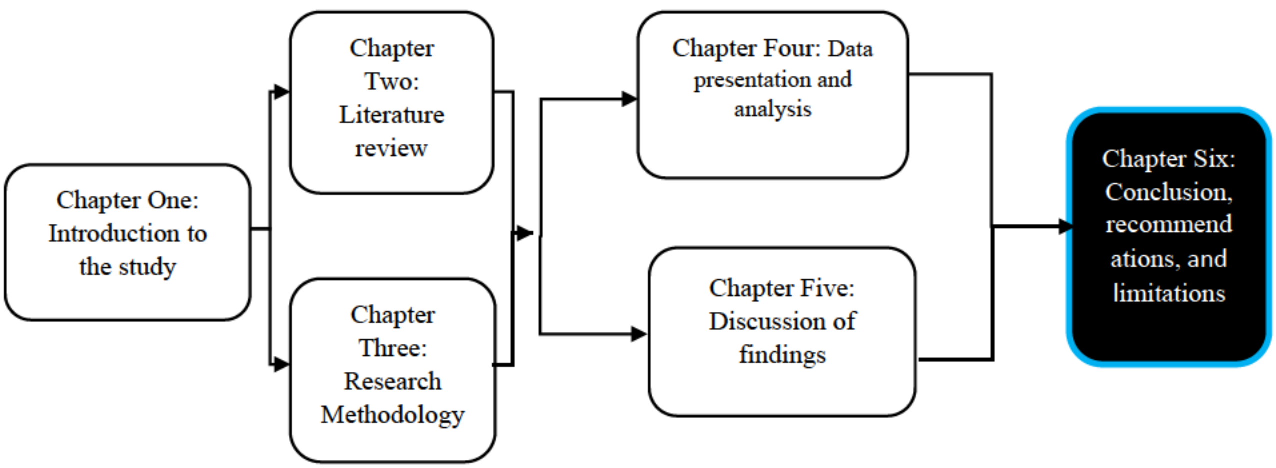
6.1 Introduction

This chapter presents a summary of the research. It begins by highlighting the main issues discussed in each chapter. Secondly, it highlights the conclusions emanating from the data analysis and discussion of the results in Chapters four and five. These were based on the research questions and the findings were compared with the reviewed literature. Drawing on the findings, recommendations are made to improve transport systems' preparedness towards a regional logistics hub for Namibia.

This study used a partially mixed concurrent mixed method research design. Multiple data collection methods, including interviews, a survey, and analysis of industry reports, were employed to gather information from various stakeholders, such as government agencies, transport operators, and customers. This comprehensive approach enabled a thorough examination of the key transportation issues in Namibia. Triangulation of data sources and methods strengthened the credibility and validity of the study's findings, providing a strong foundation for decision-making and future development.

The study mainly relied on a qualitative research approach to answer the research questions and address the research objectives using narratives. Data were collected by means of a combination of interviews and documentary review. Personal interviews were conducted with selected participants in senior management positions in the transport and logistics sectors and from procurement officials in logistics and exports. The document analysis included public records - the Namport annual report, TransNamib annual report, transport and logistics blogs, the Namibian Master Plan for Logistics for SADC, transport and logistics and transport geography journals, Maritime Logistics handbooks and the 2020 State of Logistics Report.

The study found that the majority of the respondents felt that trade is vital to Namibia's development because it fuels economic growth, supports decent jobs, raises the standard of living, and enables Namibians to provide affordable goods and services for the nation. The analysis of the data collected by means of different methods yielded themes. Several challenges were identified, including inadequate infrastructure encompassing road networks, railways, and ports, which hinders the efficient movement of goods and people. Furthermore, Namibia's vast, sparsely populated areas pose connectivity challenges, particularly in remote regions, impacting economic development and accessibility. Concerns were raised in relation to inefficiencies in the logistics sector and supply chains, resulting in longer lead times, higher costs, and reduced competitiveness. Cross-border transportation and customs processes suffer from delays, bureaucratic procedures, and inadequate infrastructure, impeding trade flows. Lastly, road safety was a significant concern, driven by factors such as inadequate road infrastructure, poor driver behaviour, and insufficient enforcement of traffic regulations. Addressing these key transportation issues will enable Namibia to enhance its transport systems' readiness for a regional logistics hub.



6.2 Summary of the Study

Logistics hubs depend on transport systems for increased efficiency (dos Santos Vieira & Luna, 2016). Some of the issues characterising transport and logistics operational systems can be addressed directly by those with long-term knowledge of the industry, such as transport and logistics managers and port managers. However, strong commitment to efficient and effective cargo operations is required to enable transport hubs to attract qualified personnel. The African continent confronts challenges in establishing regional logistics hubs, and Namibia is no exception. In order to promote effective management of transportation and logistics systems which are crucial for the success of business and the economy, it is important to identify the challenges confronted by these sectors. Appropriate transport systems and operational strategies for the transport hub would enhance port operations and improve logistics performance in Namibia and beyond.

6.2.1 Chapter One

Chapter one introduced the study by proving a brief literature review and background on the concept of a logistics hub and enhancement of transport operations to improve cargo performance in both domestic and foreign ports. The overview of transport and logistics operations in developed and developing countries noted that Africa faces critical challenges such as a lack of trade supply capacity and harmonisation of policy and the legal framework as well as the inability of local transportation systems to leverage global ones (Olayiwola, 2020). Innovative strategies are thus required to ensure an adequate, high-quality, efficient and effective transportation system.

Following the presentation of the problem statement and the research objectives and questions that guided the research process, the chapter outlined the theoretical framework on operations motivation, with specific emphasis on railway logistics. The theories were explained, and suggestions were made on how they can be used to improve transport and logistics systems. The study was underpinned by the network analysis theory, Hub-and-Spoke theory and stakeholder theory. Network-related data provides insights into transportation systems' effectiveness and efficiency. The Hub-and-Spoke theory reflects on the functionality of logistics hubs, their connectivity, and their impact on cargo performance. Lastly, data on the perspectives and actions of stakeholders involved in transportation and logistics operations sheds light on their roles, interests, and interactions.

The study was motivated by Namibia's vision to become an international logistics hub. The researcher noted the increase in freight cargo passing through the port of Walvis Bay both before and after the adoption of the Transport and Logistics Master Plan. This observation led the researcher to investigate whether the transport systems are prepared for the envisaged regional logistics hub.

The study's significance lies in the fact that its outcomes will assist the government and stakeholders in the transport and logistic sectors to revisit current transport hub and logistics strategies in order to improve logistics performance in Namibia. It was noted that a well-motivated transport hub could play a role in improving the performance of logistics operations.

Chapter one also briefly discussed the research design and methods employed to conduct the study, and presented an outline of the structure of the thesis.

6.2.2 Theoretical framework's contribution

Chapter two presented the theoretical framework that underpinned the study. The theories employed included the network analysis theory, Hub-and-Spoke theory and stakeholder theory.

6.2.2.1 The Network Analysis

The network analysis theory assisted the researcher to analyse the findings of the case study. The following five steps were followed:

Step 1: Configuring the Network Analyst environment - the researcher mapped the closest transport network facilities taking into consideration the environment, the roads routing problem, location-allocation and time-dependent analysis. The Network Analyst extension was enabled in the setup before beginning network analysis.

Step 2: Add network dataset to ArcMap - After the network had been constructed, there was no need to rebuild the network dataset because adding a network dataset to ArcMap made it easier for the network attributes to reference the source features.

Step 3: Creating the layer for network analysis - The inputs, characteristics, and outcomes of network analysis are stored in a network analysis layer. It has network analysis classes for each form of input as well as for the outcomes in an in-memory workspace. Network analysis objects are the features and information contained within the network analysis. Some properties of the network analysis layer allowed the researcher to further define the problem statement. Network datasets are used exclusively for network analyses. As a result, a network dataset must be coupled to a network analysis layer. The network dataset is set as a tool parameter if a network analysis is turned into a layer utilising a geoprocessing tool. A network dataset must be added to ArcMap first so that Network Analyst may be used to tie the analysis layer to the network dataset when the analysis layer is built.

Step 4: Adding network analysis objects - input and output characteristics utilised during network analysis are known as network analysis objects. Stops, barriers, routes, and facilities are a few examples.

Step 5: Setting network analysis layer properties - in addition, compared to its network analysis objects, the network analysis layer contains attributes that are more analysis-specific. The network impedance attributes to employ, the limitation attributes to abide by, and other such qualities are examples of generic analytic features. It was also helpful to solve the transport network problem once the researcher had constructed a network analysis level, inputted network analysis items, and established parameters for the analysis artefacts and layer.

6.2.2.2 Stakeholder theory

The stakeholder theory acknowledges that a multitude of actors – i.e., stakeholders – have an interests in any corporation. Stakeholder theory focuses on how a company should manage its business while considering the interests of its various stakeholders. The steps in stakeholder theory were used to understand the many actors that influence, and are influenced by, a company's externalities, such as the environmental impact.

The stakeholder theory conceptual model

This model provided a conceptual framework to explain the findings from the empirical evidence. This use of the stakeholder theory in this study highlights its usefulness in transport system research and, in particular, the importance of the influence exerted by stakeholders outside a focal hub. The stakeholder theory allowed for equal analysis of two focal organisations instead of one. In comparison to other models, this model allowed the researcher to describe primary and secondary stakeholders in transport and logistics operations and highlight the importance of port cargo customers. The port customer is essentially an indirect stakeholder in the Namibian port, and through the transport systems, the customer forms and frames cargo activities and targets.

Chapter two also reviewed the literature on transport hubs and logistical operations' contribution to their success. This informed the study's conceptual framework that focused on the relationship between the factors that are generally regarded as correlation values on operational factors experienced in the transport and logistics sector and in the context of this study.

6.2.2.3 Hub-and-Spoke Theory

The researcher employed the Hub-and-Spoke network theory to maximise the concentration of transport network resources and generate economies of scale through mainline transportation between hubs, thus reducing overall transport and logistics operating costs. Through the concentration of flows, the Hub-and-Spoke network layout allows for greater flexibility within the transportation system.

The analysis concluded that there were insufficient road and rail transport network resources in terms of centrality. However, the deteriorating rail service led to significant reliance on road transportation. Therefore, as the only accessible, adaptable, and reliable method of transport in Namibia for logistical activities, it is the only feasible alternative. In terms of transportation and logistical operations, this makes it the only relevant, flexible, and real means of transportation in the country. Road safety concerns, costly transportation and high logistical operating costs are a result of the high concentration of flows in road transportation.

6.2.3 The role of research methodology

Chapter three discussed the research design and methodology employed to conduct the study. It commenced by motivating for the need for an empirical inquiry into the challenges facing the transport system. The rationale for an empirical investigation lay in the fact that, given the mixed method research approach that was adopted, a study based on the literature alone would not be sufficiently substantive and conclusive to generate a holistic understanding of the transport systems' preparedness towards a regional logistics hub in Namibia. In order to gain deeper comprehension of the impact of transport system preparedness, multiple sources of data were used to investigate the subject empirically, through scrutiny and critical questioning in search of clarity, including that obtained from participants who provided their views on the transport systems and their influence on logistics operations in Namibia.

Although various research paradigms were applicable, the study adopted the pragmatic philosophy that allowed for a mixed method design that combines quantitative and qualitative methodologies to build on each technique's strengths and overcome its weakness. Creswell (2018) notes that the mixed methodology is an evolving research technique that encourages the systematic combination or mixing of quantitative and qualitative techniques and data within a single study or ongoing investigation. While this study adopted a partially mixed concurrent design as a mixed method approach, the research mainly relied on the qualitative research approach, since the phenomenon of transport systems' preparedness was studied in its social setting over a period of time.

A combined probability and non-probability sampling strategy was used to select the participants. The two sampling methods were essential given the fact that the researcher sought to involve participants who were knowledgeable about the phenomenon under investigation in order to gather rich information that would be useful in answering the research questions. Data were collected using individual interviews and document review. The interviews were recorded and transcribed by the researcher, and the data from the document analysis were noted in a document analysis tool.

The use of multiple data collection tools ensured the collection of rich data and also served as a measure for the trustworthiness of the research findings through triangulation, organising, reading, and writing memos, establishing themes, categories and percentages, and discussing the research findings in terms of the categories that emerged and the percentages established, which formed part of the data analysis and interpretation.

Various measures were adopted to ensure the reliability of the research findings pertaining to credibility, transferability, dependability, and confirmability. These were informed by the qualitative nature of this study. Ethical standards were adhered to, including gaining permission to access the research sites, informed consent, confidentiality, and anonymity.

6.2.4 Data presentation and analysis

Chapter four presented and analysed the data collected by means of interviews and document analysis, employing multi-variance analysis methods. Thematic analysis provided the themes for the main findings, which were interpreted and discussed in order to generate answers to the research questions.

The document review revealed that the port of Walvis Bay is generally accessible via all the corridors, based on indicators of distance, average travel time (ATT) and average speed per corridor. The minimum average travel speed for freight traffic was 65km/hr (Trans-Cunene Corridor) and the maximum observed travel speed was 73km/hr (Trans-Caprivi Corridor). Despite a generally high level of accessibility, low speeds were prevalent from Walvis Bay to Karansburg due to unfavourable weather conditions. The standard deviation indicated that there was no significant difference in travel time along the corridors, and they all showed a high level of accessibility to the port of Walvis Bay. This result was viewed in conjunction with qualitative measures for the highways' LOS. According to the Highway Capacity Manual (2000), LOS defines the quality of traffic flow in a transportation facility based on questionnaires that capture drivers' perceptions of traffic quality under varied operating conditions. Table 4.23 depicted the service quality or LOS (A to F) and the different operating conditions. At an average speed of 70km/hr, all the corridors experienced a reasonable free-flow condition based on the LOS table. Reasonably free-flow traffic conditions translate to higher accessibility. To corroborate or triangulate the findings of the LOS, which are primarily qualitative based on drivers' experiences, the v/c ratio was calculated. Based on the maximum traffic flow for two-lane highways, which is 1 800 vehicles per hour per lane, the v/c ratio was below 6, implying that the corridors experienced free-flow traffic conditions, albeit at lower speeds due to a high heavy truck traffic mix.

Although the statistics in the documents reviewed claimed that the port was well-connected, central and accessible, more than 80% of the participants interviewed claimed it was not well-connected and accessible. The researcher's observations supported this finding, as with only two bitumen roads and one gravel road into Walvis Bay, the port is not well connected and not easily accessible.

Rail Performance

Speed

Rail speed in Namibia was up to 60mph (100km/hr). The anachronistic state of the railway puts strain on train operations, and new reduced speed limits are introduced each year. The poor state of the railway network impedes locomotive speed and service delivery for TransNamib's trains, as do regular derailments. Restricted speed limits and carrying capacity cause bottlenecks. The international standard for speed is more than 250 km/hr.

Safety

A total of 195 rail accidents were reported between 2018 and 2021. In contrast Great Britain recorded only 11 derailments from 2013-14 to 2020-21. The net tonnage railed over the 2019/2020 financial year was 1651 511 tonnes, against the budgeted 1.8 million tonnages (TransNamib, 2022). Transnet, a South African rail transportation company, moved 183 million tonnes of goods in 2021, a 13.66% decrease from 2020.

Human resources

It was found that a shortage of skills hampers Namibia's economy, and the skills development system has not met expectations. The education sector is aiming to build capacity by running transport, logistics, and other programmes. However, many graduates are unemployed, and COVID-19 worsened the situation by forcing some big businesses to close. Due to financial, economic, and social constraints, the Namibian unemployment rate stood at 46.1% in 2018. It is impossible to forecast what will happen to logistics globally or locally in Namibia until more is known about the duration and after-effects of COVID-19. The policy suggests that the skills gap should be filled by international experts for Namibians to learn from. However, this could lead to xenophobia-related challenges, where nationals feel that jobs meant for Namibians are given to foreigners.

6.2.5 Key implications of the Findings

The discussion of the study's findings in Chapter five was categorised into four sections based on the research objectives as well as the document review, the quantitative results (response rate analysis, socio-demographic analysis, descriptive statistics, factor analysis, reliability, and validity, and testing of research hypotheses) and the qualitative findings (measurement of the extent to which the identified challenges inhibit a regional logistics hub in Namibia).

The study's objectives were to: (a) analyse the extent of connectivity, accessibility, and centrality of transport networks in facilitating a regional logistics hub. (b) evaluate the KPIs of the transport system in facilitating a regional logistics hub in Namibia; (c) identify the challenges inhibiting the regional logistics hub in Namibia; and (d) develop a TDM framework for a regional logistics hub.

6.3 Limitations of the Study

This study was affected by several constraints, including time, funding, legal restrictions, and initial reluctance on the part of some potential participants to take part in the study. The researcher encountered time constraints due to being employed full-time. This was overcome by conducting research after hours and on weekends as well as applying for leave to conduct introductory meetings, while the questionnaire was emailed to potential respondents. The financial constraints emanated from the need to travel to Walvis Bay to meet with stakeholders. This was mitigated by skype or video conferencing. Potential participants' reluctance to take part in the study was addressed by assuring them that the information would be used for purely research purposes and by a signed non-disclosure agreement assuring stakeholders that all information would remain private and confidential.

The World Health Organisation declared the Corona Virus a pandemic on March 11, 2020 and by September 2020, 31 million people in more than 215 countries had been infected (Muñoz-Fontela et al., 2020, pp. 509-515). The pandemic negatively affected all aspects of human existence. Restrictive laws and social isolation significantly impacted the education system and how the researcher conducted this study. Supply chain disruptions created a severe shortage of products, and transport and travel restrictions made mobility nearly impossible for companies; however, this provided an opportunity to observe how the crisis affected the supply chain and transport facilities. It also provided universities with the opportunity to deploy innovative research approaches as well as early interventions to minimise the challenges.

As a lecturer, the researcher took advantage of the online platforms available to collect data. However, the use of online platforms created the need for faster Internet. The researcher had to invest in high-speed Wi-Fi devices and work mainly at night when fewer devices were in use. Conducting interviews proved difficult, primarily due to missed appointments. Furthermore, the survey posed many challenges, including respondents postponing completion of the questionnaire and other problems that were not anticipated. The researcher realised that successful data collection required patience to create trust in the absence of a face-to-face connection. The transition to remote data collection was novel and required investment, innovation, and the researcher adapting to multiple types of technology that the respondents might use, such as WhatsApp, Zoom, MSteams, and Google Meet.

6.4 Conclusions

The study examined the extent to which Namibia is prepared (transport systems-wise) to serve as a regional logistics hub for the SADC region and beyond by 2025. In addressing the research problem, four objectives were crafted, which revolved around the current performance of the transport system (road and rail); the extent of transport system connectedness, centrality and accessibility; challenges inhibiting the realisation of the logistics hub and proposing a TDM as a potential solution to address specific challenges, at least in the near to medium term.

The overall conclusion drawn from the study's findings is that Namibia is lagging behind in terms of preparedness to become the regional logistics hub by 2025. It can safely be concluded that it is only prepared in two areas, namely, increased port handling capacity due to the port expansion project from 2014 to 2018 and high-quality road infrastructure.

The port expansion project raised the container throughput capacity from 355 000 to 1 005 000 TEUs and was initiated in response to increased trade-related traffic volumes. It not only provided increased container handling capacity but also increased the port's bulk and break-bulk handling capacity by freeing up the existing container terminal to become a multi-purpose one. Supporting the terminal's increased capacity is Namibia's high-quality road transport infrastructure, which is ranked first on the African continent.

However, despite its high-quality road infrastructure, Namibia confronts serious challenges in terms of road safety and capacity on certain sections of road. It has one of the highest rate of serious accidents in the world due to three major issues. First, certain sections of road are narrow in width, offering no relief to Heavy Goods Vehicles (HGVs) in the event that they veer off the road due to poor visibility or fatigue. This leads to a large number of accidents involving HGVs. Secondly, there is an acute modal imbalance between road-based and rail-based transport. Approximately 90% of freight is carried via road-based modes, and a mere 10% by rail. Rail transport is significantly underfunded, resulting in the operation of old rolling stock coupled with ageing rail infrastructure and equipment. This leads to high levels of inefficiency and accidents. The high volumes of traffic on the roads exerts pressure on road capacity and road maintenance. The axle loading from the large number of HGVs contributes to rapid road deterioration. Coupled with dwindling funding, this means that road quality could deteriorate in the foreseeable future.

Thirdly, because of Namibia's spatial extent, there are long distances (averaging 1 100km) from the Port of Walvis Bay to the ports of entry and exit to the region. This translates to increased transit times, which place strain on drivers. In turn, driver fatigue contributes to accidents and fatalities. Safety concerns are not limited to the roads; serious and frequent rail accidents in the form of derailments and head-on collisions pose a serious threat to the realisation of Namibia's logistics hub.

The scientific measures of centrality, connectivity and accessibility revealed that the road-based transport system connects well with the port, towns and cities and is relatively accessible. However, most of the study participants were of the view that it was difficult to access the port of Walvis Bay due to the fact that there is only a single road (spoke) that radiates from the port and branches at a distance to various destinations. This contradicts the Hub-and-Spoke paradigm described in the literature, which posits that multiple spokes (road and rail linkages) should emanate from a hub (port) to service multiple destinations. A mono link from the hub implies that it struggles to service increased demand, causing traffic congestion towards the port. A further challenge is the lack of investment in transport infrastructure, especially in rail, as well as a shortage of critical skills in transport and logistics. All in all, these challenges were found to impede the realisation of a regional logistics hub in Namibia.

6.5 Recommendations

The recommendations are drawn from the study's analysis and findings.

The following recommendations are drawn in response to the fourth objective, which was addressing freight TDM.

6.5.1 Proposed Freight Transport Demand Management System (FTDMS)

In response to the challenges listed in Figure 6.1 below, the researcher recommends the 'LOC TRUCK SMART' as a promising FTMDS. As discussed above, the costs of maintaining and/or overhauling Namibia's rail lines and infrastructure are unaffordable, at least in the foreseeable future. The question thus is: What is the most feasible approach to address the challenges shown in Figure 6.1?

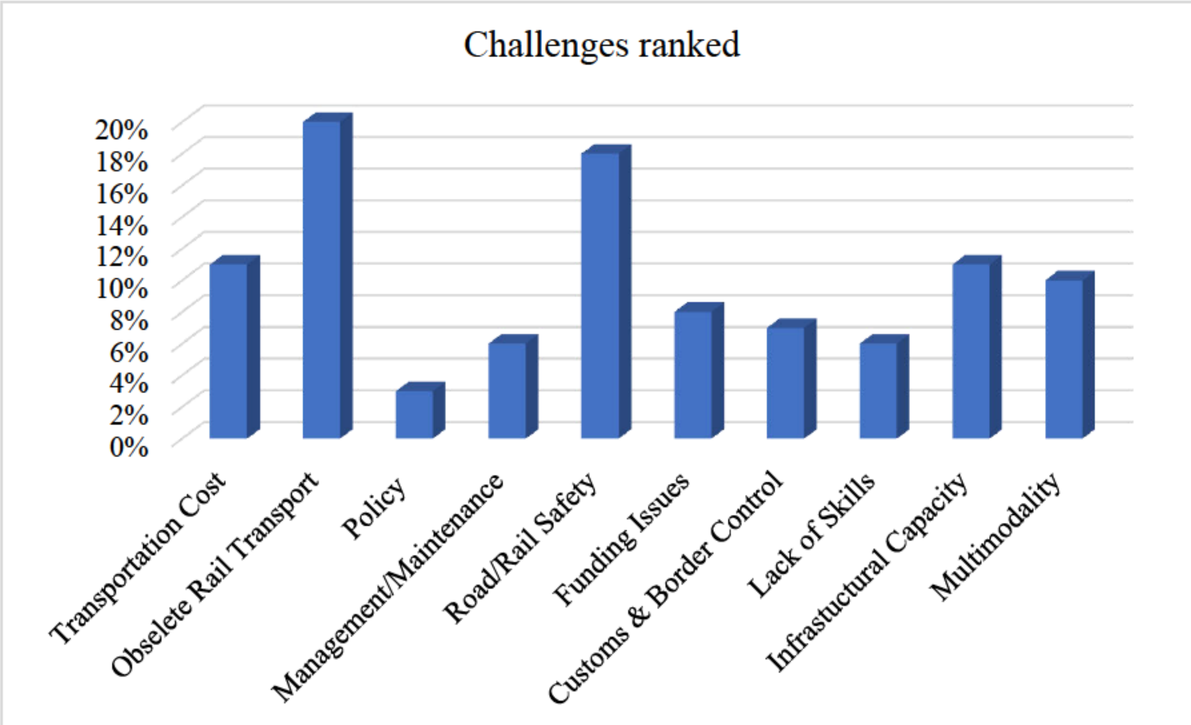


Figure: 6-1: Key challenges inhibiting the logistics hub

Source: Author's compilation (2022)

Although TDM is a well-known concept in public transportation, its application to freight transport is limited. It entails applying strategies to achieve a balance between transport supply and demand to reduce traffic congestion and improve the environment. TDM has recently played an important role in transport planning. It has become evident that providing sufficient road capacity to satisfy future demand will be extremely challenging; thus the need to coordinate various transport systems. TDM has been addressed in passenger vehicle traffic planning but rarely in freight transport planning.

The researcher proposes an innovative conceptual framework, termed the freight TDM theory, which builds on the Hub-and-Spoke, network analysis and stakeholder theories. By applying the Hub-and-Spoke theory, the researcher identified potential hub locations and evaluated their potential to enhance connectivity and efficiency in road freight transportation. Furthermore, network analysis was applied to identify key nodes, routes, and connections that will contribute to the overall efficiency and effectiveness of road freight transportation. In addition, the stakeholder theory was employed to analyse and assess the relevant stakeholders within Namibia's transportation sector. By considering their perspectives, interests, and influence, this approach aided in understanding stakeholders' needs, fostering collaboration and preparing the transport systems for a regional logistics hub in Namibia. The integration of these theories provided a comprehensive and original foundation to evaluate the transportation systems and conceptualise the freight TDM theory. This theory is the researcher’s original conceptual idea and is intended for use by developing countries which face the challenge of integrating their transport systems. The researcher developed an application called LOC TRUCK SMART based on the freight TDM theory.

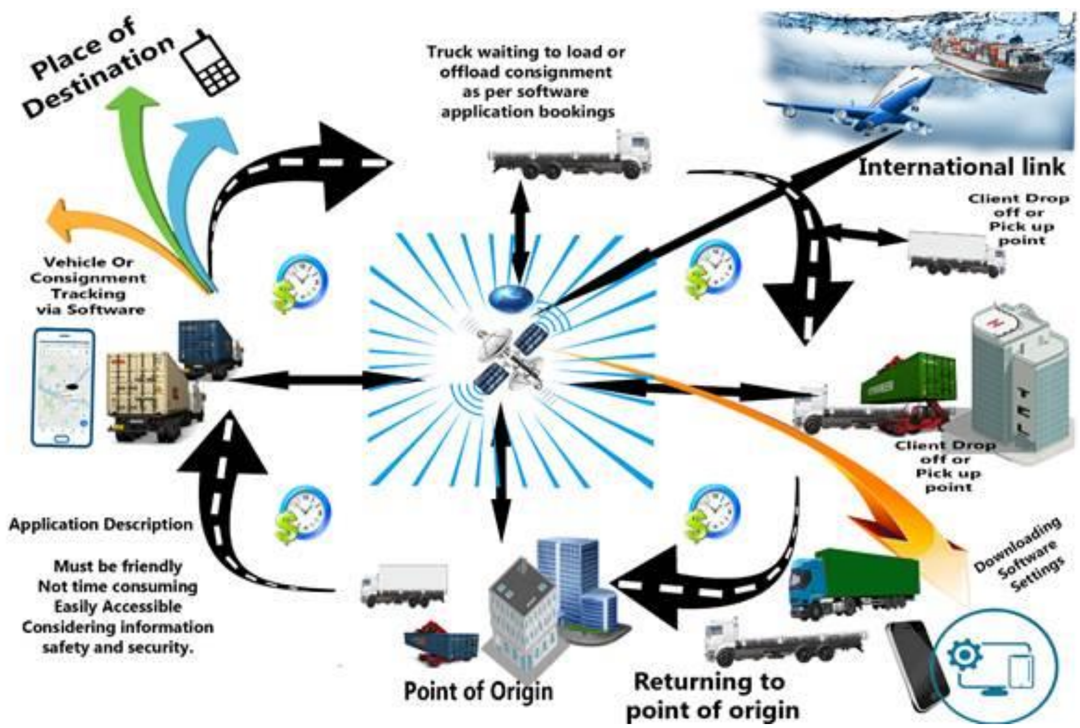


Figure: 6-2: Freight Transport Demand Management Theory

Source: Author's compilation (2022)

The 'LOC TRUCK SMART' is proposed as a promising TDM tool that promotes the rational use of automobiles. LOC Smart trucking seeks to work towards seamless transportation systems by limiting the use of private vehicles or trucking services and supporting more efficient, environmentally-friendly means of transportation by reducing the number of commercial vehicles.

LOC truck smart is an application to enhance supply chain, logistics and transportation management collaboration. It is driven by transport capacity utilisation, improved road safety and reduced carbon emissions and traffic congestion. Shared transportation reduces the number of empty trips. However, technical problems (e.g., carrying capacity) develop in a truck-sharing effort for various reasons, including the container truck itself, driving regulations, port operation hours, and a wide variety of container categories. Therefore, a substantial portion of "structural empty running" may always predominate.

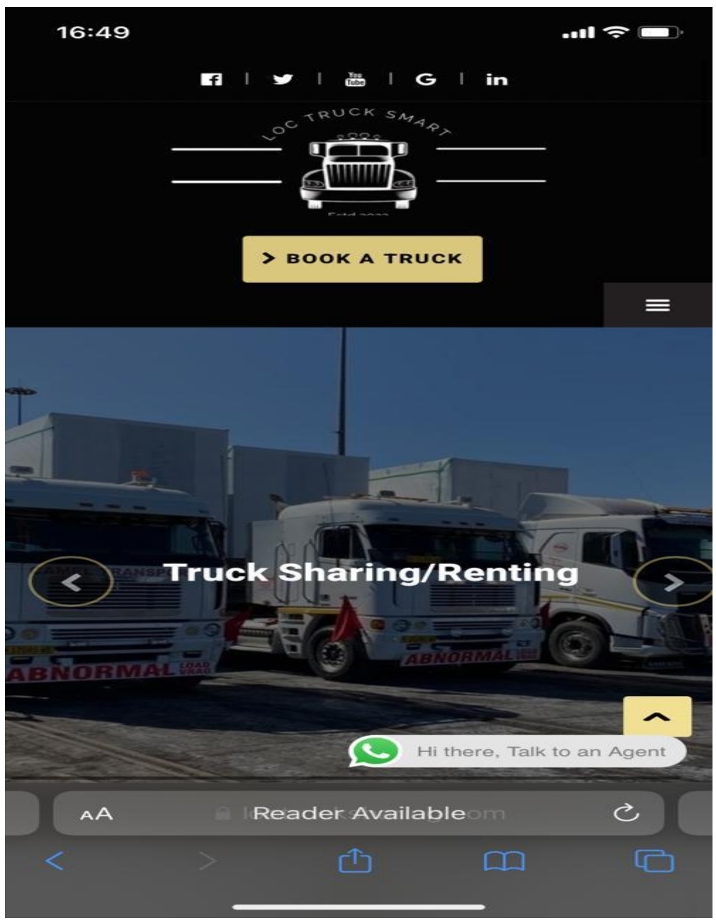


Figure: 6-3: LOC smart truck website

Source: Author's compilation (2022)

LOC Truck Smart adopts a novel and inventive strategy to reduce the number of commercial vehicles on the road for freight transportation. It will revolutionise the paradigm of transportation, allowing customers to engage in the sharing economy while reducing transportation costs. Instead of owning a truck/van/container, LOC Truck Smart transport will provide the client with a registered client's truck/van/container to transporting his/her cargo 24/7. On LOC Truck Smart, clients will be able to share/rent trucks/vans to transport cargo around Namibia. Profiles of qualified and experienced drivers will be provided and the website (proposed as http://www.LOC.com) will offer hubs across most linked cities, including Otavi, Grootfontein, Otjiwarongo, Karibib, Okahandja, Windhoek, Gobabis, and Keetmanshoop. Carriers will be able to unload/load freight at one of the hub cities, then the owner can make arrangements with another trucking company to transport the cargo to its final destination. If an owner wishes to rent or share space on a truck/container/van, he/she will be able to use LOC Truck Smart to connect and advertise for clients whilst enabling customers/transporters to use his/her trucks and earn money.

LOC Truck Smart will have no trucks of its own, but will operate as a middle person between people who wish to share truck/container/van space and those seeking to rent/share space in trucks/vans/containers. Creating an account on LOC Truck Smart will involve an annual charge of N$250 and will be straightforward, with clients required to provide their name, email address, a detailed message and contact details. LOC Truck Smart will also track trucks using Google Maps for the convenience of its users. The transportation routes will also be shared on the website. Consignees will be responsible for ensuring the safety of trucks, drivers, and cargo through the purchase of insurance coverage, with rental and space-sharing costs listed on the website. LOC Truck Smart transporters will not physically exchange cash; transporters will pay for everything on the website when making a reservation, with the option to share costs amongst firms or transporters, and LOC Truck Smart will pay hosts. Depending on the amount to be paid, LOC Truck Smart will utilise direct bank deposit, PayPal, and other payment methods. The website will include customers’ reviews of the services as well as an emergency number and a list of the institutions which LOC Truck Smart has partnered with Namibian transport companies, such as the Motor Vehicle Accident Fund, the Roads Authority, the Ministry of Works and Transport, the Road Fund Administration, Namport, and the Walvis Bay Corridor. In addition to a mobile phone, clients will be able to communicate with a consultant via WhatsApp, with their account activated thereafter.

Transporters should maintain a thorough understanding of local laws. Before renting out trucks/vans/containers, hosts should always verify local rules and acquire the required insurance coverage. Safety concerns must also be considered. Potential clients should read the terms and conditions (including the fine print) and customer reviews before reserving a truck.

6.5.2 Revisiting rail-road infrastructure upgrading and complementarity

The goal of developing Namibia into a regional logistics hub requires a review of the transport system to eliminate the shortcomings. In the short to medium term, there is a need to focus on the following:

i. Improvements made on the Walvis Bay-Kranzberg stretch;
ii. Improvements for the section of Kranzberg-Windhoek; and
iii. Investing in new equipment and maintaining rolling stock and facilities.

In the long term, there is a need to prepare and develop the "Grootfontein-Katima Mulilo" rail link. This can be made possible through budgetary allocations to stimulate transport systems and road developments towards preparedness for a regional logistics hub in Namibia. Furthermore, Namibia should prioritise low-cost, high-impact options, such as investing in effective upgrades like improved track and signal systems, or in trains with greater fuel efficiency.

Alternative financing options should also be explored, such as PPPs in which private companies invest in and operate rail infrastructure or concessional financing is obtained from development partners such as the African Development Bank. SADC nations could also establish more efficient logistics and supply chain management systems to boost the effectiveness and efficiency of rail transport. Lastly, it may be advantageous for Namibia to collaborate and exchange resources and experience with SADC countries to develop a more integrated and sustainable rail transportation system in Southern Africa. It should be emphasised that the plans should be adjusted to suit each country's context and priorities, and that a comprehensive, holistic approach is essential to success.

6.5.3 Integration of supply chain partners

Transport systems' preparedness towards a regional logistics hub in Namibia should also focus on the fact that developing effective logistics hubs requires the integration of all supply chain network partners and logistics security in terms of transport infrastructure, transportation costs, transit time and available modes of transport. Efficient, safe, and secure transportation services are essential for national development, collaboration, and job creation. Any land freight and passenger transit disruptions will have enormous effects on economic development, territorial integrity, social growth, and the environment. The stakeholders should also consider the expansion of rail transport systems in Namibia. Globally, rail is one of the safest and most sustainable means of transportation. However, due to its relative safety, hazardous material such as chemicals, petroleum, liquefied gases, and nuclear waste are regularly transported by rail. This calls for several risk-control measures, including distinctive train formations, improved vehicle and rail track maintenance, routing away from densely populated areas, specialised handling, and increased security. Poor safety and security can be catastrophic.

Despite rail's competitive advantage over road, in Namibia, rail freight has continued to lose market share to road haulage due to deteriorating rail freight services. Generally, rail transportation is underutilised in Namibia, and the infrastructure is rigid and inflexible, undermining performance. Infrastructure is likewise poorly maintained and continues to deteriorate. Therefore, increasing the efficiency of port throughput can have a significant positive impact on global supply chains and the economy.

6.5.4 Improve road and rail safety awareness in the supply chain

It is recommended that the Namibian government and stakeholders involved in logistics establish a chain of responsibility regulatory framework to hold all individuals and parties who impact the attitude and conduct of heavy vehicle drivers accountable. According to Braun (2015), governments should implement Chain of Responsibility frameworks to address supply chain accountability for road accidents and hold accountable all individuals who influence the behaviour and compliance of a heavy vehicle driver, ensuring responsibility for non-compliance with traffic rules and legislation.

6.5.5 Towards regional integration in railway transportation

Namibia needs to identify strategic business partners across the region and continent to become more competitive and use their expertise to improve rail transportation operations, increase business offerings, and drive competitiveness. This could be extended across all sectors of the economy, be they private, public, or both. Meeting the requirements of multinational companies may be an important aspect of the regional integration process for Namibian rail, as multinationals seek competitive locations to install logistics facilities where they can ensure that functional and geographical integration of their global supply chains can be accomplished.

6.5.6 Raise awareness of the risks of corruption

Prosecution of corrupt practices in infrastructure projects should increase across the world in order to boost investor confidence. Prosecution and mitigation should work hand in hand to minimise opportunities for criminal activities through enhanced infrastructural project governance. The Namibian government should implement organisational measures to avoid bribery, such as the ISO 37001 for Anti-Bribery Management System Standard. This could enhance government agencies' credibility in infrastructure projects (Markov, 2019*)*. Namibian rail and road institutions and their stakeholders should comply with anti-corruption policies and processes to instil confidence among investors that might hold perceptions of unsound governance.

6.5.7 Towards innovation in the regulatory environment

In rethinking the financial relationship between rail and road institutions and the government, innovative policy measures by government legislators (the National Assembly) could incorporate trigger mechanisms for automatic funding that do not require parliamentary approval or public notification.

Government engagement in financial decision-making needs to be regulated using policy tools, such as creating internal and external stakeholders' consortia to balance government interests with corporate and economic realities in broader strategic-level planning. This would foster responsible, streamlined decision-making and increased financial accountability on the one hand while balancing rail and road institutions' operational dynamics with government involvement and the national interest on the other. Stakeholders that are familiar with regional and continental sector procedures should be part of such consortia. A parliamentary committee could also be established to focus on logistics, transport, and related sectors and streamline the vision for the logistics hub. This would ensure that the sector has an agent for direct contact with parliament on sector-related issues.

A special alternative financing organ could also be established to supplement the regular statutory funding and incidental situation funding the government provides annually for road and rail operations. As part of this option, taxes, levies, rebates, and statutory minimum investment requirements could be imposed on all individuals, organisations, and entities for using services offered by the national economy's transport and logistics sector. All logistics firms and industries, logistics-related activities, and commercial activities backed by logistics could be part of this financing body, which would receive and handle specific taxes, levies, and possibly rebates, allowing for wide-ranging sectoral investment.

Policy might include a scheduled national review of legislation, government policy, and norms and standards governing the logistics and transportation sector to ensure that the legislative environment keeps pace with the economic environment. A favourable regulatory environment is critical in establishing and maintaining logistics clusters (Savage et al., 2013), as it sets the tone for business operations and development. A long-term perspective on jurisprudence is required to ensure that laws remain stable over time and create conditions that attract investment. Investing in a more favourable legal environment for the logistics business may help the overall industry in the long run.

6.5.8 Fiscal recommendations

The Namibian government should implement the provisions of the public-private partnership (PPP) Act of 2017 to capture private sector financing to alleviate the burden on the fiscus to develop the transport sector. Government resources are limited due to the persistent drought and COVID-19 pandemic; therefore, the government needs to address any leakages in spending, particularly in the transport infrastructure sector; this could include improved budgetary control measures and realistic expenditure projections. Such measures will reduce excess budgetary losses and ensure that budget allocations align with anticipated spending.

6.5.9 Cross border and customs

The SADC region should introduce One Stop Border Posts, ASYCUDA and single window systems to remove bottlenecks at border posts to enhance the performance of corridors and increase trade competitiveness. Additional parking facilities and truck ports need to be constructed for truckers. Given the old infrastructure at the weighbridges and border posts, customs procedures and information systems should be automated and harmonised and data should be exchanged. This will eliminate the need to reweigh trucks that have already been weighed at regional borders. Pre-clearing cargo in advance of its arrival at the border would reduce the amount of time it takes for it to be released.

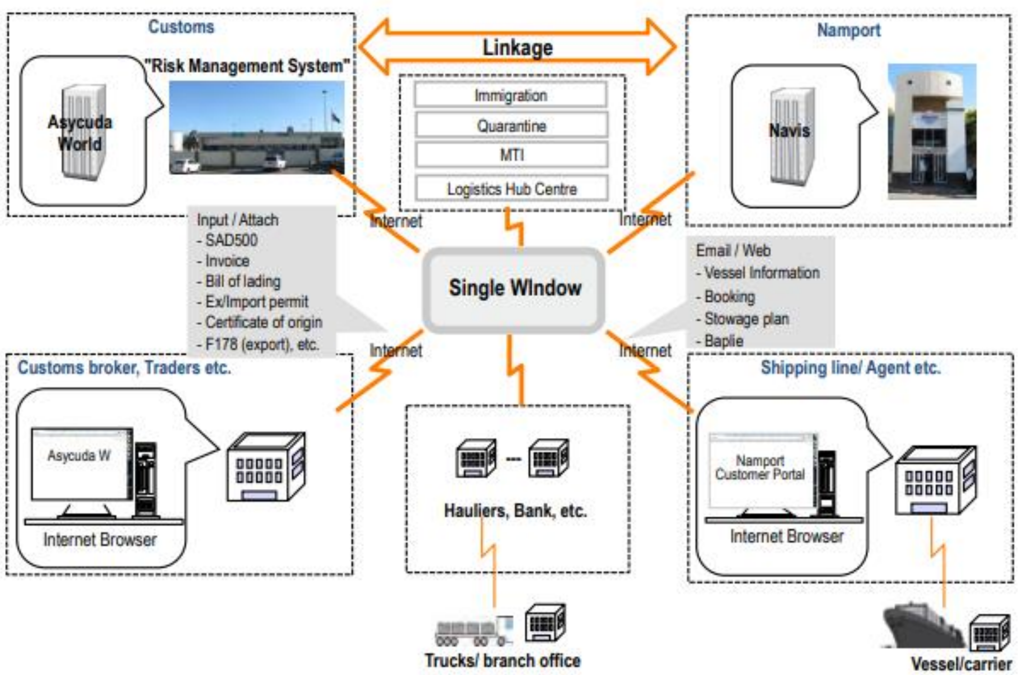


Figure: 6-4 Integrated IT system

Source: JICA team

The government could also look into using IT to optimise surveillance, safety, and security at border crossings. Rooting out bribery, corruption, and unlawful payments would ensure that only legally loaded vehicles cross the border. Law enforcement agencies should collaborate and synchronise their actions throughout corridors to reduce the number of roadblocks and increase risk identification and compliance. Physical disruption of traffic flow can be reduced by constructing strong ICT systems for traffic control and corridor visibility and monitoring. Data-sharing platforms between transport regulators and border stakeholders should be integrated to improve the region's business climate.

6.6 Contribution of the Study

Research often aims to find a possible solution. Researchers tend to focus on the disparity between what is known to be effective, theory, and how broadly such strategies are employed. This section focuses on the management implications or the study's contributions to the body of knowledge and practice. The fact that this study assessed the preparedness of Namibia's transport systems for a regional logistics hub is significant. In addition, by reviewing empirical research on this topic, the researcher identified methodological discrepancies during data analysis that were modified to address similar problems and produce this original study. The study addressed emerging national, regional, and global transport system concerns and the aspirations of countries that have an ocean front to become internationally recognised logistics hubs. Its major objective was to examine the notion of a logistics hub and the dependent variables, such as transport networks, from a novel angle. Most previous studies on logistics hubs and transport systems focused on the individual factors/variables that contribute to a port's effectiveness and/or efficiency, such as the various transport systems. This study shifted the emphasis to the vital transport systems that enabled the efficiency and effectiveness of the port of Walvis Bay in Namibia. The framework developed by the researcher, the LOC smart transport online system, would mitigate some of the difficulties encountered by stakeholders.

6.6.1 Contribution to Knowledge

A doctoral thesis traditionally indicates a high level of intellectual activity within the academic subject as a unique contribution to knowledge. This study contributes to the body of knowledge in two areas, methodological and practical. The first contribution is the development of a model/

software application for freight TDM called LOC Smart Trucking. Traditionally, the government increased road user charges to fund the expansion of transport networks, which did not raise the funding required. Most trucking companies closed down and/or could not afford fleets of trucks due to the impacts of COVID-19. Empty return haulage seems to be the order of day, placing an additional financial and infrastructural burden on businesses. The Namibian government's priorities have changed since COVID-19 and it has focussed on its after-effects and long-term effects; resources may have been redirected from long-term infrastructure development and logistics optimisation. Further research is required to build on the outcomes of this study to align with current government priorities and address the pressing needs arising from the pandemic. Flexible, adaptable research approaches will be crucial in responding to the evolving situation.

Funds budgeted for infrastructural development are being diverted to other critical needs. Given this scenario, what can be done to sustain the transport infrastructure with minimal investment? The recommended solution is LOC Smart Trucking, an initiative that seeks to improve transportation systems and work towards creating seamless transportation networks. This would be accomplished by reducing the number of commercial vehicles and the use of private vehicles and trucking services that are not required, and by promoting more environmentally-friendly, efficient modes of transportation. LOC Truck Smart is an application that will improve communication across supply chain management, logistics management, and transportation management. The concept was designed with the intention of maximising the use of available transport capacity, enhancing road safety, cutting down on carbon emissions, and minimising the impact of traffic congestion. One advantage of successfully sharing transportation is a reduction in the number of journeys made by transporters. The container truck itself, driving regulations, port operation hours, and the diverse range of container categories all contribute to technical issues (such as carrying capacity) in the context of an effort to share trucks.

The study also makes a methodological contribution in that it employed a mixed methodology integrating document review, closed-ended questionnaires and interviews. These techniques yielded results that pointed to methodological discrepancies in the findings. For example, the document review indicated that the port was well connected and highly accessible; however, the participants were of the view that this was not the case. The participants also noted that there were only three road networks, one of which was gravel and little or less utilised, and the second route through Henties Bay carried less than 2% of the freight. The obsolete rail transit system is unreliable. Moreover, the indicators from the document review on congestion implied that there was no congestion; yet, the qualitative data obtained from the interviews pointed to congestion.

Several studies have defined congestion from a quantitative perspective (Rosenbloom, 1978; Rothenberg, 1985; Institute of Civil Engineers, 1989 cited in Miller & Li, 1994; Vuchic & Kikuchi, 1994; Bovy & Salomon, 2002; Pisaraski, 1990 cited in Miller & Li 1994). However, the EMCT (1999) explored an alternative approach to congestion based on a qualitative perspective. This was based on the fact that a quantitative approach mainly focuses on the demand capacity of roads, whereas the qualitative one based on the environmental impact of congestion on roads is not considered as one of the key defining criteria of congestion. Thus, it is imperative that the qualitative approach to defining congestion is considered. These findings are crucial and demonstrate the significance of triangulating research methodologies.

6.6.2 Practical Contribution

The study makes three practical contributions: the development of a software programme, the need for more localised and precise action plans in the planning and implementation of the master plan, and the recommendation that the port be located in Arandis. The proposed LOC Smart Trucking is a viable alternative to conventional revenue-generating methods and increasing fuel taxes to garner funds for infrastructure construction. Although the collection of revenue through road user fees and fuel levies has proven effective in other nations, they are moving away from this method as a means of generating revenue for transportation infrastructure. In the short term, Namibia and other nations should pursue this novel method of smart transportation and demand management in freight transit.

Furthermore, the researcher recommends that Namibia formulate action plans and short-term plans drawn from the master plan that are subject-specific and address specific issues such as infrastructure, investment, and funding. Detailed objectives should be set along with a breakdown and procedures to achieve specific targets. This would be undertaken by the National Planning Commission. Rather than focusing on a network-wide strategy for infrastructure, planning, and management purposes, the Ministry of Works and Transport should invest in critical networks that generate bottlenecks, such as the one between Karibib and Swakopmund.

The study found that Namibian highways are quite narrow and since the port serving as a logistic operations centre is being expanded, the volume of the logistics operations' major mode of transport is extremely high risk. To securely accommodate heavy goods vehicles, roads with a minimum lane width of 3.5 metres are required; however, the survey revealed that the average lane width is 2.8 metres. The Ministry of Works and Transport should invest in expanding the road network from the port of Walvis Bay to at least Karibib to double lanes. All completed expansions are needed, but not critical to support the logistics hub vision. A functional and dependable national transportation system is also essential for the region's long-term economic development. Several elements impact the efficiency and dependability of any organisation's transport and logistics operations. Infrastructure development is an important aspect of transportation and logistics. In terms of transport management, Namibia struggles to maintain and upgrade its infrastructure since the country's road user charges (RUCS) fall short of what is required for growth and maintenance. Furthermore, railroad systems are crucial to supply chain management. Affordable rail systems can move a lot of freight a long way. Hwang et al. (2017) note that globally, current transport and logistics systems experience significant challenges, including traffic jams, environmental pollution, noise, traffic accidents, and freight flow congestion in freight terminals.

This study also highlights the importance of transport and logistics system operators in Namibia earning stakeholders' trust and commitment through proactive and reactive ways of handling their operations. Stakeholders should also consider expanding and overhauling the country's rail transport systems. Rail transportation is among the safest and most sustainable modes of transportation in the world. In order to improve transport systems' preparedness towards a regional logistics hub in Namibia, there is a need to revisit the transport system in order to eliminate the shortcomings relating to its implementation. There is also a need to improve budgetary allocations to stimulate transport systems and road developments.

Namibia should leverage its strategic location and commit to enhancing transportation infrastructure. The research highlights the potential for the nation to play a central role in shaping a sustainable trajectory for efficient and secure logistics and transport systems. Additionally, effective logistics hubs require the integration of all supply chain network partners and logistics security in terms of transport infrastructure, transportation costs, transit time and available modes of transport. Transportation efficiencies and safe and secure transportation services are essential for national development, collaboration, and job creation. Any land freight and passenger transit disruptions will have enormous effects on economic development, territorial integrity, social growth, and the environment. This calls for several risk-control measures, including distinctive train formations, improved vehicle and rail track maintenance, routing away from densely populated areas, specialised handling, and increased security.

6.7 Areas for Future Research

This study focused on transport systems' preparedness towards a regional logistics hub in Namibia based on a literature review and empirical investigation. Suggestions for further research are presented below.

6.7.1 Increased geographical scope of the study

Since the empirical investigation for this study was confined to transport systems' preparedness in Namibia, it is recommended that similar investigations be undertaken of transport systems' preparedness in other countries in the SADC region for a more comprehensive understanding of the influence of transport system preparedness as a motivator for logistics operations effectively.

6.7.2 Exploration of measures to improve training, recruitment and retention of transport and logistics personnel

This study established that the transport system in Namibia is not prepared in terms of accessibility, connectivity and centrality, especially from a rail perspective. Poor safety and security were observed in critical areas such as rail, sea, and road cargo transportation. To stimulate regional commerce, the port authority is expected to proactively manage overall port operations and aggressively advertise its ports to potential consumers by ensuring that port staff have the required level of skills and expertise. Any challenges related to port administrative services could impact port administrative management worldwide. It is thus recommended that research be conducted to establish measures to recruit and retain qualified managers in transport and logistics operations.

6.7.3 Simulation and quantification of the economic benefits of a fully-fledged logistics hub

Since this study focused on the extent of transport system preparedness, it is recommended that future studies simulate and quantify the economic benefits that are likely to accrue if the identified challenges are addressed. This would assist Namibian policymakers in understanding why it is important to address the challenges inhibiting the establishment of a logistics hub.

The study identified transport infrastructure as one of the operational challenges. Further research should be conducted on specific transport system infrastructure and areas for improvement to ensure a smooth and effective transport system to support logistics operations and enhance the transport systems' preparedness for a regional logistics hub. Due to the fact that this study was conducted during the COVID-19 pandemic, it is recommended that future studies consider sampling techniques as a limitation in obtaining reliable primary data from participants. An assessment could be undertaken to determine the extent of visibility of the supply chain process so that all the stakeholders in the flow of freight/products can track such movements in real-time (e.g., high-speed Internet connections, real time tracking (RTT) utilising GPS, GPS the IoT, barcodes, Transportation Management Systems (TMS), RFID tracking). Such integrated communication would not only enhance efficiency and effectiveness, but promote constructive, resilient stakeholder engagement and responsiveness to the dynamics of transport economics. The impact of a single heavily regulated rail operator as opposed to less regulated players in the industry should also be investigated.

6.7.3 Feasibility of pipeline transportation in Namibia

It is widely known that most freight is carried via road transport in Africa, and Namibia is no exception. Given that Namibia is a sparsely populated country with long travel distances, oil and gas transportation poses a significant risk. Delayed movement of trucks with a speed limit of 80 km/hr negatively affects driver behaviour, as drivers tend to drive more recklessly. A major challenge in this regard is the high accident rate experienced on Namibian roads, leading to fatalities and injuries. Therefore, the Namibian government should investigate the feasibility of transporting oil and gas via pipeline to reduce the number of heavy vehicles on the road network and consequently reduce the number of accidents.

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APPENDICES

Appendix A - Approval to Conduct Research – WBCG

WALVIS BAY CORRIDOR GROUP

HEAD OFFICE: P.O. Box 25220,
31 General Murtala Muhammed Avenue, Eros, Windhoek, Namibia
T. +264 61 251 669 F. +264 61 251 683 E. marketing@wbcg.com.na

DRC:	Lubumbashi	T. +322 386 5109	E. bdm@wbcg.cd
BRAZIL:	São Paulo	T. +55 11 2655-7301	E. ricardo@wbcg.com.br
ZAMBIA:	Lusaka	T. +260 21 129 4494	E. bdm@wbcgzm.com
SOUTH AFRICA:	Johannesburg	T. +27 11 258 8912	E. bdm@wbcg.co.za

WEBSITE: www.wbcg.com.na

22 February 2021

Mrs Gloria Tshoopara
Lecturer: Logistics and Transport
Marketing and Logistics
Namibia University of Science and Technology

Dear Mrs Tshoopara,

Subject: Request for permission to conduct research

Your letter dated requesting permission to conduct research bears reference.

We are in support of your topic 'Transport System Preparedness towards a Regional Logistics Hub in Namibia'. As the implementation agency of Namibia's Logistics Hub initiative, we welcome your research topic.

You are further welcome to contact Mr Gilbert Boois, who is WBCG's Manager for the Logistics Hub Project on logisticshub@wbcg.com.na

We wish you all the best with your research project and PhD studies.

Best regards,

[redacted]

Mbahupu H. Tjivikua
Chief Executive Officer

WBCG Directors: [illegible]

Company Reg. No.: 21/2000/152
VAT Reg. No.: 2527 105 - 015

Appendix B - Approval to Conduct Research – Office of the President

REPUBLIC OF NAMIBIA

OFFICE OF THE PRESIDENT

NATIONAL PLANNING COMMISSION

Tel: (061) 283 4111
Fax: (061) 226501
E-mail: enquiries@npc.gov.na

Government Office Park
Luther Street
Private Bag 13356
WINDHOEK

Enquiries: [illegible], 061 2834090

18 February 2021

Ms. Gloria Tshoopara
Lecturer: Logistics and Transport
Marketing and Logistics
Namibia University of Science and Technology

Dear Ms. Tshoopara,

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

Your letter requesting for permission to conduct research bears reference.

We support the research to your topic which is a priority for Namibia but we would encourage coordination from the Namibian side to be done by the Ministry of Works and Transport.

Yours Sincerely,

[redacted]

WILHENCIA UIRAS
EXECUTIVE DIRECTOR

NATIONAL PLANNING COMMISSION
2021 -02- 18

Appendix C - Approval to Conduct Research – NamPort

NAMIBIAN PORTS AUTHORITY

Enquiries: Helena Shigwedha
E-mail: H.Shigwedha@namport.com.na
Tel. no: 064 – 208 2371
Fax no: 064 – 208 2347

February 26, 2021

Ms. Gloria Tshoopara

Email: gloriatshoopara@gmail.com

Dear Ms. Tshoopara,

REQUEST TO CONDUCT RESEARCH FOR THE DOCTOR OF PHILOSOPHY IN THE NAMIBIAN PORTS AUTHORITY

This letter serves to confirm that your request to carry out research on Namport as part of your partial fulfilment of the Doctor of Philosophy at the University of KwaZulu-Natal has been approved on the following conditions:

Research Topic	Transport System Preparedness towards a Regional Logistics Hub in Namibia
Research Duration	One (1) Week
Conditions	You are required to sign a confidentiality agreement with NAMPORT before commencement of the study
	You are required to present the outcome of your research study to management at a time of mutual convenience

Kindly contact Mr. Jacob Orange at j.orange@namport.com.na for further guidance.

We take this opportunity to wish you the best with your research project.

Yours Faithfully,

[redacted]

JACOB ORANGE
MANAGER: OD AND TRAINING

Port of Walvis Bay (Head Office):
P.O. Box 361 Walvis Bay, Namibia

Port of Lüderitz:
P.O. Box 836 Lüderitz, Namibia

Appendix D – Approval to Conduct Research - MWT

REPUBLIC OF NAMIBIA

MINISTRY OF WORKS AND TRANSPORT

Tel: **+264 (0)61 - 208 811**
Fax: **+264 (0)61 - 228 560**
Telex: **(50908) 709**
Telegram: **NAMTRANS**

Private bag 13341, Ausspannplatz
6719 Bell Street, Snyman Circle
Windhoek, Namibia

Our Ref:...

Your Ref:...

Enquiries: Mr. H.H.J. Nambinga
Tel: 061-208 8100
E-mail: Hanganeni.Nambinga@mwt.gov.na

Mrs. Gloria Tshoopala
Windhoek

Dear Mrs. Tshoopala

REQUEST TO CONDUCT EDUCATIONAL RESEARCH AT THE MINISTRY OF WORKS AND TRANSPORT

1. Your application with regard to the afore-mentioned subject is hereby acknowledged and refers.

2. Permission is hereby granted for you to conduct research for your Doctoral thesis on Transport Systems and Logistics Hub, Titled: Transport System Preparedness towards a Regional Logistics Hub in Namibia. A case study of the Ministry of Works and Transport.

3. While conducting research at this Ministry you are requested to perform your research in a professional manner, including confidentiality. In addition, the information that you will gather, be used for research purposes only and the findings must be shared with the Ministry.

4. I wish you the best and trust that you will succeed in your studies

Yours sincerely,

[redacted]

ESTHER N. KAAPANDA
EXECUTIVE DIRECTOR

MINISTRY OF WORKS AND TRANSPORT
2021 -02- 24
EXECUTIVE DIRECTOR

"Effective and Efficient Delivery of Service"

All official correspondence must be addressed to the Executive Director

Appendix E – Interview Guide

Semi-structured Interview Question Guide

1. **What challenges inhibit Namibian's Vision of coming to a regional logistics hub?**
    - Operational challenges
    - Financial challenges
    - Infrastructural challenges

2. **Critical aspects of transport infrastructure for a thriving regional logistics hub in Namibia**
    - What is the prevailing and projected cost composition?

    Transport infrastructure cost drivers, e.g., Capital, Operational and Maintenance Costs.
    - How do current policies and regulations influence the various regional transport operations?
    - How effective and efficient is the transport infrastructure network?
    - The state of logistic infrastructural facilities (ports, container handling facilities, warehouses, modes of transportation)
    - How efficient is the intermodal transport network system?
    - Stability of the economic, political and social system for a successful regional logistics hub.
    - Do we have the required logistics expertise?
    - Collaboration between stakeholders

    The extent of centrality, accessibility and connectivity
    - Are we well connected to the regional logistics hub
    - Discuss challenges concerning connectivity and accessibility
    - Are there harmonised policies and regulations for collaborative efforts to enhance connectivity in the region
    - Discuss the degree of infrastructural and modal integration between road and rail in Namibia.

3. **Transport system Key Performance Indicators**
    - Discuss the transport systems' key performance indicators.
    - Which KPI are overlooked?

4. **Travel Demand Management**
    - Do we have a centralised system for data collection?
    - What are the challenges you experience in managing demand?
    - How does New Technology impact demand?

- How do land use and urban planning impact demand?
- What is the impact of transport charges on multimodal demands?

Appendix E -1 – Questionnaire

College of Law and Management Studies

School of Management, Information Technology and Governance

Research Thesis – Questionnaire

Title: Transport systems preparedness towards a regional logistics hub in Namibia.

Dear Respondent

I am Gloria Tshoopara, a registered PhD candidate with the University of KwaZulu Natal in Durban, South Africa. I am conducting a study on transport system preparedness towards a regional logistics hub in Namibia. This study aims to evaluate the current progress and challenges regarding the achievement of the regional logistics hub.

I humbly request you to spare a few minutes and answer the questionnaire below. Your participation is entirely voluntary. Please note your responses will remain anonymous and confidential. If you choose to participate in this research, please answer all questions as honestly as possible.

The questionnaire will require approximately 20 minutes to complete. There is no compensation for responding, nor is there any known risk. The data collected will provide valuable information regarding whether the Namibian transport system is prepared to facilitate a regional logistics hub. The information gathered will only be used for educational purposes. The study aims to produce three published articles. Should you want to review the finding, please send a request via email (gloriatshoopara@gmail.com) to receive the links to the publications. The final thesis will also be published on the UKZN library website.

Thank you for taking the time to assist me in my educational endeavours. If you require additional information or have questions, don't hesitate to contact me on the details provided below.

Your participation is profoundly valued.

Sincerely,

Gloria Tshoopara

Cell phone: +264 812415140, email: gloriatshoopara@gmail.com

Appendix E -2 Questionnaire

Section A: Research preposition

SECTION A: DEMOGRAPHICS

1. Tick the most relevant to your position.

Top Management ☐ Middle Management ☐
Lower Management ☐ Other, please specify: ____________

2. How long have you been in been employeed?

0-2 years ☐ 3-5 years ☐ 6-10 years ☐ 11 (+) years ☐

3. What is your highest level of education?

Primary ☐ Secondary ☐ Diploma ☐ Degree ☐

Masters ☐ PhD ☐ Other, please specify:

4. Mark with an X in your sector:

☐ Freight Forwarders/3PL/4PL	☐ Walvis Bay Corridor Group
☐ Transport operators	☐ Ministry of Works and Transport
☐ NamPort	☐ National Planning Commission
☐ TransNamib	☐ Regulatory Customs and border control
☐ Roads Authority/Roads Contractors Company	☐ Other, please specify: ____________
☐ Vessel Agents	

Appendix E -3 - Questionnaire

Section B: Research preposition

5. Rate the below variables on how they challenge your operations

Construct Measure	Item no	Variable	Extremely Challenging	Very Challenging	Moderately Challenging	Slightly Challenging	Not Challenging
Transport System Operational Challenges	TSC1	Long-distance travel					
	TSC2	Old transport Infrastructure					
	TSC3	Connectivity to all prefered terminals					
	TSC4	Reliability of transportation modes					
	TSC5	Transportation costs					
	TSC6	Customs regulations					
	TSC7	Cross-border delays					
	TSC8	Transit time					
	TSC9	Option to change consignment from one mode to another					
	TSC10	Availability of various transportation modes					
	TSC11	Storage facilities					
	TSC12	Transport and logistics expertise (human skills)					
	TSC13	Attitude, service and culture of service providers					
	TSC14	Intermodal transportations					
	TSC15	Traffic regulations					
	TSC16	Cross-border traffic regulations					
	TSC17	Capacity constraints					
	TSC 18	Availability of railway services					
	TSC19	Road conditions					
	TSC20	Traffic congestion					
	TSC21	Safety and Security					

Appendix E -4 - Questionnaire

1. Rate the below KPIs on how they challenge your operations

Construct Measure	Item no	Variable	Extremely Challenging	Very Challenging	Moderately Challenging	Slightly Challenging	Not Challenging
Transport System KPI	TS1	Punctuality					
	TS2	Reliability					
	TS3	Transfer of cargo/freight to other modes					
	TS4	Congestion					
	TS5	Load capacity					
	TS6	Delays					
	TS7	Availability of railway services					
	TS8	Accessability to rail services (coverage)					
	TS9	Travel disntance					
	TS10	Speed					
	TS11	Cargo security					
	TS12	Tracing and Tracking					
	TS13	Safety concerns					
	TS14	Affordability					

Appendix E -5 - Questionnaire

Section C

2. Which countries do you trade with below from the Walvis Bay port? You can choose as many countries as possible in accordance with your operations.

Construct Measure	Item no	Variable	Tick ✓
Trading partners	**TRP1**	Angola	
	TRP2	DRC	
	TRP3	Zambia	
	TRP4	Malawi	
	TRP5	Zimbabwe	
	TRP6	Botswana	
	TRP7	South Africa	
	TRP8	Namibia	

3. Would you please indicate which modes of transportation you use to connect to the below countries? You can choose more than one mode.

Construct Measure	Item no	Variable	Railway	Road	Sea
Routes connectivity	**RCO1**	Angola			
	RCO2	DRC			
	RCO3	Zambia			
	RCO4	Malawi			
	RCO5	Zimbabwe			
	RCO6	Botswana			
	RCO7	South Africa			
	RCO8	Namibia			

Appendix E -6 - Questionnaire

4. Would you please indicate your average speed on the below corridors?

Construct Measure	Item no	Variable	60 km/h	80 km/h	100 km/h	120 km/h	n/a
Corridors Average Travel Speed	RCO1	Trans Kalahari Corridor					
	RCO2	Trans Cunene Corridor					
	RCO3	Trans Oranje Corridor					
	RCO4	Trans Caprivi Corridor					

5. Would you please rate the below Logistics services for each country?

Construct Measure	Item no	Variable	Angola	DRC	Zambia	Malawi	Zimbabwe	Botswana	South Africa
Logistics Services	LSR1	Warehouses	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
	LSR2	Storages Facilities	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
	LSR3	Dry Ports	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
	LSR4	Distribution Centers	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
	LSR5	Clearing Services	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
	LSR6	Bonded Warehouses	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.
	LSR7	Efficient IT Infrastructure	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.	Choose an item.

Appendix E -7- Questionnaire

SECTION C: SOFT DATA BASED ON STAKEHOLDERS' PERCEPTIONS

6. Would you please rank the Namibian infrastructures below

Construct Measure	Item No	INFRASTRUCTURE	Very Good	Good	Relatively Milds	Poor	Very Poor
Transport modes infrastructure		**Rank the road infrastructure variables below**					
	RTI1	Road Traffic Signs					
	RTI2	Road Quality					
	RTI3	Road Coverage					
	RTI4	Cargo Security					
	RTI5	Travelling time					
	RTI6	Traffic Flow					
	RTI7	Speed					
	RTI8	Safety Concerns					
	RTI9	Travel distance					
	RTI10	Load capacity					
	RTI11	Connectivity to other modes					
	RTI12	Intermodal					
	RTI13	Tracing and Tracking					
	RTI14	Congestion					
	RTI15	Delays					
		Rank the railway infrastructure variables below	**Very Good**	**Good**	**Relatively Milds**	**Poor**	**Very Poor**
	RWI1	Load capacity					
	RWI2	Affordability					
	RWI3	Congestion					
	RWI4	Cargo Security					
	RWI5	Transfer Cargo/multimodal					
	RWI6	Tracking and Tracing					
	RWI7	Safety and Security					
	RWI8	Reliability					
	RWI9	Travel distance					

Appendix E -8 - Questionnaire

RWI10	Punctuality					
RWI11	Delays					
RWI12	Speed					
RWI13	Accessibility to rail services (coverage)					
RWI14	Availability of railway services					
	Rank the ports infrastructure and operational variables below	**Very Good**	**Good**	**Relatively Milds**	**Poor**	**Very Poor**
PTI1	Capacity					
PTI2	Material Handling Services					
PTI3	Security in the port					
PTI4	Safety in the Port					
PTI5	Storage Facilities					
PTI6	Cargo Security					
PTI7	Throughput rate					
PTI8	Skills and Expertise					
PTI9	Administrative services					
PTI10	Inspections prior to customs					
PTI11	Tracking and Tracing					
PTI12	Stay time of goods at the port					
PTI13	Availability of specialised terminals					
PTI14	Truck visit time					

SECTION D:

7. What do we need to have at the local, regional and international level become a regional logistics hub?

Local: ____

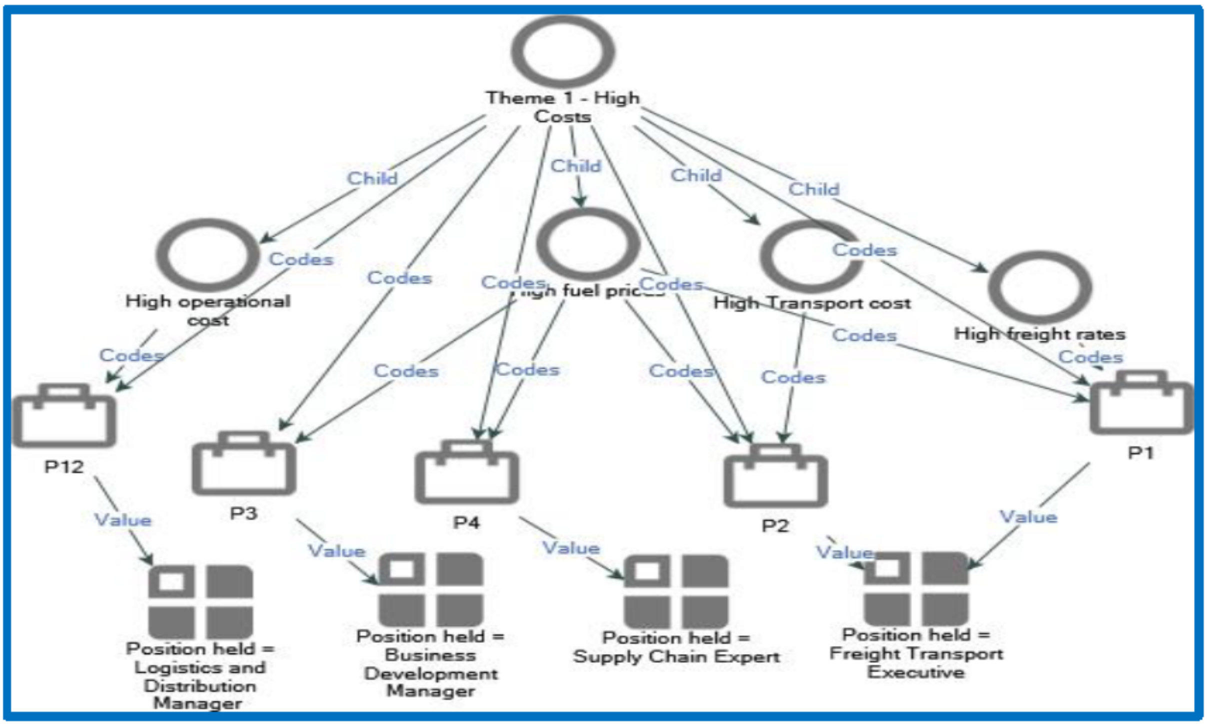
Regional: ____

International: ____

THE END

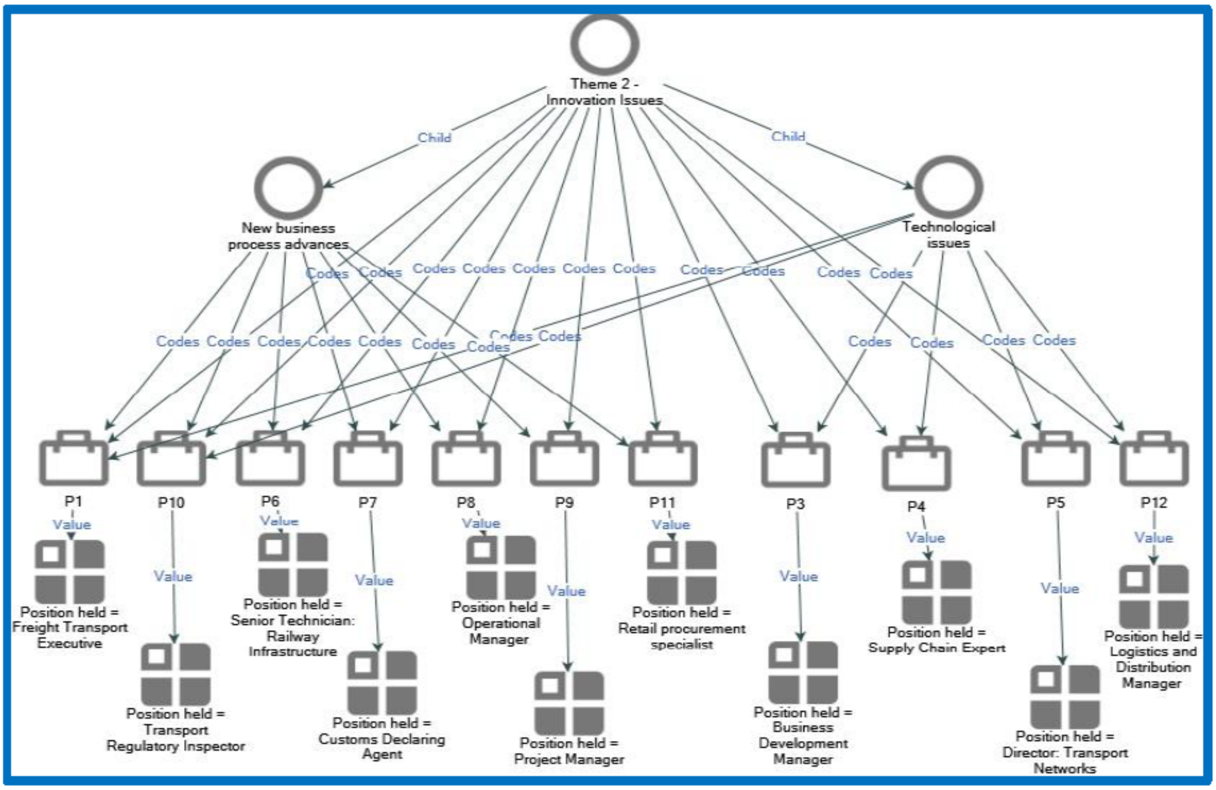
Appendix F – 1 – Thematic analysis

Figure 4-368: High Cost



Source: Extracted by Author from interviews

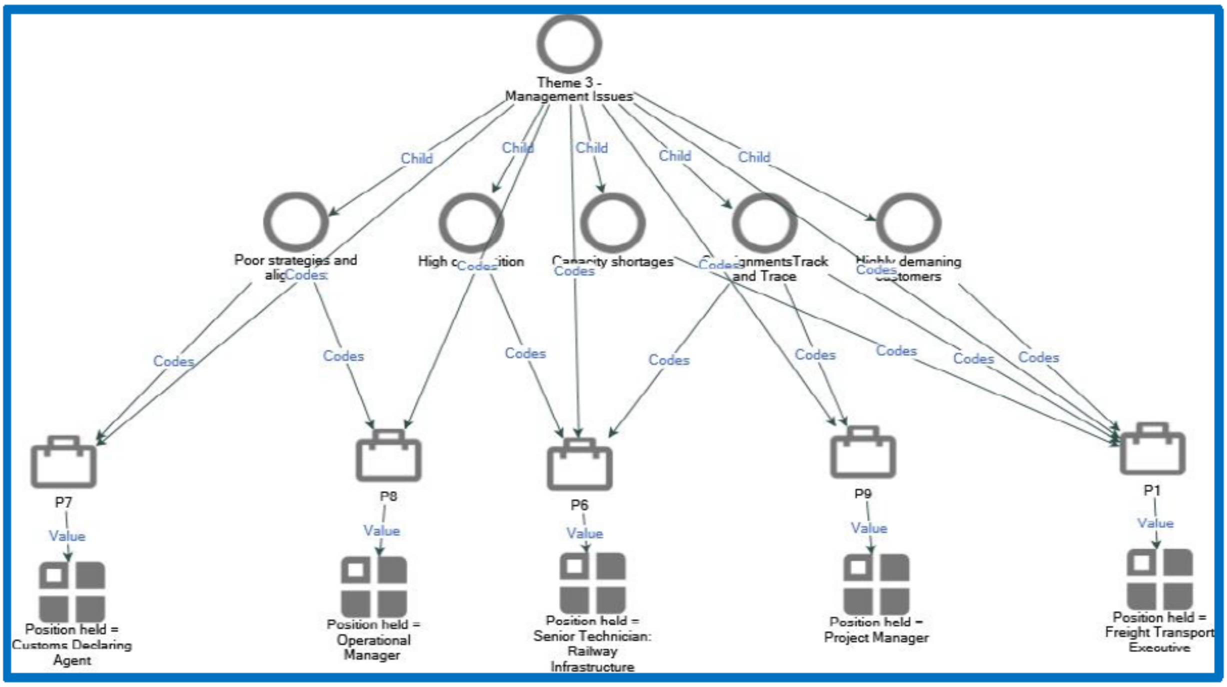
Figure 4-39: Innovation Issues



Source: Extracted by Author from interviews

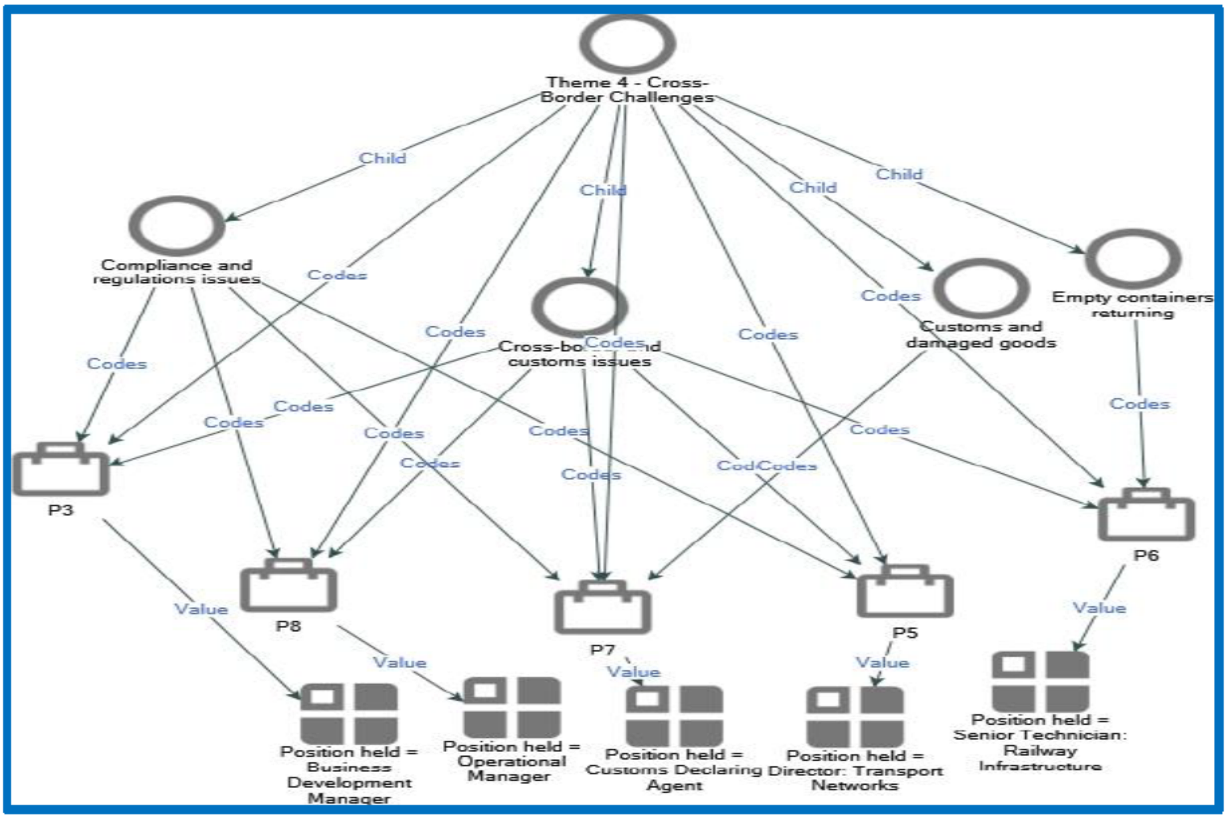
Appendix F – 2 – Thematic analysis

Figure 4-40: Managerial Issues



Source: Extracted by Author from interviews

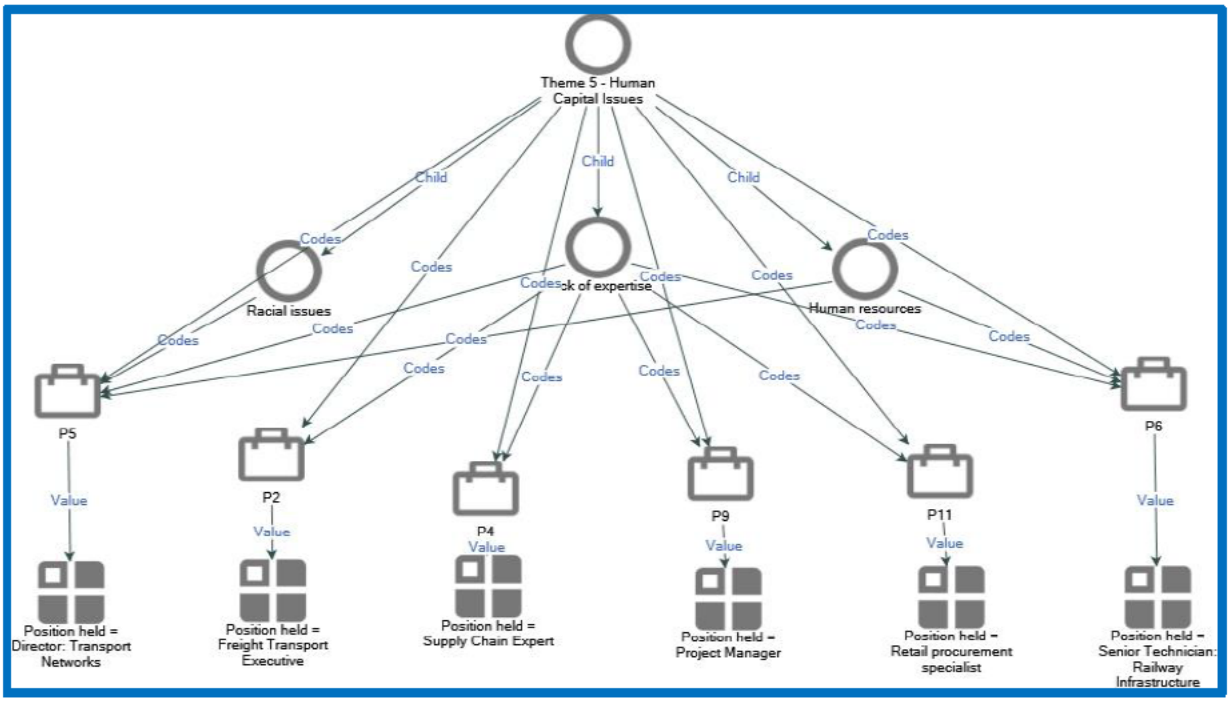
Figure 4-41: Border Challenges



Source: Extracted by Author from interviews

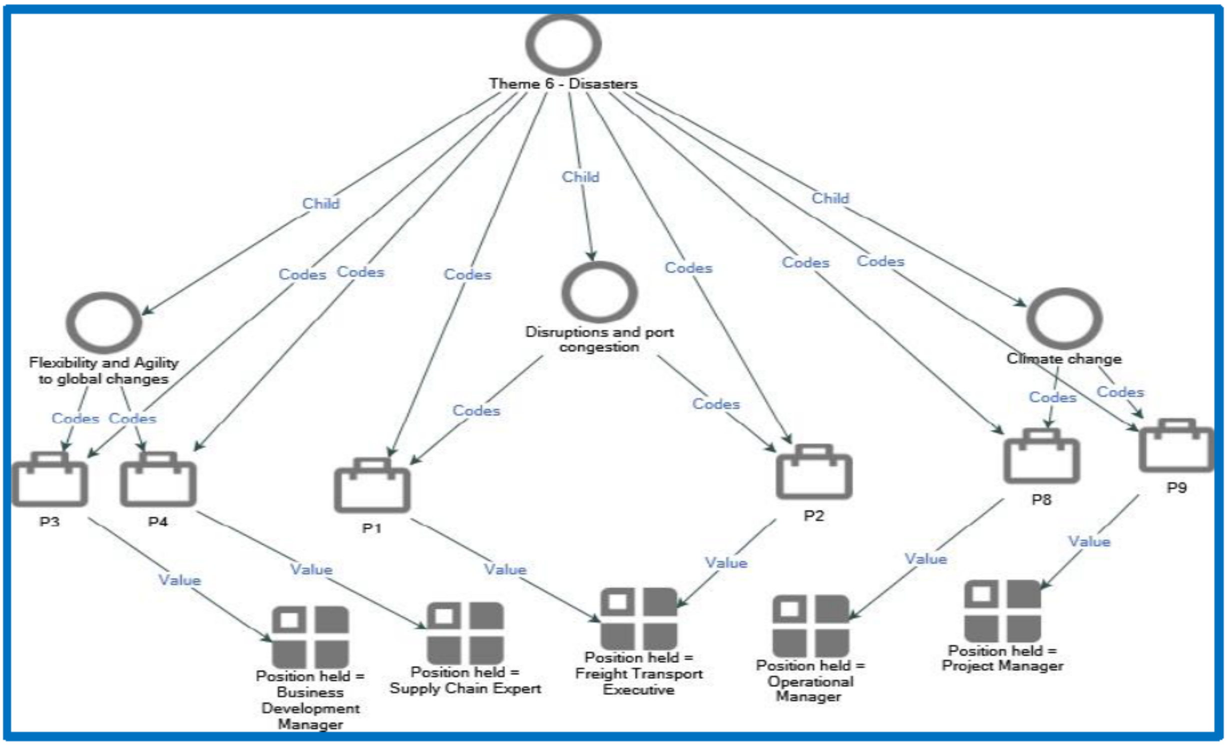
Appendix F – 3 – Thematic analysis

Figure 4-42: Human Capital



Source: Extracted by Author from interviews

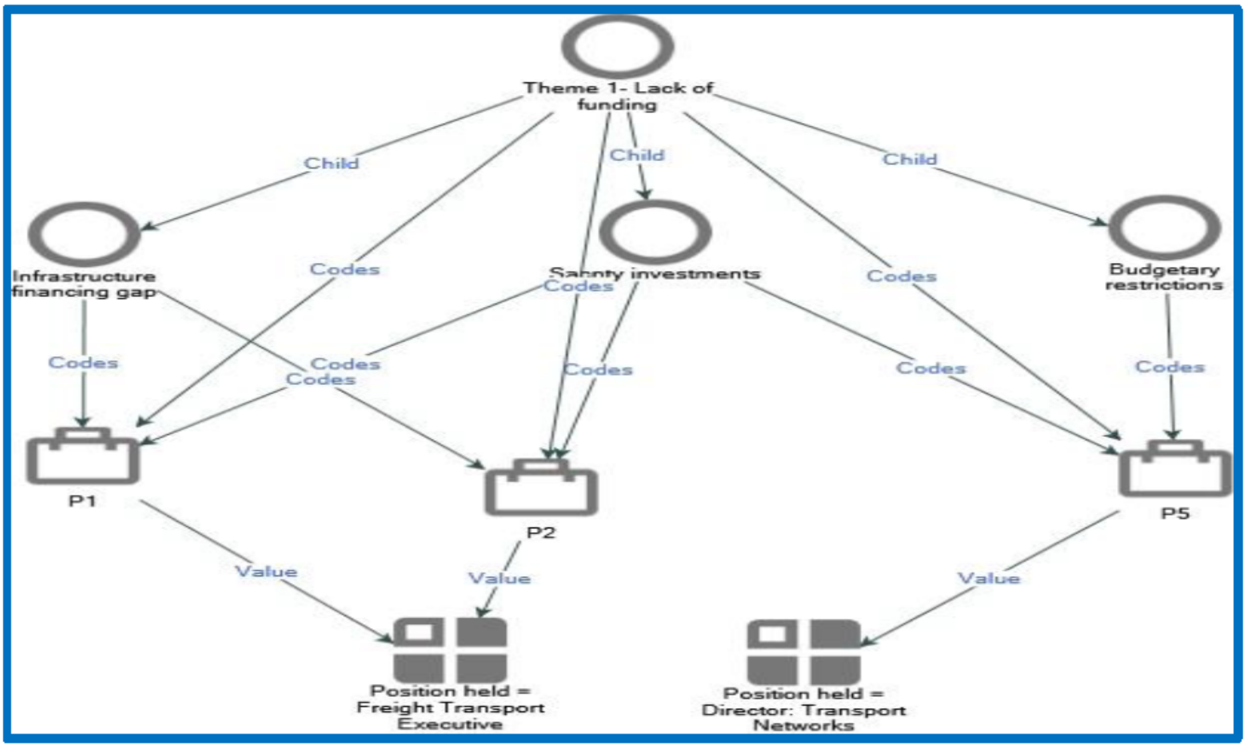
Figure 4-43: Disasters



Source: Extracted by Author from interviews

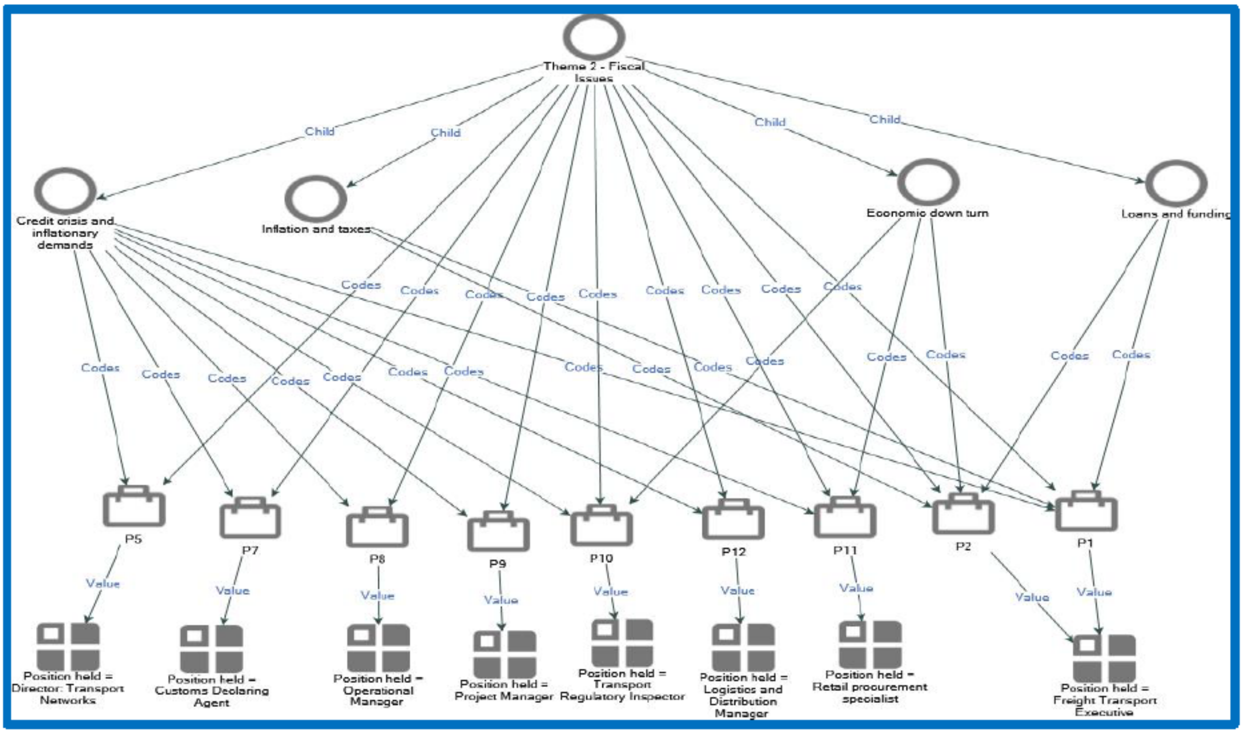
Appendix F – 4 – Thematic analysis

Figure 4-44: Theme 1 – Lack of Funding



Source: Extracted by the author from the interviews

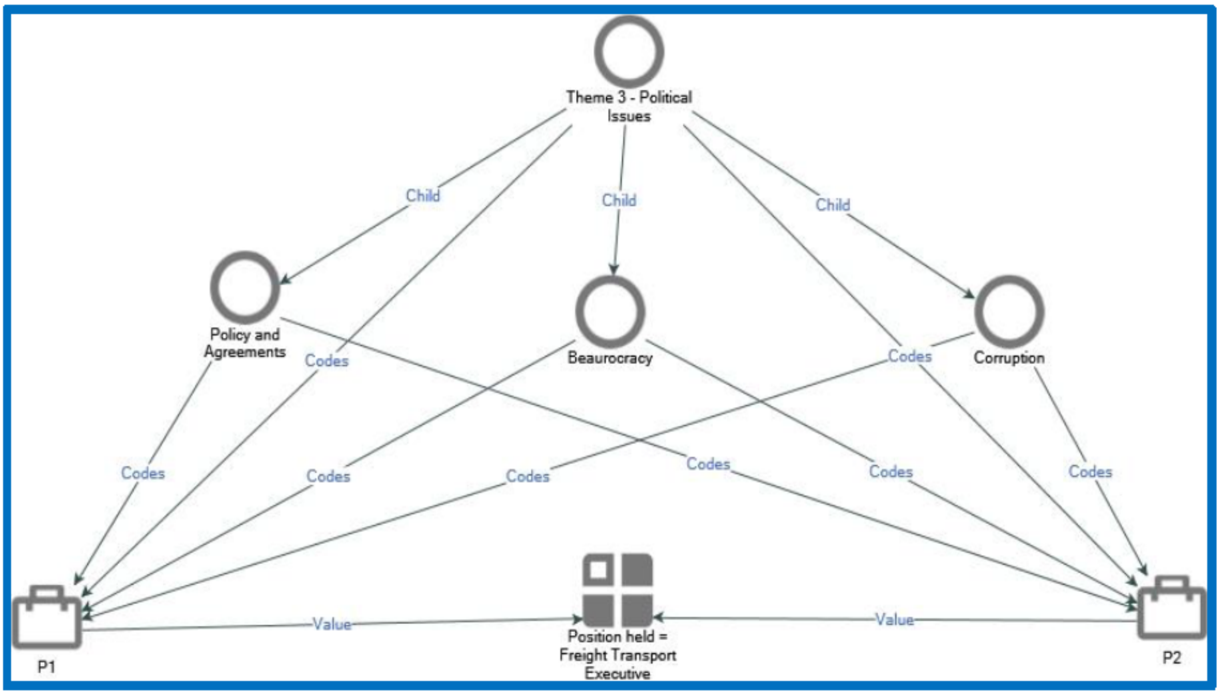
Figure 4-45: Theme 2 – Fiscal Issues



Source: Extracted by Author from interviews

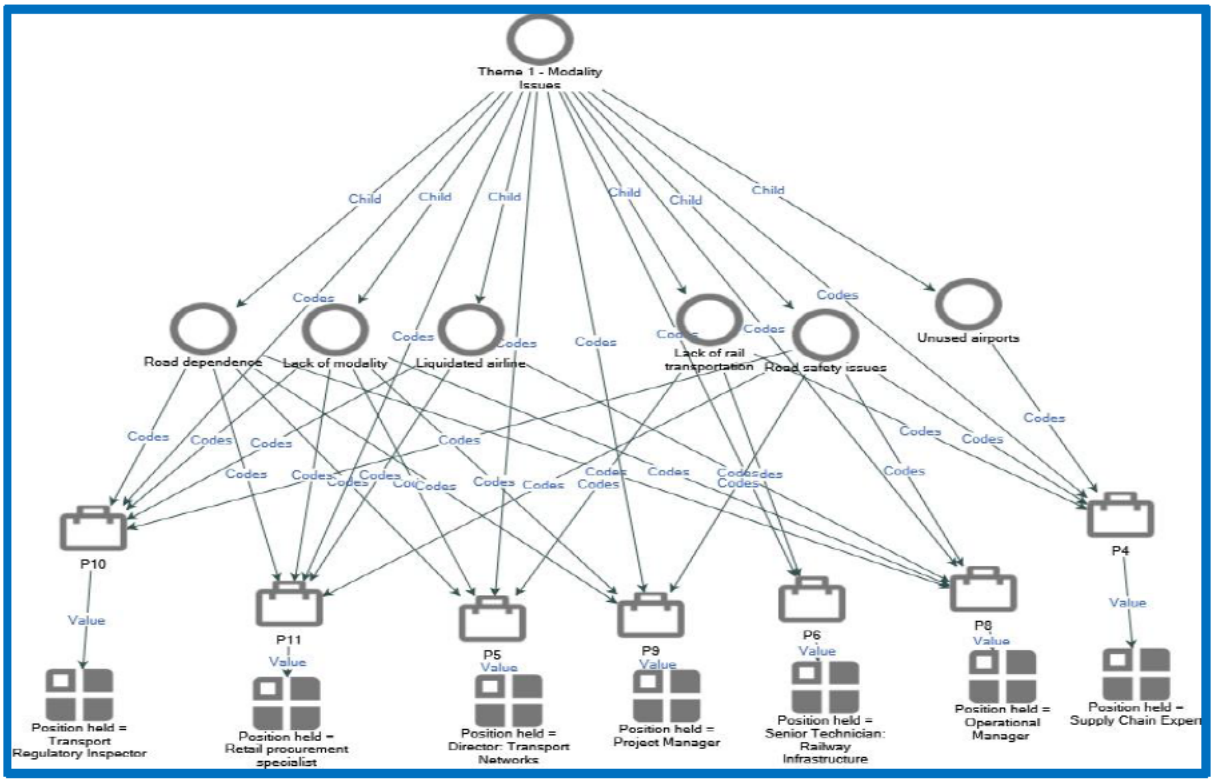
Appendix F – 5 – Thematic analysis

Figure 4-376: Theme 2 – Political Issues



Source: Extracted by author from interviews

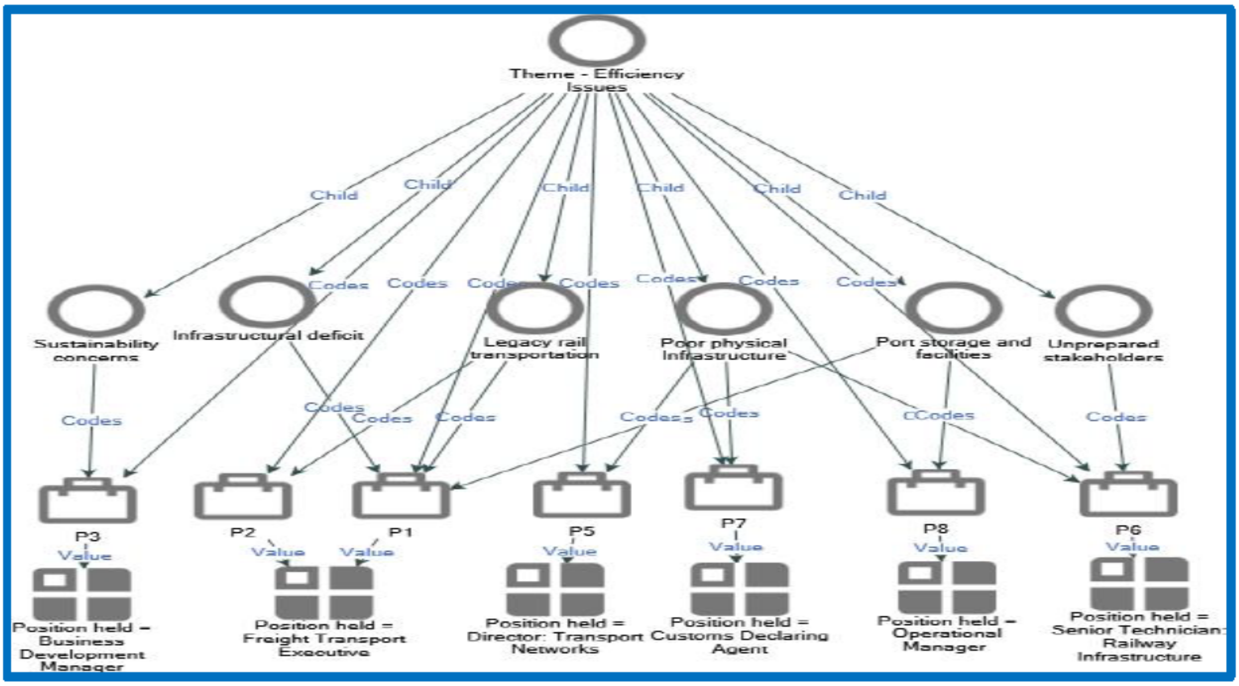
Figure 4-387: Infrastructural Challenges - Modality Issues



Source: Extracted by author from interviews

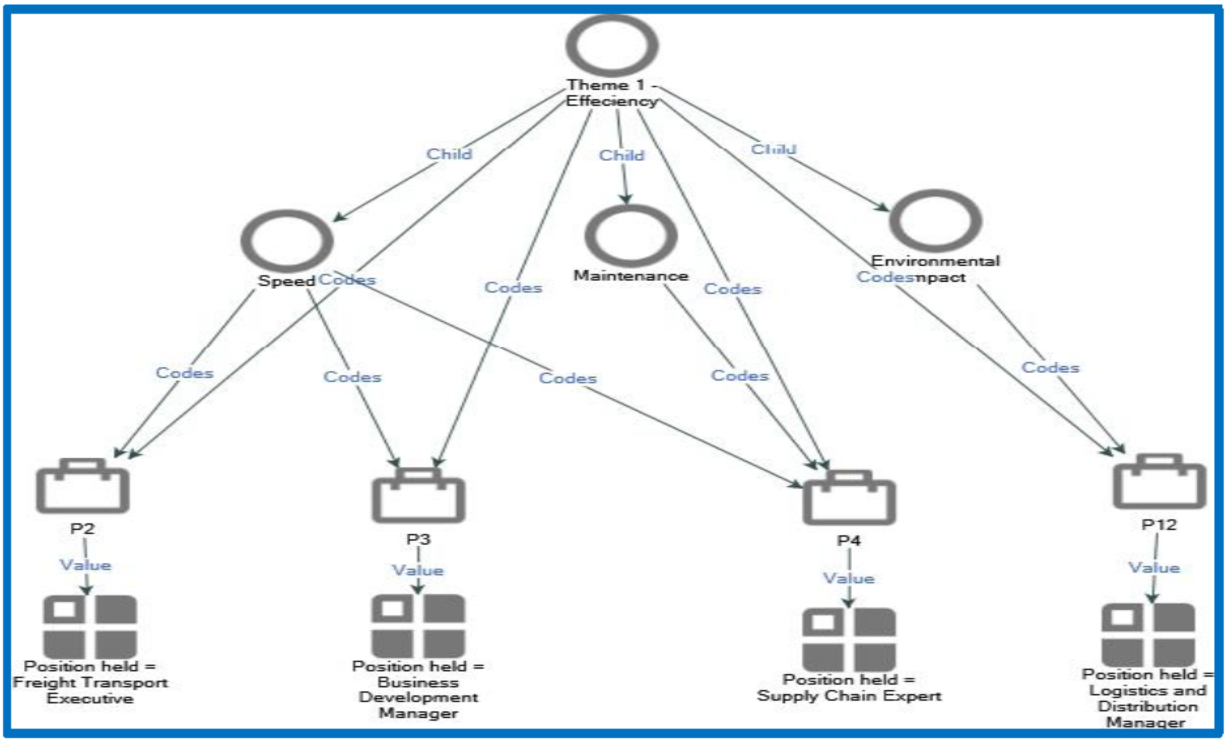
Appendix F – 6 – Thematic analysis

Figure 4-398: Theme- Infrastructural Challenges - Efficiency Issues



Source: Extracted by Author from interviews

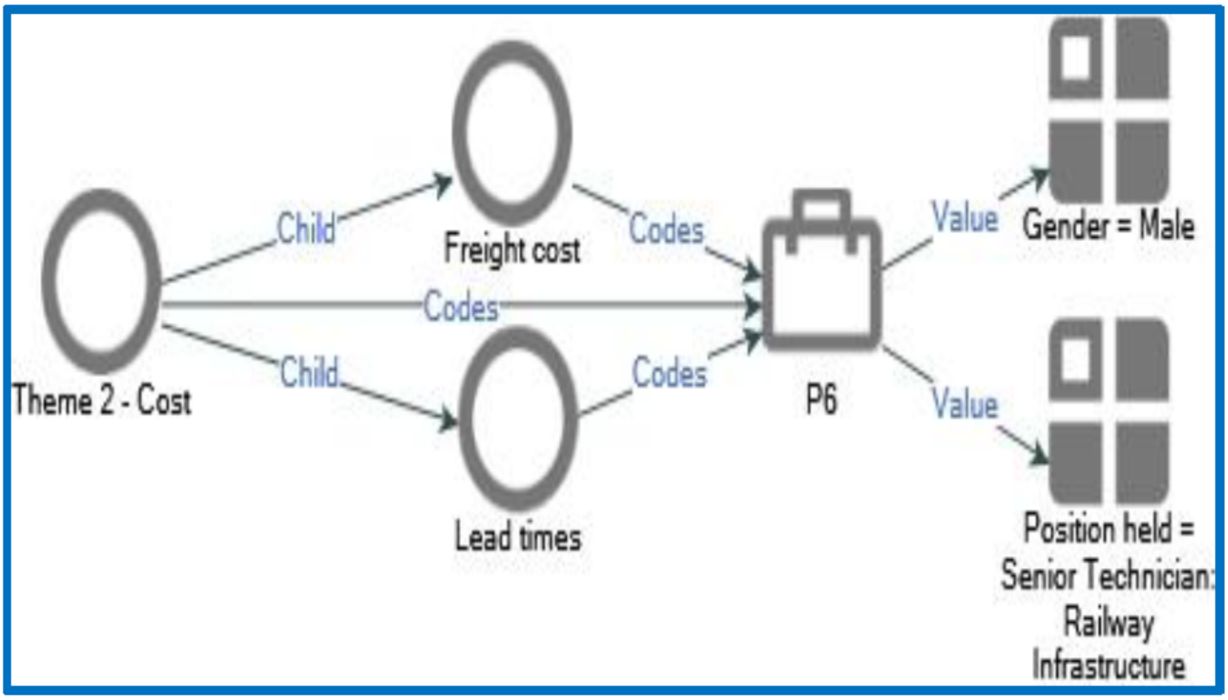
Figure 4-409: KPI – Theme 1 – Efficiency



Source: Extracted by author from interviews

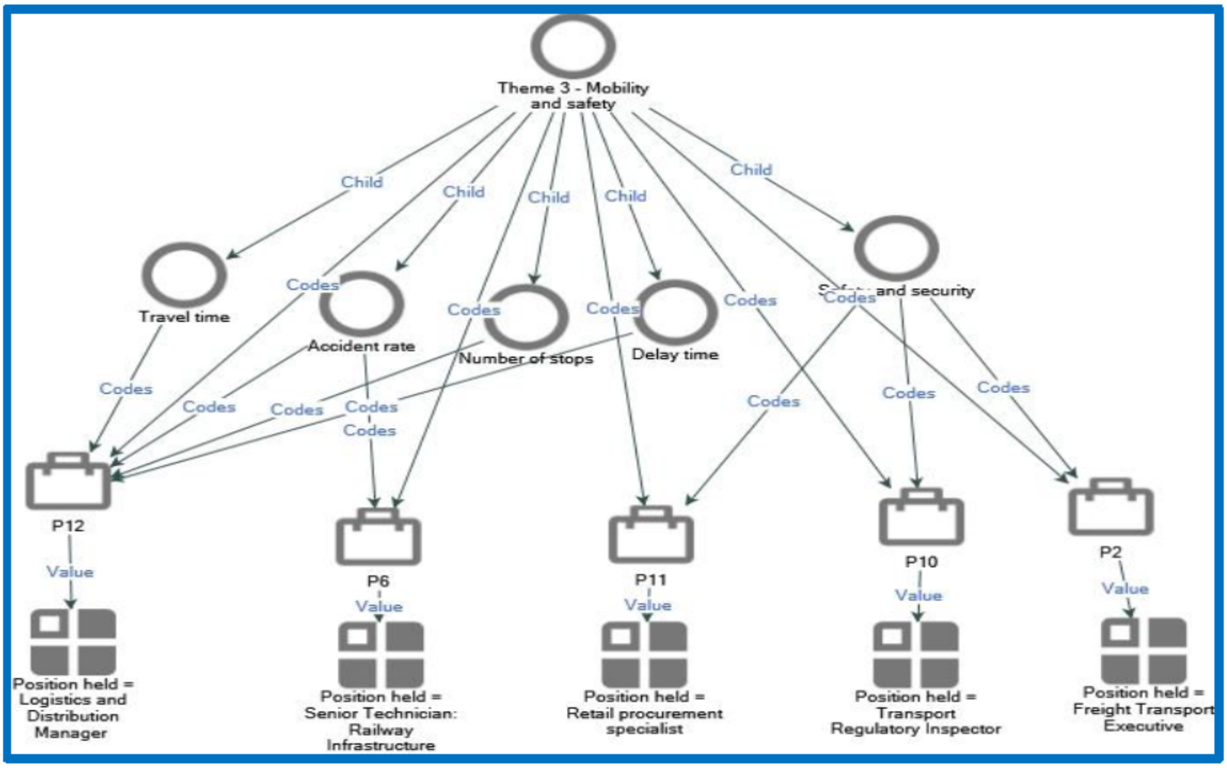
Appendix F – 7 – Thematic analysis

Figure 4-50: KPI – Theme 2 – Cost



Source: Extracted by author from interviews

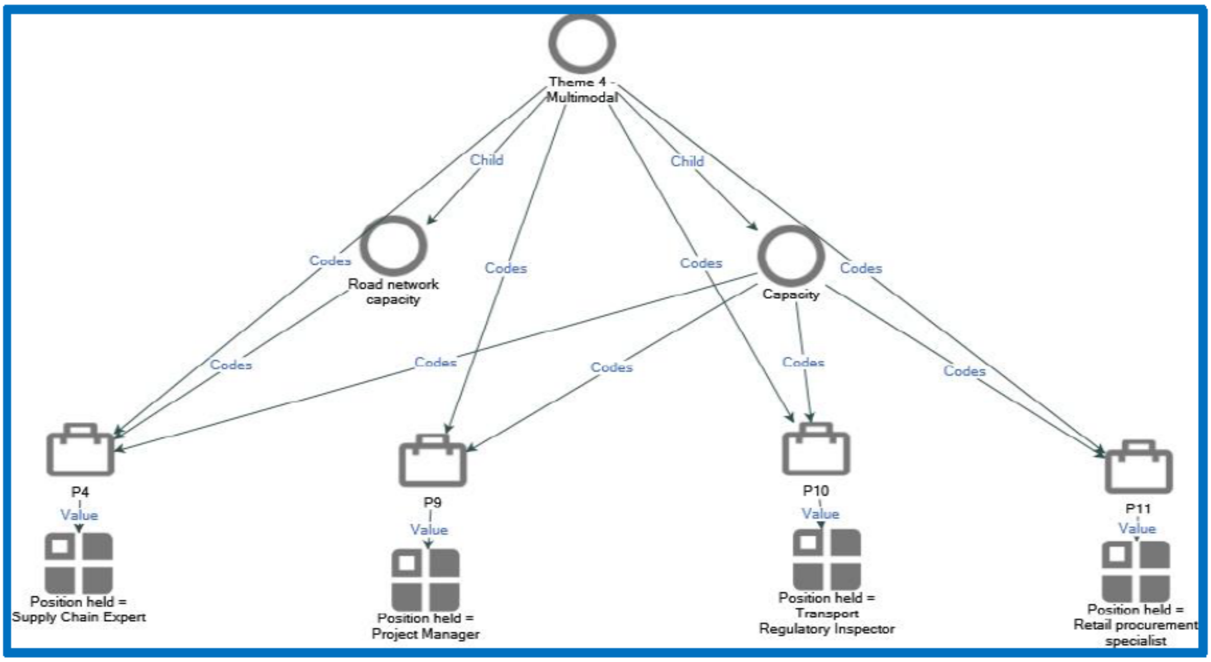
Figure 4- 51: KPI – Theme 3 – Mobility and Safety



Source: Extracted by author from interviews

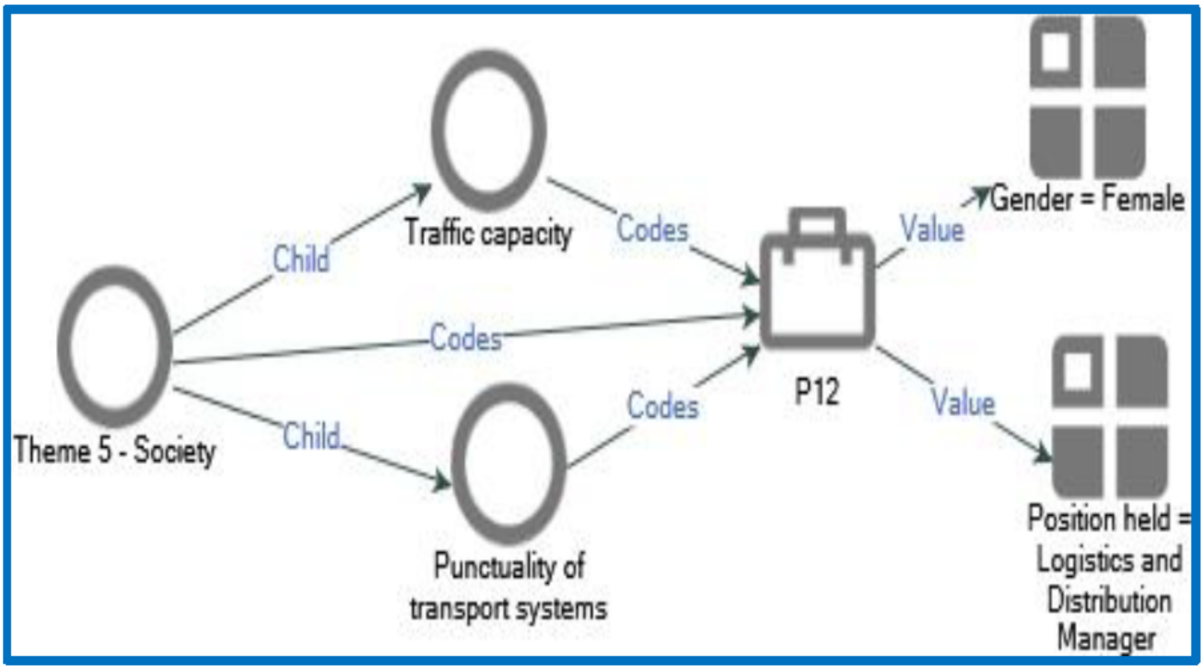
Appendix F – 8 – Thematic analysis

Figure 4-52: Theme 4 – Multimodal



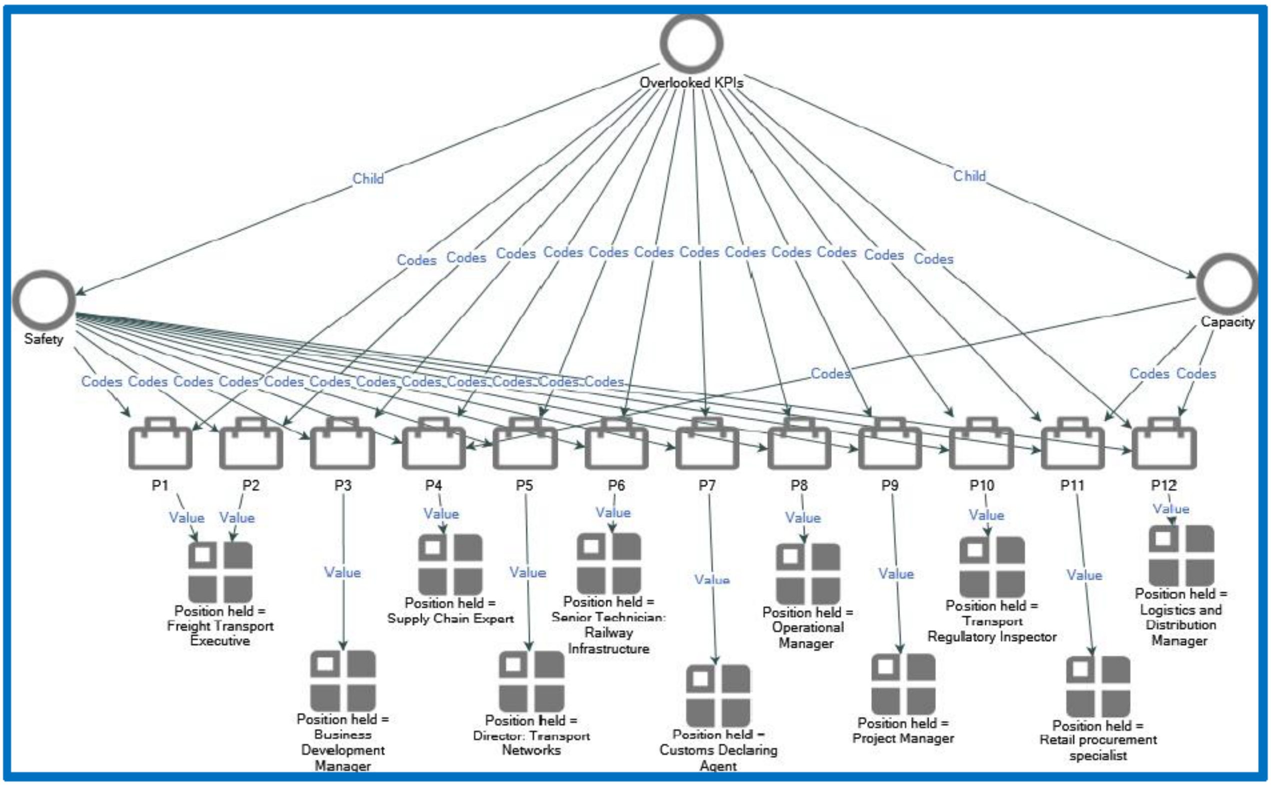
Source: Extracted by author from interviews

Figure 4-53: Theme 5 – Society



Source: Extracted by author from interviews

Appendix F – 9 – Thematic analysis
Figure 4-414: Overlooked KPIs



Source: Extracted by author from interviews

Appendix G – Letter from English Editor

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CONFIRMATION OF PROFESSIONAL EDITING

Date: 20 January 2023

I hereby confirm that I have done comprehensive language and technical editing of the following PhD dissertation:

Student:	Ms Gloria M Tshoopara (220112343)
Title:	Transport Systems' Preparedness towards a Regional Logistics Hub in Namibia
Degree:	PhD in Supply Chain Management
Faculty:	School of Management, Information Technology and Governance
University:	University of KwaZulu-Natal, South Africa

Kind Regards

[redacted]

Kefilwe Makhanya
Editor

I started my career as a Lecturer in the Department of Communication at the University of Fort Hare in 1986. My areas of specialization are Communication and Applied Linguistics. I have extensive, senior-level writing and editing experience in a broad spectrum of disciplines. For the past 8 years, I have focused specifically on editing non-fiction book manuscripts and academic work for senior students, researchers and academics from various SA universities and other parts of Africa.

Appendix H - Approval Notification

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

27 June 2021

Mrs Gloria Tshoopara (220112343)
School Of Man Info Tech & Gov
Westville Campus

Dear Mrs Tshoopara,

Protocol reference number: HSSREC/00002928/2021
Project title: Transport systems preparedness towards a regional logistics hub in Namibia
Degree: PhD

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 08 June 2021 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted FULL APPROVAL.

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

This approval is valid until 27 June 2022.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

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

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

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

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