A FRAMEWORK FOR IMPROVING STAKEHOLDERS' ACCEPTANCE OF PUBLIC TRANSPORTATION INFRASTRUCTURE PROJECTS IN MANGAUNG METROPOLITAN MUNICIPALITY, SOUTH AFRICA

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DECLARATION OF INDEPENDENT WORK

DECLARATION WITH REGARD TO

INDEPENDENT WORK

I, INNOCENT SHIMA AZEGE, identity number and student number , do hereby declare that this research project submitted to the Central University of Technology, Free State for the degree MASTER OF ENGINEERING: INGENIEERING: CIVIL ENGINEERING, is my own independent work; and complies with the Code of Academic Integrity, as well as other relevant policies, procedures, rules and regulations of the Central University of Technology, Free State; and has not been submitted before to any institution by myself or any other person in fulfilment (or partial fulfilment) of the requirements for the attainment of any qualification.

24/01/2020

SIGNATURE OF STUDENT **DATE**

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ABSTRACT

Quality and resilient transportation infrastructure plays a significant role in the socio-economic development of any nation. To underscore this, Goal 9 of United Nations' Sustainable Development Goals (SDGs) is devoted to the provision of quality and resilient transportation infrastructure. Despite its obvious significance, providing quality and resilient infrastructure is hampered by the chances of its non-acceptance by critical stakeholders from both developed and developing nations. Practical aftermaths of such a scenario can be seen in such transportation problems as traffic congestion, delays and accidents. This in turn leads to a slow pace of socio-economic development. A careful survey of available literature indicates that the prevailing non-prioritisation of this critical socio-economic infrastructure is traceable to the aloofness of stakeholders, poor communication among them, the location of projects, inadequate knowledge of infrastructure, project environmental impact, lack of trust, and administrative bottlenecks. However, the Bloemfontein Courant (15 December 2016; 22 July 2019) and Vaidyanathan, King and Jong (2017) have indicated that the rejection of some public transportation infrastructure projects or assets is closely related to planning and design parameters of the projects. For instance, the Mangaung Intermodal Transport Facility, the Bloemfontein Bus Station and the Bangalore Municipal Road projects are being opposed by some stakeholders on this basis. Nevertheless, critical studies on the planning and design parameters that influence stakeholders to accept or reject public transportation infrastructure, particularly in South Africa, are few. This study is, thus, aimed at developing a framework of planning and design parameters of public transportation infrastructure for improving their acceptability chances by stakeholders in South Africa. Put differently, this study evaluates the nexus between stakeholders' acceptance factors and the planning and design factors of public transportation infrastructure and proposes a framework for improved acceptance of such infrastructure projects by stakeholders in the cities of South Africa. For this purpose, two important public road transportation infrastructure, namely the Central Park Interstate Busline Terminal and Mangaung Intermodal Transport Facility served as the sources of data. The data were collected through a survey method that included physical observation, measurements and administration of a questionnaire among selected stakeholders. Empirical models and statistical methods were used for the quantitative data analysis. The Interpretive Structural Model (ISM) was subsequently employed to develop a framework for planning and design of the public transportation infrastructure. The findings of this study demonstrate that public transportation infrastructure projects should be planned with the involvement of all relevant stakeholders in the process. The study also established that the choice of design parameters should be in accordance with approved standards and specifications. A careful consideration of these during the pre-construction stage of a project enhances proper public transportation infrastructure project delivery and minimises mobility challenges. The developed framework can provide a project management team with guidance on identifying critical planning and design parameters that influence stakeholders' acceptance.

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ACRONYMS AND ABBREVIATIONS

CBD – Central Business District

CSIR – Council for Scientific and Industrial Research

D – Dependence

DP – Driving power

GDP – Gross domestic product

IDP Integrated Development Plan

ISM – Interpretive structural model

IBL – Central Park Interstate Busline

MITF – Mangaung Intermodal Transport Facility

MMM – Mangaung Metropolitan Municipality

NDoT – National Department of Transportation

RM – Reachability matrix

SAICE – South African Institute of Civil Engineers

SANRAL – South African National Road Agency Limited

SPSS – Statistical Package for Social Sciences

SSIM – Self-structural interaction matrix

UN – United Nations

USA – United States of America

CHAPTER ONE: INTRODUCTION

1.1. Background

Infrastructure is considered critical for the socio-economic development of societies. It offers platforms that enable people to carryout socio-economic activities (Buhr, 2014); therefore it is vital for national development through economic growth and social development. In other words, the national competitiveness of a country or city is often measured according to the quality of infrastructure and its influence on economic growth (Kwak, Chih and Ibbs, 2009; Loto and Nkaogwu, 2013). Among infrastructure categories, transportation infrastructure is considered as the backbone of human habitations at different scales such as nations, regions, cities, and towns. Consequently, the role of transportation infrastructure as a catalyst for economic development in both developed and developing nations cannot be overemphasized (Janusova and Cicmancova, 2016).

Transportation infrastructure offers a number of functions to any country (Trimbath, 2010). In this way, it provides mobility for goods and services, thereby fostering effective and efficient economic and social activities (Nistor and Popa, 2014). For example, in countries such as the United States of America (USA), Canada, and China investment in transportation infrastructure has been prioritized. Similar strategies have also been developed in various developing countries such as South Africa, India, and Brazil. Consequently, in the various countries with good transportation systems, it was found that international trade and the creation of employment opportunities have been improved whilst contributing significantly to the country's total gross domestic product (GDP) (Banerjee and Qien, 2010; Loto and Nkaogwu, 2013).

Furthermore, public transportation systems at city level, i.e. road network systems, public transit systems and nodal points such as bus stations and taxi ranks have become one of the most prioritised infrastructure assets provided by government and city development authorities. Sufficient and efficient estimation of distinct elements are usually essential for the planning and design of transportation infrastructure Public transportation infrastructure provision is further aimed at facilitating the movement of goods and people with ease in a cost-effective and efficient manner without disruptions

(Martani, Jin, Soga and Scholtes, 2016). It is not an exaggeration to say that the planning and design of transportation infrastructure are critical for its successful delivery and sustainability.

1.1.1. Transportation infrastructure planning and design

Transportation infrastructure has been evidenced to be highly critical for the development of societies. However, the delivery and success of the transportation infrastructure are found to be a serious challenge. According to Oyedele (2012) and Fourier (2014), poor planning and design processes, inefficient and inadequate management and maintenance programmes, dwindling finances and rapid population growth are factors inhibiting the development and delivery of the transportation infrastructure. Therefore, it is vital that the various phases of infrastructure project life cycle are managed to optimise the resources. This can also improve the functionality of the infrastructure asset. Among the various activities associated with the development of transportation infrastructure, appropriate and adequate planning and design are deemed critical for its success (Anvari, Ochieng and Zhang, 2019; Kagioglou, Cooper and Auoad, 1989; Picchi, Van Lierop, Geneletti and Stremke, 2019).

Delongui, Matuella, Nunez, Fedrigo, Filho and Ceratti (2018), Hasan and Tarefder (2017) and Meyer (2008) stated that some parameters are critical for the planning and design of sustainable transportation infrastructure. Among them are environmental and geotechnical parameters such as temperature, precipitation, location, water levels, and soil which all affect the infrastructure. Bakogiannis, Siti and Kyriakidis (2016), Berna (2016) and Vayalamkuzhi (2014) added that parameters such as traffic and passengers' factors, land use, government policies, accessibility, radii of curvature, and infrastructure management are necessary considerations for these processes. Further, Kruger and Landman (2007) pointed out that public convenience in the use of an infrastructure is dependent on the adequacy of its information guideline, road markings and its signage. Additionally, the efficient accessibility of the infrastructure as well as adequate safety and security are critical in the design of public transportation nodal areas such as bus stations and taxi ranks. These factors are found to have motivated a positive or negative perception of a public transportation infrastructure among stakeholders.

1.1.2. Influence of stakeholders' perception of transportation infrastructure

Studies have identified the effectiveness in planning and the adequacy of design parameters as critical to the success and sustainability of transportation infrastructure projects and assets as stated in the previous subsection (Bakogiannis, Siti and Kyriakidis, 2016; Berna, 2016; Hasan and Tarefder, 2017). However, the success of the public transportation infrastructure is also dependent on the level of acceptance by the stakeholders, including the users and local community (Glaeser and Ponzetto, 2017; Ryley, Burchell and Davison, 2013). The stakeholders accept or reject the existence of infrastructure depending on the level of information provided to them about the positive or negative impacts, the convenience of the use of the infrastructure, and feelings of belongingness to and ownership of the project. The involvement and engagement processes in the project development has an influence on their perception (Abuzeinab and Arif, 2014; Bourne, 2016; Tengan and Aigbavboa, 2017). Early engagement and collaboration of project stakeholders during planning and design facilitates the identification and resolution of issues that might negatively influence part of or the whole project (Tammer, 2009). Leucht, Kölbel, Laborgne and Khomenko (2010) identified stakeholders' perceived risks and trust in project development as a factor that calls for the elicitation of acceptance. Other factors include stakeholders' level of education concerning the project, climate change, gender, extant government policy, the distance between residence and infrastructure, location, the nature of the project design, corruption, transparency, and the prevailing culture (Chen, 2011; Cohen, 2014; Huang, Duan, Bi, Yuan and Ban, 2010).

In this regard, it is noticed that the neglect of those factors that influence the public or stakeholders' acceptance during the planning and design stages sometimes results in opposition and less efficient use (Raoof, 2017). Moreover, in cases where stakeholders are dissatisfied with the degree of convenience and efficiency of use that could emanate from poor planning and design, there is a tendency for the public or stakeholders to oppose the infrastructure project from inception through to operation phases (Walkins, 2014). On the other hand, scholars have argued that there is inadequate time and expertise required for getting key stakeholders involved and therefore this is considered difficult during pre-construction stages (Preskill and Jones, 2009). Also, there is a lack of a structured and proper framework for identifying critical planning and design parameters that have driving tendencies regarding stakeholders' non-acceptance to the utilization of the transportation infrastructure (Ahbabi, 2014). However, studies have shown that the incorporation of stakeholders' interests or concerns influences project success and sustainability. Ahbabi (2014) further argued that project success levels will be significantly increased if all stakeholders (i.e. the public) are involved and extant nuances in public interest are considered during infrastructure planning and design. Summarily, stakeholders are generally expected to be involved in infrastructure project planning and design to ensure project success and not just project management success as has been the case (Jugdev and Muller 2005; Mir and Pinninngton 2014).

Lack of stakeholders' engagement and acceptance has been identified as a major barrier in the successful performance and sustainability of the infrastructure asset (Li, Ng and Skitmore, 2011). Therefore, to ensure improved rates of project success in the delivery and operationalization of transportation infrastructure in South Africa, it has become imperative to establish and model the relationships between stakeholders' acceptance and the planning and design of the projects. Such modelling is expected to culminate in the development of a conceptual framework for facilitating higher levels of stakeholders' acceptance of the public transportation infrastructure.

1.2. Problem statement

Transportation infrastructure, which provides mobility for people and freight, cannot be overemphasized. This type of infrastructure provides linkages so that gaps that exist which affect effectiveness and efficiency in the production process are possibly closed. It further facilitates the provision and development of other types of infrastructure. However, some of these transportation infrastructure projects have been opposed by stakeholders in many parts of the world, including South Africa. Different study researchers globally have made many attempts to identify the causes of this negative attitude (Sridharan, 2018). For instance, Vaidyanathan, King and Jong (2017) give the example of public protest against increasing the width of a road by the Bangalore Municipal Corporation in India, associated with reasons of politics, lack of public consultation and nearness to residence. This public protest resulted in increased costs of transportation, traffic congestion, costs associated with design change, poor inter-regional integration, political conflict, social violence, abandoned projects and assets and unemployment (He, Mol and Lu, 2016). In South Africa, it has been observed that some of such infrastructure projects have faced similar challenges of stakeholders' opposition and consequently negating the effective utilization and functionality of the asset.

Moreover, several factors have been identified as playing an important role in facilitating their acceptance of the infrastructure such as poor planning and design; infrastructure project location; social, environmental and economic costs; and stakeholders' engagement and involvement in the planning and design process (Cohen, 2014; Glaeser and Ponzetto, 2017; Ryley, 2013). For example, it is noted that perceived inconvenience from the use of some planning and design parameters of public transportation infrastructure in South Africa have motivated poor acceptance of their usability, thereby leaving the infrastructures abandoned (Bloemfontein Courant, 2016; The Citizen News, 2019). These have posed more challenges to the provision and adequacy of public transportation infrastructures in South Africa to manage traffic and travel-related problems such as congestion and accidents.

It is noted that little or no attention is/has given to research on the influence of planning and design aspect that affects stakeholders' attitude to transportation infrastructure projects. Owing to the fact that transportation infrastructure is defined by the planning and design parameters, it is important to assess the influence of the planning and design parameters on stakeholders' perception. The identification of various factors that can influence stakeholders' perceptions in accepting or rejecting the existence of public transportation infrastructure is dependent on the experience and competence of the planners and designers. The absence of structures or tools that can enhance the identification of the criticality of various planning and design parameters that influence stakeholders' acceptance or non-acceptance leaves a gap in managing the situation at early stage for improved acceptance and sustainability of public transportation infrastructure. This research has therefore proposed a framework that can be used by policymakers, transportation infrastructure planners and engineers to identify various planning and design parameters that can influence non-acceptance of a transportation infrastructure in South Africa.

1.3 Research questions

The problem stated above has made the following questions researchable.

- How can planning and design factors that influence stakeholders' acceptance of transportation infrastructure projects during planning and design phases be identified?
- How can stakeholders' engagement and participation in the planning and design processes of infrastructure projects in South Africa be assessed?
- What are the linkages between the control variables of stakeholders' acceptance and the planning and design variables of public transportation infrastructure?
- How can stakeholders' acceptance of public transportation infrastructure be improved based on planning and design parameters that influence their perception?

These questions are therefore answered with the following aim and objectives:

1.4. Research aim

The aim of this study is to examine the linkage between the stakeholders' acceptance factors and the planning and design factors of public transportation infrastructure and propose a framework for the improvement of acceptance of such infrastructure projects by stakeholders in the cities of South Africa.

1.5. Research-specific objectives

For this purpose, the central question to this study is 'How can stakeholders' acceptance of public transportation infrastructure projects be improved through planning and design?' Based on the research question, the following specific objectives have been set up. The specific objectives are the following:

- To identify the planning and design factors that influence stakeholders' acceptance of transportation infrastructure projects during the planning and design phases;
- To assess stakeholders' engagement and participation in the planning and design processes of infrastructure projects in South Africa;
- To develop models to establish the linkages between the control variables of stakeholders' acceptance and the planning and design variables of public transportation infrastructure; and
- To propose a framework for the planning and design of transportation infrastructure based on stakeholders' acceptance influencing parameters.

1.6 Structure of the dissertation

The rest of the research is structured as presented in the chapters as follows:

Chapter 2: This chapter presents the literature review of knowledge around transportation infrastructure development, its challenges, the theoretical framework of influencing factors of stakeholder acceptance of infrastructure projects and the strategies to managing stakeholders' attitude towards transportation infrastructure.

Chapter 3: This describes the Mangaung Metropolitan Municipality and the case study public transport facilities.

Chapter 4: In this chapter, the research philosophy and methods adopted to collect data and analyse the data to achieve the aim and objectives of the research are explained.

Chapter 5: This chapter discusses the results and findings from the research study.

Chapter 6: Chapter six is a model of relationship between planning and design parameters and it is presented as an ISM.

Chapter 7: Conclusion and recommendations based on the research are presented in this chapter.

1.8 Conclusion

Transportation infrastructure availability provides an opportunity for the socio-economic upliftment of an area through the effective movement of people and goods. In this way, government, sometimes in partnership with private sector, makes transportation infrastructure available for efficient performances. These transportation infrastructures are provided by the way they are planned and designed for successful delivery and sustainability. It is noted that different factors influence this process of planning and design. These also affect the management of stakeholders at different phases of a project life. Therefore, stakeholders have been found to be opposed to infrastructure as the result of perceived inconvenience from one or more planning and design parameters. Owing to the available reports of stakeholders' protests against the usability or existence of public transportation infrastructure as the result of the negative perception, this study has proposed a framework for the identification and management of stakeholders' concerns with critical planning and design parameters.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Premised upon the review of available literature, this chapter provides a broader understanding of transportation infrastructure and its successful development, which is critical for the economic growth and social development of a nation. In this way, it has also highlighted the concept of transportation as an infrastructure that facilitates infrastructure development. The delivery success and sustainability of any infrastructure as discussed here are the objects of planning and design factors as well as the stakeholders' acceptance. The chapter also looks at the various factors that influence stakeholders' perception about transportation infrastructure and its acceptance by the stakeholders. It further reviews available methods that have been used to overcome the challenges of successful and sustainable transportation infrastructure development and delivery.

2.1 Infrastructure, infrastructure projects and assets

Infrastructure is a term that has been used frequently to apply to different matters such as roads, telecommunication, and buildings. However, it does not have common definition as the result of varying understandings and the development that is associated with it. Attempts are always made to define an infrastructure using its functions or characteristics to obtain understanding of it (Grimsy and Lewis, 2002). Silva and Wheelers (2017) concur with the infrastructure definition in terms of functionality as any element which provides goods and services that enhance and sustain societal living. The meaning is therefore better explained by different types of infrastructure in terms of its contribution to a nation or what it entails. Audretsch, Hegrar and Veoth (2014) added that infrastructure is any entity that provides entrepreneurs with an opportunity to actualise investment goals. Chrest, Smith, Bhuyan, Iqbal, and Monahan (2012) consider infrastructure as non-natural resources that are used for the production and distribution of products. The attempt to define infrastructure from varying concepts has made it possible to distinguish different types of its assets which are obtained from the completion of well organised activities within a given time. In general, infrastructure can be defined as any element needed to ensure that a society functions or operates to satisfy the needs of societal members.

From the foregoing, infrastructure projects involve organised activities for the purpose of establishing infrastructure. These activities are carried out in phases. An infrastructure project constitutes an initiation phase, plan and design phase, construction phase and operation phases (Miller and Hobb, 2005). All these activities are undertaken by stakeholders usually in a legal, socio-economic and political environment. However, several infrastructure projects, small or mega, have suffered some influences that may challenge their successful delivery. These projects have failed or failed to be delivered on time as the result of inadequate finances (Al-Hazim, Salem and Ahmad, 2017) which is the reason for many poorly delivered infrastructure projects (Invernizzi, Locatelli and Brookes, 2019). This implies that infrastructure projects are associated with risks that threaten their existence through project delays or reworks (Wang and Yuan, 2017).

In an event of infrastructure project risks, it is crucial to identify such threats, and mitigate or avoid them. Owing to diverse actors in an infrastructure project, Van Os, Van Berkel, De Gilder, Van Dyck and Groenewegen (2015) regard stakeholders as mostly attributing risks that affect their social identity to other stakeholder(s), thereby increasing their opposition to interferences in their affairs from other stakeholders. This social defensive measure affects communication among stakeholders by reduced levels of information circulation in infrastructure project (Esposo, Hornsey, and Spoor, 2013). In addition to social risks in infrastructure projects, the funding aspect of a project also involves a great deal of threat. This is associated with increase in the price of materials, interest rates, cost of labour, poor planned financial structure and in some instances, withdrawal of funding for a project by a financier (Ng and Loosemore, 2007). These risk factors if managed properly, increase the project delivery success.

In attempt to ensure that transportation infrastructure projects are delivered successfully, Wang and Yuan (2017) developed a system dynamic (SD) model which shows the interactions among various components of infrastructure project construction which influence the completion time. The model shows that for a project to be completed on time, requirements such as labour quantity, rate of tasks' completion, work plan, engagement of new labour, and the acceptance of completed tasks must be adequately managed. Furthermore, some infrastructure project management teams use a collaborative method whereby many or all team members participate in a process (Guo, Cheng-Richards, Wilkinson and Li, 2014). In this way, the project management team takes responsibility for risks and also minimises the attribution of risks to external stakeholders. The entire infrastructure project life cycle provides infrastructure assets if associated risks are managed appropriately. The different types of infrastructure projects and assets are therefore discussed in the next sub-section.

2.1.1 Infrastructure project types

There are many ways of classifying infrastructures. This depends on different perspectives such as function, characteristics and location. A few decades ago, infrastructure was believed to be either owned by public enterprise (public infrastructure) or by private organisations or individuals (Grimsy, 1995). In the past, governments had the sole responsibility of providing public infrastructure that serves the needs of citizens. However, an increasing population and demand for increased infrastructure development despite dwindling public revenue has posed challenges on governments to provide adequate infrastructure (Kiggundu, 2009). In recent times, a contractual understanding between the public sector and private companies to provide transportation infrastructure in the form of public-private partnerships has received attention (Kwak, Chih and Ibbs, 2009; Shahbaz, Raghutla, Song, Zameer and Jiao, 2020; Xiong, Cheng and Zhu, 2020). Infrastructure can also be categorised in terms of its location and factors that influence its relocation. According to Martin (1995) and Martincus and Blyde (2013), some infrastructure is located within a country and has all its influencing factors in the same country. Such infrastructure is domestic infrastructure. On the other hand, some infrastructure has an international location tendency as the result of the availability of resources in different countries. Another perspective holds that infrastructure exists in two forms: physical and knowledge infrastructure. Physical infrastructure is tangible infrastructure such as transportation, energy, telecommunication, water and sanitation. On the other hand, knowledge infrastructure has to do with the infrastructure that provides learning and skills acquisition to society. This includes universities, research laboratories and training centres (Chrest, Smith, Bhuyan, Iqbal and Monahan, 2012). All these perspectives about infrastructure are for the purpose of effective economic and social activities.

In recent time, researchers have paid more attention to infrastructure projects and development among nations (De Jong, Vignetti and Pancotti, 2019). This is as the result of the roles of infrastructure in providing economic opportunities for a nation and also supporting the social well-being of its citizenry (Lan, Gong, Da and Wen, 2019). Owing to the functions of infrastructure projects, which are an engine to economic growth, governments, corporate organisations and individuals are committed to investing resources in this sector (Bennett, 2019). Calderon and Serven (2010) have identified infrastructure project performance as a critical indicator in meeting sustainable development goals (SDGs) of United Nations (UN). In this regard, governments and public enterprises have the responsibility of providing basic infrastructure to the public. However, adequate infrastructure projects, especially those related to transportation, have been challenged by several factors. These factors are funding and material price, design quality, communication among stakeholders, project schedule, management techniques, shortage of construction materials, and manpower competence (Fugar and Agyakwah-Baah, 2010). Aziz (2013), Le-Hoai, Lee and Lee (2008) and Niazi and Paintin (2017) agree that those factors, with the inclusion of corruption and inadequate planning, are the causes of certain challenges such as time and cost overruns of an infrastructure project. In addition, the rapid world population growth and land use demands are increasingly posing problems on the provision of these engines of economic growth (Baltacharya and Romani, 2013).

Given that transportation infrastructure provides linkages among other kinds of infrastructure through mobility, it is important to have an improved understanding of the concept. This is because this type of infrastructure is at the nucleus of facilitating national development which usually depends on its quality and operations.

2.2 Transportation infrastructure

The movement of people, freight and services from one location to another is inevitable. Therefore, the need to connect these locations cannot be overemphasized. Transportation infrastructure is the type of infrastructure that exists with human settlement. However, it is known that a transportation system is characterised by continuous development from primitive to modern systems. These changes are in attempt to meet the changes in the needs of people, and nations or regions (Dimitrakopoulos, 2010). In the Stone Age for instance, a transportation system constituted a footpath, waterbody, land, walking and swimming which facilitated mobility. Human efforts have been to bridge the gap that exists in meeting satisfaction of needs through the provision of improved transportation networks (Arimah, 2017; Cohen, 2014). However, the sustainability of these critical infrastructures is influenced by several factors and this has recently received the attention of researchers, governments and the construction industry. Lim and Yang (2008) have identified project risks, sustainability of transportation management agency, resource usability, transportation stakeholders management, impact of transportation project on environment and citizens, the nature of water control, compliance to standard and specifications as aspects that have influencing tendencies on transportation infrastructure delivery. They added that accessibility of transport facilities, carbon gas emission and local community cultural heritage have direct or indirect impacting on transportation infrastructure. This kind of infrastructure which has undergone development and changes to meet mobility needs has been modernized in recent times through the use of various technologies to strengthen the transportation system.

A transportation system enables people and freight to change location by a vehicle through a route under its operations and management plans (Boyce, 2012). This system involves different categories which is based on its mode, sector of management and the technology of its operations. Each of these categories is aimed at solving mobility problems. However, Cedar (2004) identifies funding, traffic congestion and urbanisation as the challenges in modern transportation development. In view of this, certain interventions such as the use of a dedicated lane for bus mobility to transport people has gained popularity in modern transportation. This is known as bus rapid transit (BRT) (Cervero and Kang, 2011). Cervero and Dai (2014) regard the BRT as a system to minimise public mobility problems in urban areas. The system helps to reduce travel time, traffic congestion, and road accidents and also improves travellers' comfort in the course of their journey. For example, according to Taotao and Nelson (2013), the BRT in Beijing draw about 75% of passengers from conventional bus services. Similarly, the daily trip on the Bogota BRT corridor increased to average of 120,000 with a reasonable degree of comfort and safety. According to Adebambo and Adebayo (2009), the use of dedicated lanes for public transportation using buses does not only demonstrate improvement on traffic parameters on a highway but also influences improvement on the level of services on the adjacent roads in cities. Such improvement in traffic parameters encourages road users to make use of adjacent roads owing to increased social comfort and safety. Successful and sustainable transportation infrastructures are better initiated by the planning and design process.

2.3 Planning and design of transportation infrastructure

Transportation infrastructures usually provide services that strengthen human habitation. The mobility needs which change with changing land use motivate travel demand. In this way, transportation infrastructure is usually planned and designed in such a manner that its performance meets travel demands to avoid negative experiences (Naude, 2005). The performance is therefore improved in planning and design through adequate forecasting of traffic needs and appropriate choice of design parameters that solve practical problems. Beckers (2013) and Kwofie, Allhassan, Botchway and Afranie (2015) attribute the success of transportation infrastructure delivery to the capacity of professionals to foresee and avoid all risks at the pre-construction phase of project. Affleck and Freeman (2010) pointed out that there is always a capacity gap among local engineers which affects transportation infrastructure design and development. Given that transportation infrastructures are faced with unforeseen risks, many stakeholders, apart from transportation planners and engineers, have become involved in the process. The integration of engineers, community members, transport facility users, government agencies and other interest groups contribute to the identification of norms and culture, opportunities and challenges that are crucial in the environmental sustainability of infrastructure (Malekpour, Brown and De Haan, 2015). Apart from the risks that are associated with the norms and culture of a people, transportation infrastructures are designed with particular attention to the comfort of the users. Zhao, Carstensen, Nielsen and Olafsson (2018) stated that the quality of transportation infrastructure and the location (where there is possibility of changing the mobility mode) offer the level of comfort to its users. Naude (2005) added that transportation facilities should be designed with openings to allow adequate ventilation. Such transportation infrastructure should have one-way entry and exit circulation for user-friendliness. In order to ensure that transportation infrastructure serves the mobility needs of a region, the design considerations are integrated with the planning process (Iliopoulou and Kepaptsoglou, 2019).

In relation to the above, transportation infrastructure project success delivery is premised on the choice of parameters that define its characteristics and services. This is done within the specifications and standards for design. In the case of transportation infrastructure, both geometric and traffic parameters are considered as important in the course of planning and design. However, the planning and design of an infrastructure are undertaken and influenced by various stakeholders. These are discussed in subsection 2.5.

2.4 Geometric parameters for transportation infrastructure

Geometric parameters are parameters or data that define the shape or size of a transportation infrastructure. In transportation design, such parameters are widths, lengths, curvature (horizontal and vertical) and grade (Al-Mudhaffar, Nissan and Bang, 2016). Each geometric parameter has its standards or specifications within the transportation infrastructure design. For instance, the lane width of 2.70m to 3.65m is recommended at a straight of a carriageway (SANRAL, 2009). However, it is important that this lane width is increased to a minimum of 3.70m along the horizontal curves of a highway. It is also critical in the design of highway to note the manoeuvrability of different vehicles at the horizontal curve. The Council for Scientific and Industrial Research (CSIR) recommends the minimum internal turning radius of 6.20m for a passenger car unit, 12.80m for single unit vehicles and 13.10m for buses. Maurer, Gerdes, Lenz and Winner (2016) add that the minimum turning radius depends on design speed. According to the authors, the minimum turning radius, $R_{min} = v^2/127(e+f)$ where *v* is the design speed, e is the angle of superelevation and *f* is coefficient of friction. The CSIR (2009) also uses speed function for the determination of stopping sight distances (SSD) of 30m for 30 km/hr, 50m for 40km/hr, 115m for 80 km/hr and 210m for 120 km/hr. The use of these geometric parameters to shape a transportation infrastructure is dependent on the various stakeholders involved in the project delivery process.

These geometric parameters are key to the geometric features of a transportation infrastructure. It is important that they are selected to accommodate expected traffic. The operational efficiency and safety of a transportation infrastructure are dependent on the horizontal and vertical alignment (Findley, Schroeder, Cunningham and Brown, 2015). Bassani, Dalmazzo, Marinelli and Cirillo (2014) pointed out that geometric parameters such as road width and turning radius greatly affect the safety of vehicles in motion and during manoeuvring. A turning radius, for instance, has a great influence on the length of vehicles that can manoeuvre and it can restrict some vehicles to use a transportation infrastructure.

2.5 Stakeholders management in transportation infrastructure project

In recent times infrastructure sustainability has gained popularity in industrial and academic fields. It is no longer only about providing infrastructure for socio-economic development. It is further a concern of everyone involved in the provision and delivery of transportation infrastructure to consider its future impact in terms of economic, environmental and social aspects (Hu, Shu and Huang, 2019). The objective of infrastructure services is to meet the needs of different groups of stakeholders (Rall, Hansen and Pauleit, 2019; Que, Awuah-Offei and Samaranayake, 2015). Stakeholders are therefore commonly regarded as a group or individual who is influenced or affected, either negatively or positively, by a transportation infrastructure project (Abou-Sena, 2017). This has to do with different sets of people probably with varying roles and interest in the project. This leads to the fact that stakeholders of an infrastructure project are dependent on the size of the project and the concerns of the citizens (Li, Hong, Xue, Shen, Xu and Mok, 2016). Odimabo and Oduza (2018) added that stakeholders of transportation infrastructure projects are not fixed, but that there are always changes across the project delivery. These changes happen as a result of continuous monitoring and evaluation which makes some stakeholders very important at some point while others become redundant. In this case, stakeholders are identified and included or excluded as the need arises for the purpose of successful and sustainable delivery (Gregory, Atkins, Midgley and Hodgson, 2020). The effective management of the people together with resources is too crucial to be ignored. Managing these stakeholders in transportation infrastructure projects has to be done by understanding the project complexity and possibly the citizens who may have influence over or are affected by its implementation and existence (Erkul, Yitman Celik, 2016). Luyet, Schlaepfer, Parlange and Buttler (2012) stated that the complexity of an infrastructure determines the kind of stakeholders that must be involved. The stakeholders must therefore be understood in relation to their power influence and the kind of interest they have on the project, either as individuals or groups. According to Wang, Zhang and Skitmore (2015), the interest of stakeholders of infrastructure is usually driven by the way in which the citizens want to live.

Huang and Kung (2010) grouped stakeholders into those who are directly involved in the project (internal stakeholders) and those who not involved in its delivery but are affected by it (external stakeholders). Such internal stakeholders are clients, architects, contractors, financiers, suppliers and the project team. External stakeholders such as the local community or the public are also considered owing to the influence they may have on its sustainability or successful delivery. The inclusion of different stakeholders in the planning and implementation of infrastructure project is important, owing to a belief that there is a possibility of harnessing different types of knowledge from them to complement each other for optimum project delivery (Soma, Dijkshoorn-Dekker and Polman, 2018) based on their experiences and skills (Brink, Alders, Adam, Feller, Henselek, Hoffmann and Wamsler (2016). This makes the management of these stakeholders for a particular project very important. In this regard, the identification, engagement and involvement, participation, and motivation of stakeholders throughout the life cycle of transportation infrastructure project delivery constitute stakeholders' management (Mok, Shen and Yang, 2015). In properly managed stakeholders of an infrastructure project, the various stakeholders contribute meaningfully to the success delivery of the project. This also enhances the identification, assessment, evaluation and reduction of risks which are naturally a threat to construction process. Additionally, relevant stakeholders take ownership of an infrastructure and actively participate in the process to ensure that the project is completed and operations are commenced. The success of infrastructure project delivery is driven by stakeholders and how their interests and influence are addressed. The infrastructure project entails that many people are part of its delivery despite that not all are actively involved. Both active and passive stakeholders have roles and inputs to contribute for infrastructure project delivery success.

2.5.1 Identification of stakeholders in transportation infrastructure project

The identification of the stakeholders of an infrastructure project is one of the challenging activities in the stakeholders' management process. This is as the result of diverse interests among stakeholders who are motivated by different reasons within the same transportation infrastructure project or asset (Crane and Ruebottom, 2011). Some of the factors that drive an interest are economics, social value, infrastructure usage and infrastructure proximity to a stakeholder (Creighton, 1986; Orts and Strudler, 2009; Pomeroy and Douvere, 2008). The identification of all relevant stakeholders of an infrastructure project in its context is critical to their effective engagement and participation in the project, thereby minimising the risks associated with stakeholders that can cause project failure (Axelsson and Granath, 2018). In order to support this process, many attempts have been made by researchers to have a framework to identify stakeholders for projects despite stakeholders' differences in type, roles and interests for different types of transportation infrastructure projects. Ballejos and Montagna (2008) developed a framework for identifying stakeholders in inter-organisational projects by first of all specifying the type of stakeholders that is needed for a project. Subsequently, their required roles should be stated which will guide the selection of stakeholders. Each stakeholder's roles are clearly stated and finally, an appropriate analysis of their influence and interests on an infrastructure project should be carried out to ascertain their involvement and the kind of participation in the delivery process as shown in Figure 2.1 (Bellajos and Montagna, 2008). Bredbeck, Kerschreiler, Mojzisch, Fey and Schulz-Hard (2002) stated that diverse opinions by stakeholders result in more divergent and rich new innovations and ideas in managing infrastructure projects. On the other hand, Luyet (2005) and Luyet, Schlaepfer, Parlange and Buttler (2012) pointed out that the involvement of all stakeholders in a project increases the risk of project failure due to inadequate time and the diverse interests and opinions that stakeholders may have. Vos and Achterkamp (2006) developed a model that facilitates stakeholders' identification by classifying them into the different roles they have to play or according to different interest groups. Such a model enables a project manager to have all the details of different stakeholders of a particular project. The model states the structure that includes all relevant stakeholders with their roles and influence or interest in the project.

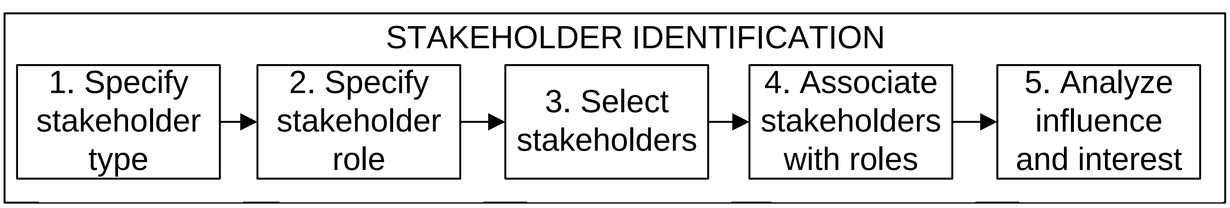

Figure 2. 1: Stakeholders' identification framework (Source: Bellajos and Montagna, 2008)

Several research studies have revealed that considerable efforts should be made in a project to know stakeholders as groups or individuals and engage them appropriately in an infrastructure project (Noland and Phillips, 2010). One of the approaches to acquire knowledge of external stakeholders is by applying the snowball approach by the project management team through continuous consultation and communication with stakeholders during project delivery (Ogu, 2000) as demonstrated in Ibadan Urban environmental development in 1995 (Colvin, Witt and Lacey, 2016; Leventon, Fleskens, Claringbould, Schwich and Hessel, 2016). Junghan, Kreft and Welp (2018) argued that the cultural and social differences of stakeholders involved in an infrastructure project must be considered while considering who has to be part of the project delivery.

Although stakeholders' identification is a continuous process, it is important that it is given adequate attention during the planning phase of a project. This can then form the structure of stakeholders who have influence, interest and roles to play as well as the citizens whose lives and existence will be affected by an infrastructure. In a case study of housing project Olander and Landim (2005) present a power/interest matrix to assist project managers to identify stakeholders and understand how to manage them. The matrix shows that minimum attention needs to be paid to stakeholders with low levels of power and interest in a project. However, stakeholders identified with high levels of interest but low levels of power need constant information about the project (Olander and Landim, 2005). Some stakeholders' power levels are high but they have a low level of interest in a project and such stakeholders' interest must be satisfied in a project. They further indicated in the matrix as shown in Figure 2.2 that those stakeholders who have high levels of power and interest need to be fully involved in the affairs of the project as they are the key players for the success of the project. The engagement and participation of the identified stakeholders are required for effective project delivery.

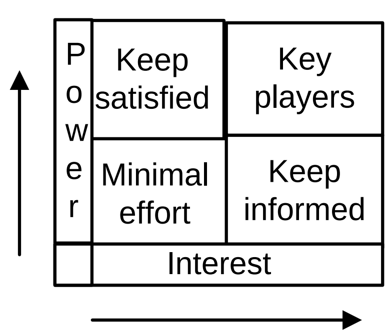

Figure 2. 2: Stakeholders' power/interest matrix (Source: Olander and Landim, 2005)

2.5.2 Stakeholders' engagement and participation in infrastructure project

It is important that the various stakeholders who have roles, influence or interest in an infrastructure are engaged in the project. This engagement provides an opportunity for various stakeholders to make contributions or inputs for the purpose of project delivery and management. Erkul, Yitman and Atelik (2016) define stakeholders' engagement as a practice which is used to identify and include stakeholders' concerns and values in decision making. This stakeholders' engagement is practised through effective communication among interest groups to share their concerns and values, thereby resulting in the cohesive management of an infrastructure project. Nahyan, Sohal, Hawas and Fildes (2014) agreed with the importance of effective communication in project delivery as an approach to engage stakeholders. They further added that poor communication among government authorities can cause several conflicts among stakeholders that may result in redesigns and interrupted progress of the infrastructure delivery process. When different stakeholders are involved in infrastructure development, there is a probability of having diverse interests or opinions which makes decision-making difficult. In other words, the knowledge gap about an infrastructure among stakeholders has been a point of concern in managing them in infrastructure project (Bal, Bryde, Fearon and Ochieng, 2013). The different interests that are commonly found with stakeholders in some transportation infrastructure projects have affected its delivery. This does not overshadow the contributions of various interests in executing such viable project.

It is important, however, to note that the engagement and involvement of stakeholders in an infrastructure project pools different resources and minimises the risks that can cause its failure (Vos and Achterkam, 2016). Such resources that stakeholders have for the successful implementation of projects are knowledge, political influence or finances which they are sometimes willing to contribute to a system or project of their interest and to their benefit. Marthur, Price and Austin (2007) pointed out that it is a democratic right of citizens to be engaged in a project delivery process as they have the right to determine the services as well as assessing its value and impact (economic, environmental and social) on them. Additionally, it is good that public opinions are considered during a project delivery process and that this is done by engaging relevant stakeholders at different point in time for specific challenges (Antonson and Levin, 2018; Hao, Guo, Tian and Shao, 2019; Pucci, Casprini, Galati and Zanni, 2018). Cundy et al (2013) stated that the effective engagement of relevant stakeholders in a project is crucial for reducing the remediation of project risks, thereby improving its acceptability and reducing delays that may be associated with non-acceptance. The involvement of stakeholders enables a positive perception which motivates them to take ownership with adequate support of its successful delivery and sustainability (Li, Ng and Skitmore, 2012; Kishor Mahato and Ogunlana, 2011; Manowong and Ogunlana, 2010). This engagement is done to be able to identify or foresee possible risks that may affect its sustainability such as social acceptance of the infrastructure.

In an infrastructure project, there are activities that enable the engagement and participation of stakeholders in its delivery. The neglect of public engagement has over the years posed challenges in managing stakeholders, especially the local community residents (Jarzabkowski, Balogun and Seidl, 2007). Maher and Buhmann (2019) stated that the bottom-up engagement of stakeholders gives the local community a sense of belonging. In addition, the expected transparency through round table discussions by different actors reduces community-related conflicts that affect infrastructure projects. Junghans, Kreft and Welp (2018) identified the use of the World Café method to hold plenaries with stakeholders where members of the same attributes and roles are grouped together to identify challenges and solutions in a project. In this method, members from different groups are mixed up to discuss the previous identified challenges and suggested solutions for improved plenary results as in the case of the climate change problem in Gurgaon and Purri, India. Such a plenary also facilitates social learning by project stakeholders which results in multiple benefits gained from diverse viewpoints and objectives among stakeholders (O'Donnell, Lamond and Thorne, 2018). These mixed views support the interrelationship that exists among stakeholders as a group or individuals and minimises the problems that might remain unidentified and unresolved as the result of its independent stakeholders' relationship (Nijsten, Arts and Ridder, 2008).

The engagement and involvement of stakeholders at early phases of the project life cycle lead to more efficiency in managing them (Mojtahedi and Oo, 2017). This does not mean that the engagement is only important at the early phase. Cundy et al (2013) added that stakeholders need continuous information, consultation, involvement, collaboration and empowerment as the result of any infrastructure project in which they are involved. In the review by Musesengwa and Chimbari (2017) of stakeholders' engagement in the health sector in Southern Africa, they reported that community structures such as the chiefs, political leaders and community-based organisations usually played significant roles in supporting health projects and programmes in the region. When integrated in the management of infrastructure projects, the contributions and collaborations of these stakeholders make the project more successful and sustainable. The various inputs facilitate the identification of risks associated with the project as well as possible methods of mitigating these. Moreover, the opportunities and benefits from the project are better perceived or communicated.

The management of infrastructure projects is associated with challenges that impede the effective infrastructure delivery process. Some infrastructure projects and assets have failed to meet the desired outcome owing to problems that arise from the engagement of stakeholders and their participation (Turner and Zolin, 2012). It is the expectation of infrastructure project management that the stakeholders serve as a structure that provides strategies for successful delivery. O'Donnell, Lamond and Thorne (2018) hold that poor communication within and between stakeholders groups, particularly by government departments, have been the cause of conflicts in projects. They added that stakeholders of a project sometimes perceive that a project does not concern them and they decline to be part of its delivery. This perception, as also noted by Bissonnette et al (2018), makes stakeholders in some cases to regard infrastructure projects as a policy being imposed on them by a government authority. However, it is also evidenced that the challenges or problems that affect infrastructure projects as the result of stakeholders are mitigated through their active participation (Harrison, Bosse and Phillips, 2010; Pita, Pierce and Theodossiou, 2010).

Stakeholders' participation has received attention in both the construction industry and academia. It has been one of the approaches in stakeholders' management which facilitates the success of infrastructure projects (Turner and Zolin, 2012). However, some issues that affect effective participation in various projects have been identified. Reed (2008) identified inequalities of stakeholders influenced by age, gender, background and power as barriers that affect participation to contribute meaningfully to any project. Aragones-Beltran, Garcia-Melon and Montesinos-Valera (2017) further noted that some of stakeholders use their knowledge, social status or finance to manipulative other stakeholders to resolve an individual interest. In a situation where there is partial or denied participation, Tengan and Aigbavboa (2017) relate this to non-conformity to project standard, client dissatisfaction, and corrupt practices which have challenged construction project delivery in developing countries. In other words, the participation of stakeholders, especially at the planning stage, usually improves the quality of project outcomes and the effectiveness of construction process (Cillier and Timmermans, 2014). Stakeholders' participation is further regarded as a driver of project success through their knowledge resource contribution and generation of new ideas or innovation in a process (Ommen, Blut, Backhaus and Woisetschlager, 2016). Amobile and Kramer (2011) noted that infrastructure project progress experienced by stakeholders is a great motivation to their active participation. This is because most stakeholders expect a project to progress with the achievement of various objectives as the result of activities undertaken. Stakeholders' active participation is one of the indications of their acceptance of the project. On the other hand, their refusal to participate or failure to engage various stakeholders can hinder its successful delivery.

2.5.3 Factors influencing stakeholders' acceptance of infrastructure projects

Infrastructure projects or assets are meant to provide services for economic and social activities. These services are evident in the functionality of such infrastructure projects through their usage. Every infrastructure is planned and designed to meet the needs of society as the product of its project. Like project monitoring, stakeholders' acceptance is expected at all stages of an infrastructure project. Stakeholders' acceptance or non-acceptance of infrastructure has two indicators: (i) the existence of the infrastructure project which is influenced by the understanding, well-being and cautiousness of the project stakeholders and (ii) the usability of the infrastructure after completion of its construction (Yazdanpanah, Komendantova, and Ardestani, 2015). These indicators are measured through infrastructure stakeholders' behaviours or participation.

In general, there are factors that are capable of motivating stakeholders' perception or attitude towards an infrastructure. Among these is trust which is guided by the degree of familiarity of stakeholders with the infrastructure in question (Midden and Huijts, 2009). Hammami et al (2016) added communication, economic and social opportunities as well as an opportunity to participate actively in the infrastructure project as factors that lead to stakeholders' acceptance or non-acceptance of an infrastructure. Stakeholders' attitude towards an infrastructure project is influenced by their perception of its impact. Bashingi (2016) added that perceived usefulness and ease with which an infrastructure can be used have a significant influence on people's acceptance of an infrastructure. She further pointed out that public transportation infrastructure users usually consider affordability and their safety in the course of using public transport services. Therefore these are critical to their decision to use public transportation infrastructure. He, Boas, Mol and Lu (2018) pointed out that environmental factors such as air pollution and noise can also lead to stakeholders' acceptance or non-acceptance of an infrastructure. In many instances, stakeholders are found to weigh up the benefits of an infrastructure project or asset to them. Infrastructure benefits are an important consideration and driver of public buy-in of a project. It is common that society supports anything that can bring about improvement and development (Hsia and Yang, 2010; Hao et al, 2019). Yuan, Zua, Ma and Wang (2017) added that the advantages which an infrastructure has over already known or existing infrastructure influences its acceptance. The authors cited the example of nuclear energy being accepted by the public in China as the result of its advantages over solar energy and wind energy in terms of electricity generation.

Another social factor that affects stakeholders' acceptance is the confidence and trust they have in an agency delivering the infrastructure (Hao et al 2019; Hsia and Yang, 2010; Earle, Siegrist and Gutscher, 2010). Bernal (2016) and Lu, Heywood, Sheldon, Lee and Barber (2018) stated that in the case of transportation infrastructure, design parameters such as travel and waiting time, the existence of amenities, a sense of security and safety, reliable information, walking distance and connection to external services at a transit facility can have either positive or negative effect on passengers. Hwang and Ng (2013) further added that unfamiliarity with green technology, greater communication and interest, the time required for implementation of its practices, and the skills of a project manager are factors that affect green infrastructure project delivery and stakeholders' perception. These factors that can influence stakeholders' negative attitude towards an infrastructure can be mitigated through efficient and effective stakeholders' management activities by applying a relevant system or model (Bellajos and Montagna, 2008).

2.6 Methods and models to analyse and develop interventions to overcome challenges in infrastructure project delivery

Transportation infrastructures are generally made available to provide services that facilitate activities for the economic and social development of a region or country. It is usually intended from planning and design that their delivery, both in implementation and operations, is not challenged. However, certain factors are critical for the success of an infrastructure project or asset which may be known from the planning and design phase. There are still some uncertain issues which arise during the project life cycle that affect either its successful delivery or its sustainability. Hwang and Ng (2013) have argued that the role of the infrastructure project manager is vital to the success of a project. In this case, sustainable delivery is tied to the ability of a project manager to identify challenges for which his or her knowledge and skills are the basic requirements for infrastructure construction. The qualities of infrastructure project managers are not sufficient to assure successful project. Shehu and Akintoye (2010) pointed out that the sharing of knowledge among the managements of infrastructure construction projects or among stakeholders' groups of a particular project are enablers of successful and sustainable construction process and project delivery. Aiyetan and Das (2016) emphasized that in infrastructure project delivery, contractors deserved optimum motivation through capacity building and rewards for work done to enhance the success of a project. This shows that the success of a transportation infrastructure project depends on the competence and skills of the different stakeholders involved in the process of construction.

Contrary to the commitment, knowledge and abilities of transportation infrastructure projects' implementation team, other elements also have an influence on transportation infrastructure delivery. These elements are capable of having interdependencies which can be managed as a system. Das (2016) stated that a systems approach can enable the identification of crucial features in a system, looking at practical scenario which facilitates the prediction of any future occurrences in an infrastructure project. It can be understood that these features exist interdependently and can be modelled out to show the dynamism of system. Pfaffenbichler (2011) added that features which are dynamic in nature sometimes pose challenges to a system. Such issues surrounding a particular concept can be anticipated by means of a model. In order to have a visual representation in a system to enable the identification of issues, John Forester founded a system dynamic (SD) in the 1950s. A system dynamic is a model which shows a causal loop diagram (CLD) consisting of a number of entities that are connected and using arrows to show how those entities influence one another. A simple example of such a loop diagram which shows how one entity influences another is presented in Figure 2.2. The figure shows that the number of births per year influences the total population and the total population in turn influences the number of deaths per year. Conversely, the number of deaths per year determines the total population and the total population plays a role in the number of births in a year.

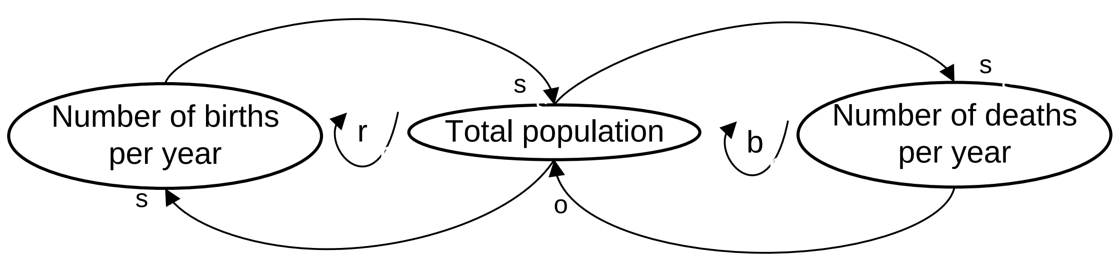

Figure 2. 3: System dynamic causal loop diagram (Source: Pfaffenbichler, 2011)

However, system dynamic models do not provide a picture of where certain entities or factors exist that might have a significant influence on most other factors in a system. The fact that these exist in a system means that some entities have a cumulative influence over the connections and it is necessary to understand how such factors exist and to show interdependences. This leads to the necessity of constructing a model that provides a systematic approach to understand relationships among various factors surrounding a particular issue in a system.

In 1973, Warfield provided a methodology for project managements to react to challenges in infrastructure projects. This methodology facilitates the analysis of complex social or economic variables using interpretive structural modelling (ISM) (Sharma and Singh, 2012). These challenges or issues which are complex can be modelled into a simpler structure, stating/indicating? the various levels of the existence of different factors or barriers associated with a system through the application of ISM methodology. When such factors or barriers are identified in the course of managing a system, a discussion on these among experts can enable the elimination of insignificant factors or barriers for the purpose of applying an ISM approach on a manageable number (Shen, Song, Liao and Zhang, 2016). However, ISM is limited in that it is difficult to employ when there are many issues or problems. It also leads to variables least affecting a system to be removed from its structure. Moreover, it cannot be validated statistically (Attri, Dev and Sharma, 2013). Bolanos, Fontala, Nenclares and Pastor (2005) also stated that ISM cannot be validated statistically; however, structural equation modelling can be used to validate the model. Apart from these shortcomings of the ISM, many researchers have used the model to solve industrial challenges. Singh and Kant (2008) demonstrated how interpretive structural modelling can be used to develop relationships among various factors under consideration. It therefore enables an infrastructure project manager to understand the importance of the factors influencing its delivery and their interdependencies when managing uncertainties (Sharma and Singh, 2012).

Figure 2.3 presents the various steps involved in employing ISM methodology in order to have a structure that can be used to manage issues or problems in a system. This shows that the literature around an issue is reviewed and the opinions of expert stakeholders to a system are sought to identify different factors that are connected to the issue. The contextual relationships between every pair of factors (i and j) are established. After establishing the relationships, a matrix of structural self-interaction matrix (SSIM) is developed. The SSIM is used with denoted letters such as V for i influence j, A for i is influenced by j, X for i and j influence each other while O means that there is no influence between i and j. The SSIM is converted to a reachability matrix (RM) using binary numbers (0 and 1). In RM, V is 1 when I influences j but 0 when j is influenced by I; A is 1 when j is influenced by I but 0 where I influences j; X is 1 when I influences j and j influences I; O is 0 for both directions of influence between I and j. The reachability matrix is further used to partition the factors into different levels and a directed graph is drawn from the determined multi-levels partition using SSIM to show the directions of influences. The transitivity in relationships is maintained in a digraph. It is also important at this point that a well-defined diagram is examined for the purpose of checking for consistency before developing the final model of the earlier identified factors. If there is no inconsistency in the model, the ISM is finally developed based on the relationships as stated in the digraph. However, if there is inconsistency in the relationship statements, experts are sought to review the relationships established in SSIM. After the review of SSIM as the result of the noted inconsistency(-ies), the same procedure is followed all over to develop an ISM model.

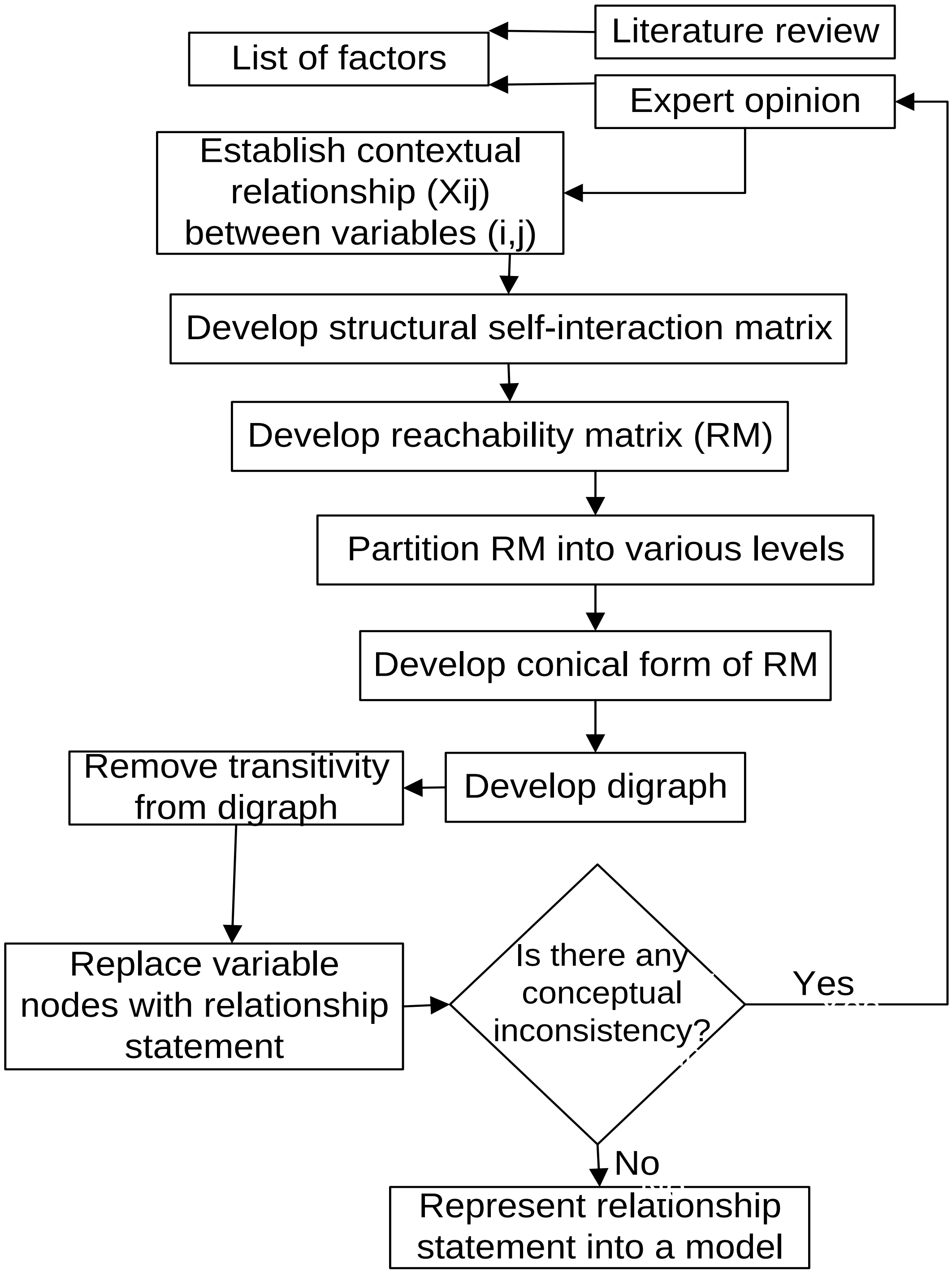

Figure 2. 4: Flow diagram for preparing ISM model (Attri, Dey and Sharma, 2013)

The success and sustainability of an infrastructure project and its delivery have to do with the competence of a project manager and how the resources and factors available for the project are harnessed to avoid negative uncertainties. In this case, the application of interpretive structural modelling is proven to examine the interdependencies among factors influencing an issue and provide a guide to make decisions that attempt at its best, to solve a prevailing or anticipated problem.

2.7 Conclusion

The literature reviewed has provided that a nation thrives in the presence of adequate and quality transportation infrastructure. Therefore, the provision of these infrastructures is through projects which avail transportation infrastructure assets to facilitate mobility. In this way, the roles, influences and interests of these actors of transportation infrastructure projects, namely stakeholders are examined. It is implied from the literature that the influences and interests of stakeholders must be considered. To achieve this, it is necessary to have integrated stakeholders' participation through the efficient engagement and adequate choice of planning and design parameters to ensure successful transportation infrastructure delivery and sustainability. Apart from stakeholders' management by ensuring adequate communication, participation and consultation, other factors such as geometric and traffic-related parameters have an influence on transportation infrastructure projects and asset sustainability.

The factors influencing project success and sustainability have an influence on stakeholders' perception about transportation infrastructure projects. The stakeholders' perception motivates their acceptance or non-acceptance of the existence or usability of a transportation infrastructure. Different models and methods such as system dynamics, structural equation model, World Café and interpretive structural model principles are variously used for the purpose of managing stakeholders. All these models and methods are used to manage the stakeholders of a project. However, there are reports of stakeholders' non-acceptance of transportation infrastructure that is attributed to planning and design parameters regarding which little or no research has been carried out as a factor influencing stakeholders' acceptance or non-acceptance. The interrelatedness of these parameters in their choices during design is associated with ISM methodology which shows linkages of factors' influences and how the influences show their degree of criticality of factors.

The absence of available research on this, particularly in the MMM in South Africa, makes it worthwhile study area. Therefore, in the next chapter, the research study discusses the municipality by presenting an overview of the area and the public transportation infrastructure and networks.

CHAPTER THREE: STUDY AREA

3.0 Introduction

The MMM is one of the eight South African metropolitan municipalities. It is located in Free State Province (See Figure 3.1). The name, Mangaung, is means 'the place of leopards'. The MMM covers an estimated area of 9886 km^2. This metropolitan municipality is located on latitude -29.10 and longitude 26.216 (Das, Burger and Eromobe, 2012). The population of Mangaung Municipality was approximately 787 930 in a 2016 community survey (IDP, 2019). Like most of the other municipalities in South Africa, the MMM's population cuts across different races. The Metropolitan Municipality 2019/2020 Integrated Development Plan shows that the black Africans amount to 673 710 (326 725 males and 346 988 females), the coloured people make up 27 775 (13 093 males and 14 682 females), there are 1 501 Indians (1 021 males and 480 females) and 84 944 whites (41 218 males and 43 726 females). The population is distributed across the municipality settlement areas. The population distribution shows 63% for the Bloemfontein area, 24% for the Botshabelo area, 9% for Thaba Nchu, 1.5% for Dewetsdorp and Wepener, 0.8% for Soutpan and 0.2% for Van Stadensrus. In the MMM, the largest city, Bloemfontein is its capital, the Free State Provincial capital and the judiciary capital of South Africa where both the Judicial Appellate and the Supreme Court are located. The approximate area of the metropolitan municipality is 9886 km^2. Three major towns lie within the district of the MMM, namely Bloemfontein, Botshabelo and Thaba Nchu. The spatial integration of these three major settlements makes the MMM attractive to both private and public investors.

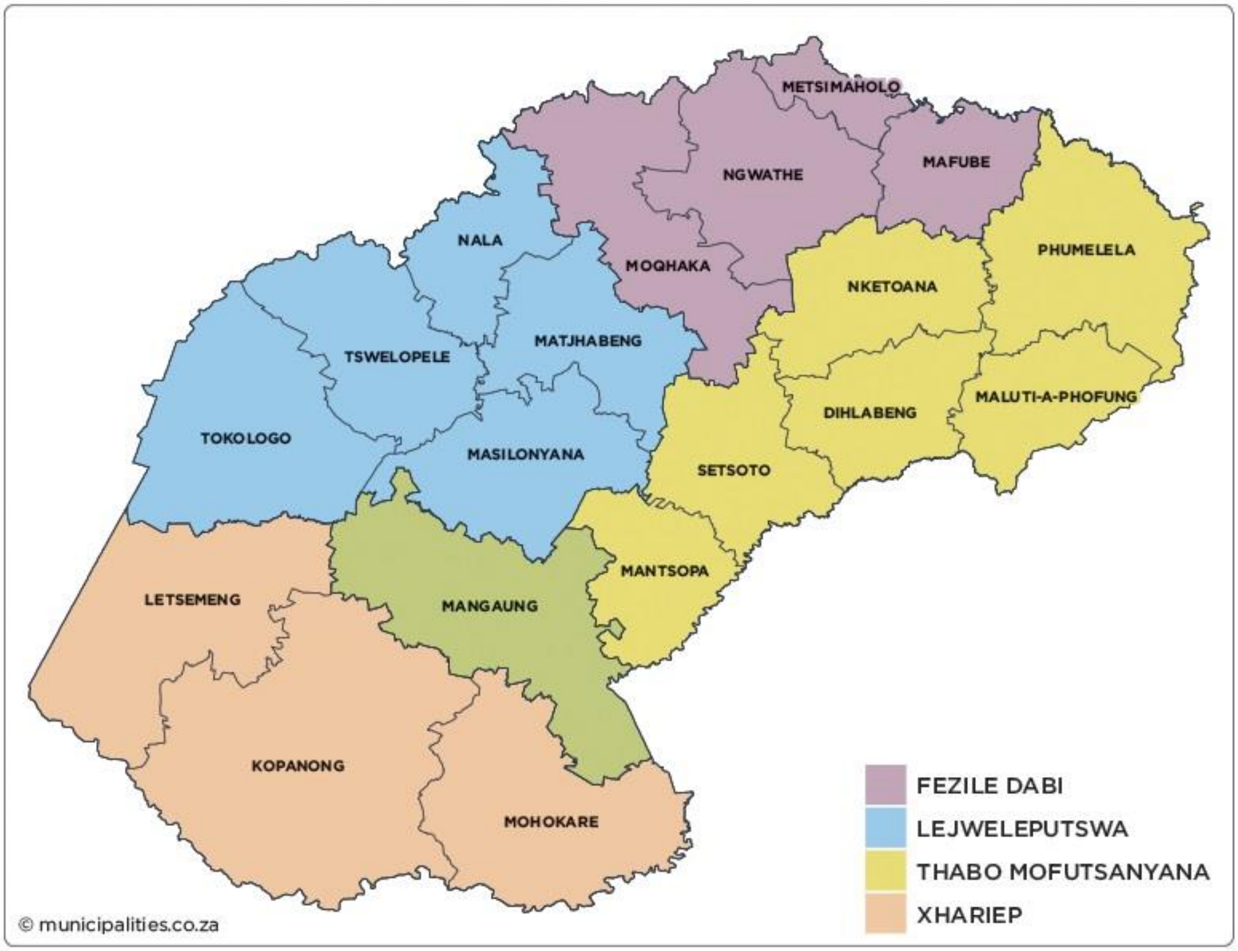

Figure 3. 1: Mangaung Metropolitan Municipality in Free State Province (Source: municipalities.co.za, 2016)

3.1 Economic activities in Mangaung Metropolitan Municipality

The MMM is the major contributor to the economy of the Free State Province. The municipal economic sector is made up of community services (35.3%), finance (26.8%), trade (16.0%), transportation (11.8%) and manufacturing (3.5%). The economy is mostly driven by the government sector which is growing through government programmes on livelihood improvement interventions. Most of the economic activities that generate revenue for government and provide livelihood opportunities are concentrated in the main settlements such as Bloemfontein, Botshabelo and Thaba

Nchu. However, the rural areas of MMM are characterised by mixed farming of crop production and cattle farming. Despite the fact that the metropolitan municipality is the major contributor to the economy of Free State Province, its contribution to the national gross domestic product (GDP) among the eight South Africa metropolitan municipalities is as low as 1.9%. Within the province, the metropolitan municipality government has provided infrastructures at strategic areas such as the Bloemfontein central business district CBD, Botshabelo and Thaba Nchu to motivate small and medium-scale businesses and farming to boost the economy as regards government interventions (Mpiti and Rambe, 2016). Each of the major settlements has its economic and social activities and infrastructures.

Bloemfontein

Bloemfontein City is the economic hub of MMM. This city has a number of both arterial and access roads that link it to other parts of the Province and country. The N1 road links Bloemfontein to Gauteng and the Western Cape, N6 to the Eastern Cape while the N8 links Bloemfontein to Lesotho and the Northern Cape. The city has several infrastructures that attract people from other areas. Examples of such land use are Bloemspruit Wastewater Treatment Works, Mangaung Solid Waste Management Facility, Government departments, shopping malls, colleges and universities. These have provided employment opportunities in Bloemfontein City which led to its increasing population from neighbouring towns and rural areas. However, it is common to find in Bloemfontein that the public transportation routes are not very close to residents owing to the city plan. This disadvantages the poor citizens who use public transport that is more affordable. Approximately 13,000 people travel from other areas to Bloemfontein on a daily basis for social and economic activities available in the city. This places a great deal of pressure on public transportation in the MMM. In terms of finances, not less than R90 million is spent annually to subsidize public transport for the citizens of the MMM. This financial commitment into the public transportation sector is a demonstration of the government to ensure that the citizens participate in activities with little or no challenges. The subsidy alleviates public challenges and encourages integration of settlements.

Botshabelo

Botshabelo is approximately 50 km away from Bloemfontein City and it characterised as an underdeveloped area. The town does not have a clearly identifiable central business district and commercial activities are spread all over the town. The area is characterised by many undeveloped school sites and public open spaces. Botshabelo has about 138 factory buildings for the purpose of production. However, according to the Community Survey (2016), the unemployment rate of the town is 56% which means that most residents travel to Bloemfontein daily to participate in business activities and other social engagements.

Thaba Nchu

Thaba Nchu is one of the major towns in the MMM. It is situated 67 km from Bloemfontein. The town has the Mmabana Cultural Centre that attracts tourists. There is a stadium which hosts major events in the area. Like Batshabelo, most residents from the area travel to Bloemfontein for employment. This contributes to daily movement between two areas thereby increasing to public transport demand.

These three settlements play a major role in the socio-economic sphere of the MMM. The various characteristics and socio-economic activities of the MMM present attractive employment opportunities to citizens.

3.2 Common occupations in Mangaung Metropolitan Municipality

The economic activities and social development play collective roles in providing work opportunities and the engagement of citizens in productive ventures. The MMM has a number of public and private institutions such as trading centres, transport, manufacturing, and agricultural sections which enable a good standard of living for households.. According to the 2011 Census, 29 2971 people in MMM are economically active but its unemployment rate is higher than the national rate of 27.7%. Within the productive age bracket, 20.2% earn from between R19 601 to R38 200 per month, 17.2% earn from R9 601 to R19 600 per month and 11.4% of the population has no any means of income. Given that the citizens of the MMM are either low-income earners or unemployed, most people depend on public transport for mobility. There is an increased need for a public transportation system, especially owing to the fact that public income is low and the citizens travel long distances from various towns to Bloemfontein where there are more employment opportunities. Therefore, the provision of public transportation infrastructure by the government becomes crucial to meet the needs of its citizens.

3.3 Public transportation system in Mangaung Metropolitan Municipality

The transportation system of a region provides it with an opportunity for linkages within the region as well as surrounding areas. This is also the need for the MMM to optimise its performance and growth. The MMM is situated in the central region of South Africa and the Free State Province. This requires that there is an adequate transportation system for mobility. Bloemfontein, for instance, has socio-economic and business needs of households, as is the case with other cities. Feike, Das and Mostafa (2018) pointed out that Bloemfontein has schools, colleges, health facilities, and shopping centres which attract people from other areas to commute daily to and from the city. The available public transportation system constitutes rail, road and air which provide the linkages for the movement of people and freight. Owing to the high cost and inaccessibility of air transportation in the metropolitan municipality and the poor rail transport services, there is a high demand for the use of road transportation. However, the road transportation system which is nearest to residents is faced with challenges such as an inaccessible public transportation system. This has caused increasing ownership of private vehicles which is associated with increasing road traffic-related challenges such as traffic congestion and accidents in the MMM (Emuze and Das, 2015; Feike, Das and Mostafa, 2018). The present public transportation challenges in the MMM are relatively fewer compared to other major cities of South Africa such as

Johannesburg, Cape Town, Pretoria and Durban, if traffic congestion and travel delays are considered as indicators. This can be attributed to the number of public transportation infrastructures available in the area.

The MMM has public transportation infrastructure such as an airport, railway station, bus stations and taxi ranks to facilitate people's mobility. These provide transport services to the public. These are, however, characterised by inadequate taxi and mini-bus stations for picking up and setting down passengers. It is common, especially in the Bloemfontein CBD, that passengers are set down from mini-buses or taxis on a road by making use of a traffic-congested point. It is further a challenge in the CBD that many streets such as Peet Street, Douglas Street, Harvey Street and St Andrew's Street are turned into temporary taxi rank. This inhibits the free movement of traffic on the roads, thereby increasing the congestion on roads and delay time. There are public transport facilities that are built to reduce these negative occurrences on Bloemfontein CBD roads. These facilities are the Central Park Interstate Busline terminal (IBL) and the Mangaung Intermodal Transport Facility (MITF).

3.4 Mangaung Intermodal Transport Facility

Mangaung Intermodal Transport Facility is a terminal where taxis and mini-buses board and set down passengers off the road segment in the Mangaung CBD. This facility was constructed by the MMM and completed in 2012. Following its pilot operation in 2012, the users protested against its functionality connected to some geometric and traffic parameters. The non-utilization of the MITF has caused some traffic-related problems around these public transportation nodes such as congestion on Hanger's Street, St Andrew's Street and St George's Street during peak hours as shown in Figures 3.1 and 3.2. The completed MITF was commissioned and piloted for operations in 2012. Following the users' protests against its functionality, the facility has been left abandoned and locked against unauthorized access. Inside the transport facility are three floors of parking lots which can accommodate about 480 taxis and mini-buses. The MITF has one-lane entry and one-lane exit carriageways. The first and second floors of the parking lots are connected by one-lane and two-way carriageways. The one-way lane takes traffic from the first floor to the second floor whereas the two-lane carriageway collects traffic from second and third floors and takes them to the first floor. The third and second floors are connected by two lanes of two-way carriageway. The first floor has twenty-three (23) parking lots and second floor has twenty-one (21) parking lots. Each parking lot on the floors measures 42.0m by 2.5m. The third floor has seventy-six (76) parking lots which measures 20.0m by 2.6m each. Figure 5 shows the parking lot and passengers' waiting area of the MITF first floor.

Figure 3. 2: Mangaung Intermodal Transport Facility

3.5 Central Park Interstate Busline Terminal

Adjacent to the MITF is the IBLT which is a transit facility for IBL buses operating in Bloemfontein and neighbouring towns and cities. This facility has one-lane entry and one-lane exit carriageways. Unlike the MITF, it has one floor with twelve (12) parking lots. The parking lots measure between 45.0m and 52.0m long and between 4.0m and

7.0m wide. There are passengers' waiting areas with seats that run between the parking lots. Figure 3.3 shows an area view of the IBLT in the Mangaung CBD. The entry and exit lanes join Hanger Street at a Y-intersection. At the exit point to Hanger Street, there is a Y-intersection traffic control signal. There are several shopping centres below the facility on the ground level.

Figure 3. 3: Interstate Busline terminal parking lots and passengers' waiting areas

It is observed that the traffic congestion in the area is as the result of the temporary taxi ranks along Douglas Street, Harvey Street, Peet Street and St Andrew's Street. The intersections of roads with high traffic volume in the area have functional traffic signals and appropriate road markings to guide the movement of vehicles and pedestrians on the streets in the CBD.

3.6 Conclusion

MMM is one of the metropolitan municipalities in South Africa. It has an estimated population of 787 930 living in an area of 7886 km^2. It is a business hub of Free State Province. This is because of the economic and social activities in the metropolitan municipality. Some of the economic activities of the area are farming community services, transportation and trade. Mangaung Metropolitan Municipality is also a centre of attraction to people from different regions of the wold due to the presence of tourist centers like stadia. Furthermore, the various settlements in MM is connected by good road networks that facilitate integration of the settlements within the metropolitan municipality and other parts of South Africa. In addition to road networks are other transportation infrastructures such as bus terminals, railway and railway station and national airport which strengthen economic and social activities of the area. However, MMM is one the regions in South Africa that suffer traffic related challenges like congestion and accident.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.0 Introduction

In the previous chapter, the characteristics of the geographical area under study were discussed as well as the two public transport facilities selected for this research study. This chapter further explains in detail the approaches and strategies adopted to ensure that the objectives set out for this research study are met. It also describes the various methods used to collect data, the instruments used and the methods of analysis of each set of data obtained. The geometric parameters and traffic parameters taken by physical observations and measurement of the case study public transport facilities are compared with stakeholders' opinions to identify planning and design parameters that have an influence on stakeholders' acceptance of public transport facilities in the study area. The chapter also presents an ISM methodology to further collect opinions of transportation infrastructure stakeholders' groups and propose a framework of interrelatedness of the planning and design parameters.

4.1 Research philosophy

Every research study carried out is guided by certain assumptions and philosophy(ies) which a researcher holds on. These research assumptions and philosophies offer a direction by means of which sampling can be done and how data can be collected and analysed to be able to answer a research question (Fellows and Liu, 2015; Saunders, Lewis and Thornhill, 2016). This study has adopted ontological assumptions to conduct the research in the context of public transportation infrastructure and the stakeholders of these infrastructures to ensure that the data collected represents what is encountered on the public transportation infrastructure and the perspectives of stakeholders through their responses. Given that different groups of stakeholders have subjective views about a problem associated with public transportation infrastructure, the study has employed an ontological interpretivism philosophy to survey bus and minibus terminals, drivers and passengers for the study. This is to minimise the generalisation of the research findings to the entire public transportation infrastructure and stakeholders as is expected of positivism philosophical research. The study is devoid of critical realism which could be open to too many factors influencing stakeholders' acceptance of public transportation infrastructure beyond the scope of this research study. Such factors can be categorised under cultural values and beliefs, and environmental, political, social and financial factors. The ontological assumption used in the interpretivism approach leads the choice of research methodology explained in section 4.2 in order to achieve the study objectives.

4.2 Research design/ methods

This research study is aimed at proposing a framework to improve the acceptance of public transportation infrastructure by its stakeholders to answer the question 'How can stakeholders' acceptance of public transportation infrastructure be improved?' In order to answer the research question, this study has been designed to achieve its objectives stated in section 1.4. Given the study objectives, the research is designed as is shown in Figure 4.1 to use a survey method which includes a physical survey of two public transportation infrastructure projects through physical measurements and observations of geometric and traffic parameters. The choice of the public transportation infrastructures as a case study was guided by the stakeholders' acceptance indicator, namely usability. It was observed that the Central Park Interstate Busline Terminal is being used by passengers and bus operators whereas the Mangaung Intermodal Transport Facility (MITF) was not used during the operation phase of the project. The physical survey was adopted to obtain data from the case study public transport facilities. This enables gaining indebt knowledge of the facilities in their contexts.

In addition to the physical survey conducted on the public transportation infrastructure projects in the Bloemfontein CBD, the study reviewed literature on public transportation infrastructure planning and design factors and identified the various factors that can influence stakeholders' perception. A questionnaire was designed with the identified factors on a Likert scale. A stakeholders' survey was used to sample stakeholders' opinions. Furthermore, their perceptions were collected with the use of questionnaires. The stakeholders' responses were analysed statistically using SPSS software to collate their opinions and perceptions regarding the various planning and design factors. Semi-structured interview questions were administered to the stakeholders of public transportation infrastructure to gauge their engagement and involvement process in public transportation infrastructure projects in the MMM of South Africa. Furthermore, a focus group discussion with public transportation infrastructure project experts in the MMM was held. These experts were identified through snowballing purposive sampling. The group discussion enabled the establishment of a relationship among planning and design factors that influence stakeholders' acceptance of public transportation infrastructure projects in South Africa. The stakeholders' opinions were analysed by interpretive structural model methodology to model the relationship among the factors and to propose a framework of the relationship among the factors for the purpose of providing suggestions for the improvement of public transportation infrastructure acceptance. The details of the data collection, analysis and modelling are discussed in sections 4.3, 4.4 and 4.5 respectively.

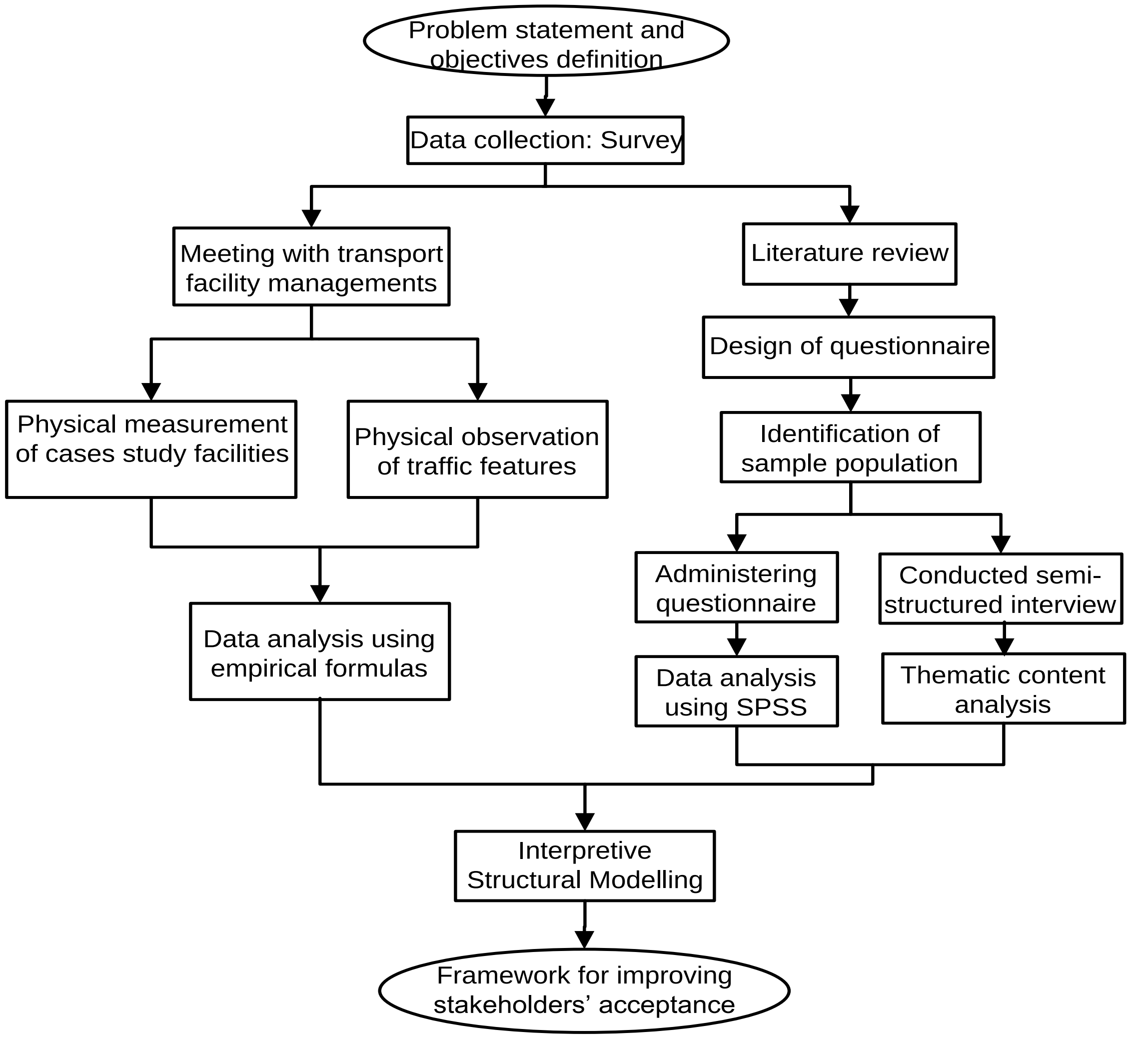

Figure 4. 1: Methodological framework for research study

4.3 Data collection

Data collection requires a systematic approach to obtain information for specific purpose(s) (Halstead, 2019). In order to achieve the aim and various objectives of this study, a set of activities were predetermined and followed up through survey research methods. The methods adapted to survey planning and design parameters of public transportation infrastructure and stakeholders' opinions and perceptions are explained in the sub-sections 4.3.1, 4.3.2, 4.3.3, 4.3.4 and 4.3.5. Sub-section 4.3.6 presents a focus group discussion for ISM methodology to model the relationships between the various planning and design parameters identified to influence stakeholders' perceptions of public transportation infrastructure projects.

4.3.1 Geometric parameters of public transport facilities

The physical measurement of the Central Park Interstate Busline Terminal (IBLT) and Mangaung Intermodal Transport Facility (MITF) in the Bloemfontein CBD of the MMM was carried out at different times. The researcher received a letter of introduction from his research study promoter (attached as Appendix A) to be presented to anyone from whom he may need assistance. The researcher went to the IBLT that has open access and conducted a preliminary physical observation survey of the facility. On the other hand, the MITF was found to be locked against unauthorised access. Owing to the inaccessibility of the MITF, it was necessary to seek authorization for access from the facility owner, the MMM. The Transportation Department of the MMM was visited in November, 2018 to explain the purpose of the research and the need to access the facility for a physical survey. The researcher was then directed to the manager of the Land Development and Property Management section of the municipality for appropriate action. Access to MITF was granted by means of a letter to the security company in charge of safeguarding the facility (Appendix B). The management of the IBLT was presented with a similar the letter of introduction. The purpose of the research was explained to the management and a request for permission for a physical survey was sought. The IBL manager requested a staff member at the IBLT to allow a physical survey of the facility for study purposes. Both the management of the IBLT and MITF demonstrated interest in the study objectives through maximum cooperation with me in accessing the public transportation infrastructure projects for a physical survey and data collection.

After obtaining permissions from the two managements, structured observation tables were designed to record the various measured or to observe the data collected. Two survey assistants were further recruited to support the process of measuring geometric features such as the parking lots, driveways, manoeuvrability, passengers' waiting areas and entry/exit lanes' width. After recruitment, a pilot physical observation, sketching of geometric diagram and physical measurements using a grip measuring wheel were carried out. This pilot physical survey was carried out to pre-test the accuracy and completeness of all geometric parameters through repeated measurements and data analysis using empirical formulas. The geometric dimensions such as lengths and widths of parking lots, width of lanes, length of parking bays and horizontal curves were taken after a successful pilot exercise. The measurements were also recorded in data collection tools for further use. Figure 4.2 shows the diagram of the IBL terminal in the Mangaung CBD with its various geometric dimensions on which the geometric measurements were taken.

After the physical measurements of the relevant dimensions of the IBLT in December, 2018, the MITF was accessed with a letter permission from the MMM to the security company guards. This facility has three floors of parking lots. At the same time, there was a physical observation of the various floors and the lanes connecting them. The geometrical features such as parking lots dimensions, driveway widths, length of tangent to curves and horizontal curve lengths of the various floors were measured. These were taken to be able to determine the adequacy of the parking lot to vehicle size and the parking lot size and length for vehicles, as well as determining the turning radii and traffic capacity of the parking lot. These measurements were taken with the use of grip measuring wheel which was always reset at 0 reading for each measurement and moved along the length of required measurement. All measurements taken from the MITF were recorded in a geometric measurement diagram designed for each floor as shown in Figures 4.3, 4.4 and 4.5.

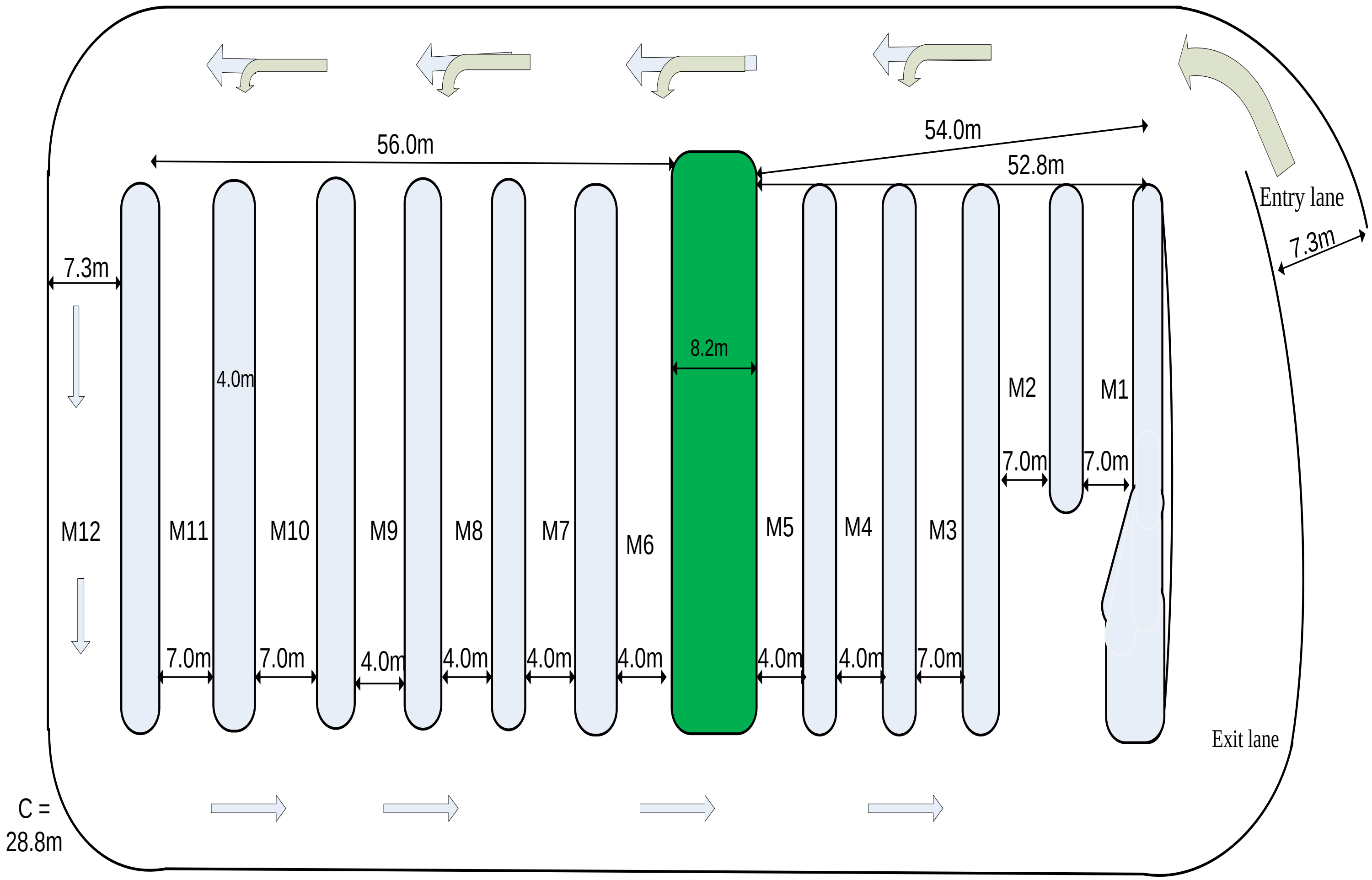

Figure 4. 2: Interstate Busline Terminal parking lot

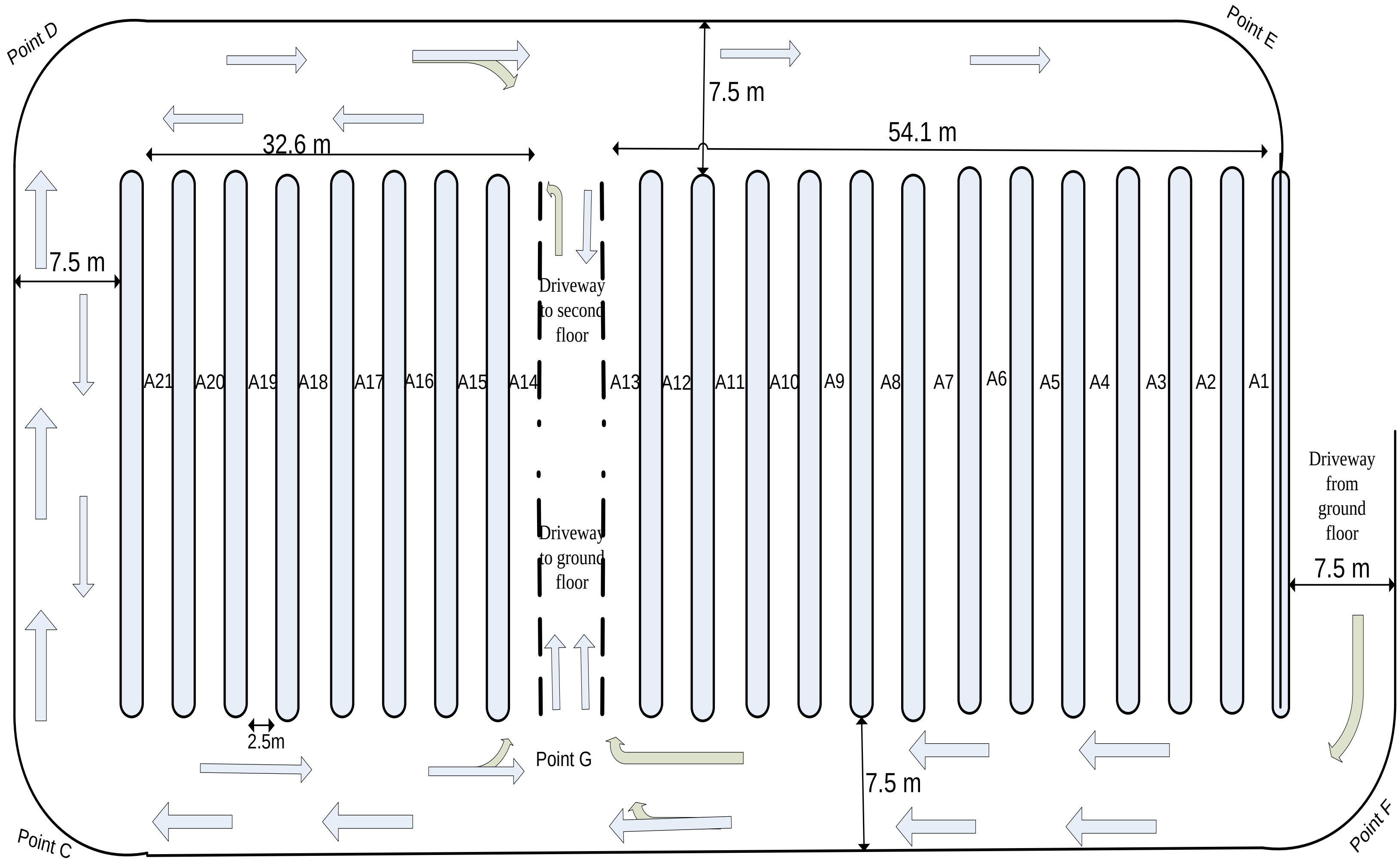

Figure 4. 3: First floor IBLT parking lot

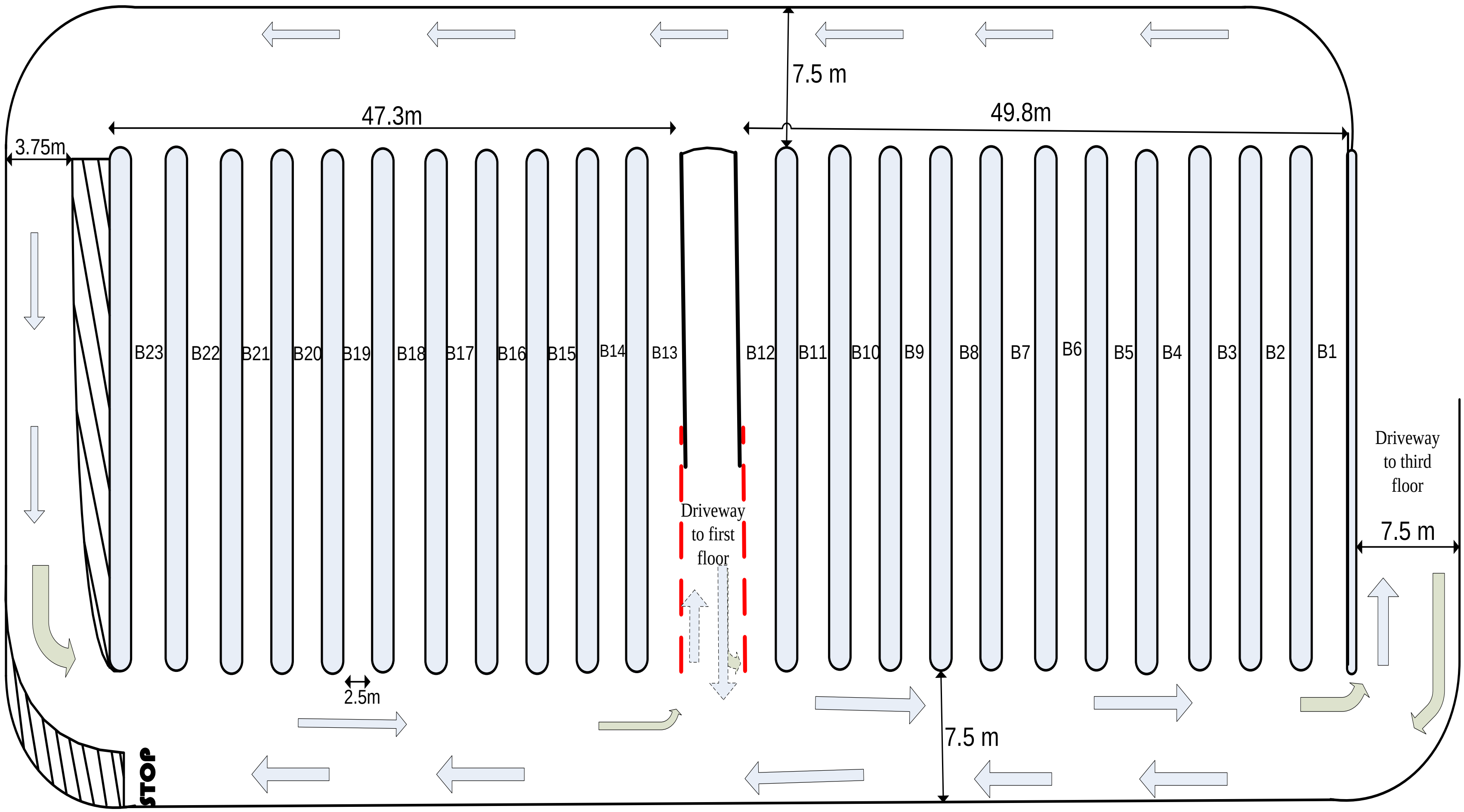

Figure 4. 4: Second floor IBLT parking lot

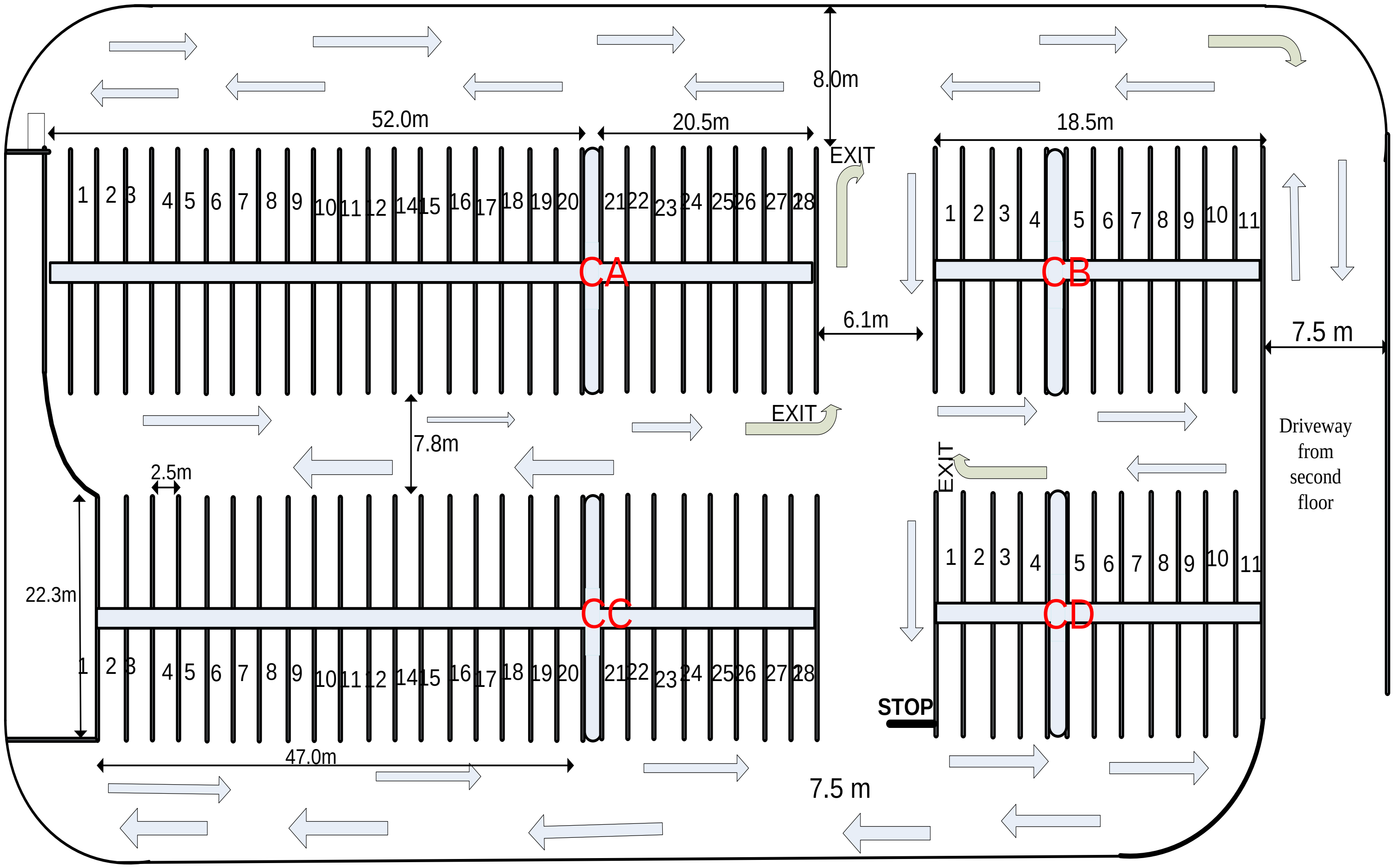

Figure 4. 5: Third floor IBLT parking lot

4.3.2 Traffic volume and traffic speed of vehicles

The Bloemfontein CBD has two bus terminals, namely the IBLT and the MITF. These public transportation infrastructures are meant to be used for public transport services and are located adjacent to each other. A physical observation of traffic flows in the CBD shows that these two facilities are strategically located so that two streets, Hanger and Harvey Streets, playa major traffic role in relation to them. Among many streets such as St Andrew Street, East Burger Street, St Georges Street, Aliwal Street and others, Hanger Street and Harvey Street are directly connected to the entry and exit points of the two facilities. These streets also take traffic from arterial roads into the CBD and mostly lead to both the IBLT and MITF. Given the observed traffic demand on the streets as well as the major role of connecting traffic at the entry and exit points of the transport facilities, the study chose Hanger Street and Harvey Street for surveying the traffic behaviour in relation to the accepted and non-accepted public transportation infrastructure projects in the Bloemfontein CBD.

In order to carry out the traffic survey, the use of manual traffic count to obtain traffic volume was employed with the assistance of trained observers (Leduc, 2008; Toth, Suh, Elango, Sadana, Guin, Hunter, and Guensler, 2013). The recruited traffic observers used tally sheets to record the number of vehicles observed entering the IBLT as well as the traffic on Hanger Street. In the case of the MITF, the traffic count of taxis and minibuses into the transport facility was not done because of a non-accessibility order by the MMM. A further traffic volume count was carried out on Hanger Street and Harvey Street.

On Hanger Street and Harvey Street, there was a pilot manual traffic count from 06:00 to 18:00 on the Monday, Tuesday and Saturday. These days and periods were chosen because they covered both peak and off-peak hours in the area as well as working days and the weekend. The collected data was then reviewed to ascertain the competence of the observers in the traffic count exercise through the collected data. The actual manual traffic count exercise was carried out for seven consecutive days. On each day, the counting started at 06:00 until 18:00 (Ludec, 2008). This period was chosen for the traffic count owing to the fact that in the Bloemfontein CBD where the counting took place, the activities such as economic and social that motivate travel demand are very intense in the daytime. It was observed that most business activities, social activities and government department offices started work at 08:00 and closed between 16:00 and 18:00. Very few activities happen at night and the number of people and traffic is very low. Apart from the high traffic flow within the period, the safety of the observers and materials at night was not guaranteed; hence the exclusion of the period from 18:00 to 06:00.

4.3.3 Spot speed determination

Spot speed is the speed determined at a selected section of a road to find the average speed of vehicles on the section. In this research, spot speeds were determined along Hanger Street and Harvey Street at points before the entry into IBLT and the IMTF and a section just after exit point of IMTF. On each of the selected roads, a distance of 76.5m was marked on the pavement. An observer stationed himself at the first marked point where he signalled the arrival time of a vehicle for starting the time recording at the departure marked point. The timing with a stop watch ceased once the vehicle had reached the end of the 76.5m mark on the pavement. The time taken by each vehicle under observation was recorded on a spot speed record sheet. This observation was repeated for twenty vehicles. The observation was also carried out on the entry and exit lanes of the IBLT. The spot distance recorded was 64.8m on the entry lane and 55.0m on the exit lane. Twenty different buses were observed for each lane and recorded on a spot speed sheet as previously explained. This was done to determine the entry and exit speed at the IBLT. There were no vehicles accessing the MITF within the physical survey period. Therefore, it was not possible to obtain the average speed of vehicles on each of the lanes in the facility. After recording the time taken by vehicles travelling through a section of the road, the traffic control mechanism, the traffic signal, was assessed at road intersections around the case study public transport facilities.

4.3.4 Signal timing and queue lengths at signalised intersections

Road intersections on major streets that feed traffic into the IBLT and MITF facilities were selected to evaluate the traffic control and characteristics. This was important as the traffic control system could influence public behaviour as regards the transportation infrastructure assets of an area. In this case, the intersection of the exit lane from the IBLT and Hanger Street was selected for this purpose. At each intersection, recruited traffic observers were assigned to each lane's traffic stream. The traffic observers obtained the number of vehicles that queued on each lane during the red traffic signal and these were recorded on a data sheet. The number of vehicles queueing at a junction before commencement of effective green interval was repeated five times so that the average queue lengths could be determined. Meanwhile, a stopwatch was used to time the green change interval, red change interval and yellow change interval. The various traffic light intervals were repeatedly timed until at least three common values were obtained and then recorded on the data sheet.

4.3.5 Collection of stakeholders' opinions and perceptions

The researcher reviewed literature that presents various factors that influence stakeholders' perceptions of a transportation infrastructure for acceptance or non-acceptance. The stakeholders' engagement in infrastructure projects was also identified from literature. These were used to draft a questionnaire to collect stakeholders' opinions (Rattray and Jones, 2007). Joshi, Kale, Chandel, and Pal (2015) state that in research to seek participants' opinions or perception about a 'latent' variable among many items, a Likert scale type is suitable for understanding the construct. In this case, the various factors identified from literature were scaled on the questionnaire on a five-point Likert scale. The scale ranged from 'strongly disagree', 'disagree', 'neutral', 'agree' and 'strongly agree' and weighted 1, 2, 3, 4 and 5 respectively. The Likert scale sought to find a respondent's level of agreement with a factor's influence on stakeholders' acceptance of the usability of public transportation infrastructure. The scale implied that 1 represented that the factor does not have an influence on stakeholders' acceptance and the degrees of agreement to a factor's influence increased along the scale to 5, which is a very strong. The five-point scale was also used to measure the levels at which respondents agree with stakeholders' engagement and involvement in public transportation infrastructure projects. The Likert scale ranged from 'very poor', 'poor', 'good', 'very good' and 'excellent' according to the numbers 1, 2, 3, 4 and 5 respectively. In addition to the scale, the questionnaire contained demographic information such as the gender, common mode of transportation (public and private), age range (19–24, 25–34, 35–65 and above 65) years, and participation in public transportation infrastructure project (driver or passenger). The questionnaire has instructions regarding the ticking of a preferred option among the five alternatives as scaled from number 1 to 5.

In order to collect data by means of the questionnaire, four data collectors were recruited who assisted in administering the questionnaires from February to May, 2019. The data collectors were recruited based on their understanding of both the English language and the local language (Sesotho) so that they could interpret some of the contents of the questionnaire for respondents that needed an explanation of the questions in their local language. A letter of introduction was attached to the questionnaire requesting the kind cooperation of the respondents for the purpose of research study. Stakeholders were surveyed and sampled by random sampling since the users of public transport systems in MMM were needed for the study (Fellows and Liu, 2015). The random sampling followed the citizens that use public transport in MMM to commute for their economic or social activities. It also did not neglect citizens with private cars whose mobility is however influenced by transportation infrastructures in Bloemfontein CBD. The choice of samples was based on the influence which public transportation infrastructures have on them to affect their perception. Due to the distance between places of residence of people and their daily activities, it is common that a number of people in the metropolitan municipality make use of public transport facilities especially at Bloemfontein CBD.

It is estimated that 13 000 people use public transportation as drivers or passengers for travelling on a daily basis in the MMM (IDP, 2016). Before the actual stakeholders' survey, 22 questionnaires were administered to respondents during the pilot survey exercise. This presented an opportunity to evaluate the common understanding by the respondents of the each question (factor) on the questionnaire. The pilot exercise was also conducted so that the respondents' attitude towards the length of the questionnaire could be assessed and the collected data tested for statistical analysis using SPSS (Flowerdew and Martin, 2013; Parfitt, 2005). During the pilot survey, respondents were further given the opportunity to make input into the questionnaire where necessary so that the questionnaire could be redesigned for the improved understanding of the tool. The pilot exercise was carried out among stakeholders in the MMM. The piloted questionnaires were reviewed and improved on using stakeholders' comments and observations made while administering them. These were done in an attempt to ensure that respondents had the same understanding of the pretested tool (Murray, 2013; Willis, 2004).

The redesigned questionnaire (Appendix B) was printed out in large numbers. This was administered to stakeholders in MMM. Bloemfontein City was used for the random sample selection of drivers because it is the area within which both accepted and non-accepted public transportation infrastructures are sited. Since the research is based on the emergence of non-acceptance of public transportation infrastructure which is common with facility users and community members, the sample selection of stakeholders for the study targeted the drivers and passengers on public transportation infrastructure. The number of citizens that uses public transportation in the municipality was targeted as sampled stakeholders given that the study considered the usability of transportation infrastructure projects as an indicator of acceptance or non-acceptance of public transportation infrastructure. According to Delice (2010), a sample of size between 30 and 500 is adequate for survey research which is the method of approach to the data collection in this study. A total of 412 questionnaires were administered to stakeholders, of which 308 were completed and returned to researcher. This represents a total of 75% of completed responses which shows respondents' cooperation and interest in the study (Waris, Liew, Khamidi and Idrus, 2014). The passengers in the Mangaung CBD had problems of responding to the questions due to their tight schedule of ensuring that they reached their place of work or residence on time. This made it difficult for some of them, who demonstrated interest in the research. Some declined to participate, citing the possibility of forgetting the questionnaire at home or at work. However, the drivers were more cooperative as their bus and taxi terminals and association office were points of contact.

Table 4.1 shows the demography of the respondents of the stakeholders' survey. Of the 308 completed questionnaires, 226 (73%) were males and 82 (27%) were females. The respondents represented all adult age groups. There were 100 (32%) respondents between the ages of 19 and 24 years, 139 (45%) were between 25 and 34 years, there were 64 (21%) between 35 and 65 years and only 5 (2%) were above 65 years old. The data were collected from 145 drivers (47%) and 163 passengers (53%) represented a total of 100% respondents. There were 72 (23%) who indicated that they use private vehicles for mobility whereas the majority of respondents, namely 236 (77%), indicated that they normally used public transport vehicles for their journeys.

The completed questionnaires were also checked against data irregularities such as selecting two options for an item; However, there were no cases of multiple responses. The questionnaire data were further coded as given in Table 4.2 and entered into the Statistical Package for Social Science (SPSS) software for statistical analysis. In the SPSS software, the data were first of all checked for duplicate data entry by running them with 'identify duplicate cases' on the software. There was no duplicate case of data entry identified.

Table 4. 1: Demographic data of respondents

Description	Category	Frequency	Percentage (%)
Gender	Female	82	27
	Male	226	73
Age range in years	19 – 24	100	32
	25 – 34	139	45

	35 – 65	64	21
	65 +	5	2
Role in public transportation	Drivers	145	47
	Passengers	163	53
Common mode of transportation	Public transport	236	77
	Private transport	72	23

Table 4. 2: Questionnaire data codes

Data	Code
Male	1
Female	2
Below 19 years	18
19 – 24 years	24
25 – 34 years	34
35 – 65 years	65
Above 65 years	66
Driver	1
Passenger	2
Private vehicle	1

Public transport vehicle	2

After checking for duplicate data entry, the reliability and internal consistency of the items under study from the questionnaire were determined. The data reliability measures the adequacy of a construct in a quantitative data using a questionnaire (Aiyewalehinmi, 2013; Peterson, Crosby, Wonderlich, Joiner, Crow, Mitchell, Bardone-Cone, Klein and Le Grange, 2007). This was determined with the use of SPSS 16.0 software. From the dataset in the software, the ‘Analyse’ on the menu bar was selected and the ‘Scale’ option was clicked to display the ‘Reliability analysis’ dialogue box. The Cronbach alpha was determined from the reliability analysis of the questionnaire data. These variables were grouped into two groups as regards the concepts which they measured. The first part had to do with the level of stakeholders’ engagement in public transportation infrastructure projects in the MMM. The second group measured the degree of stakeholders’ perception of the influence of planning and design factors on the acceptance of public transportation infrastructure projects and assets. The reliability was checked using Cronbach’s alpha. Both the Cronbach’s alphas were above 0,7 However, seven variables measuring the degree of stakeholders’ perception of factors’ influence on the acceptance of a project indicated a higher internal consistency if they were deleted from the list of variables. They were then removed from the list and the level of reliability and internal consistency increased. The determination of internal consistency was done to ensure that all variables were relevant to the concept (Tavakol and Dennik, 2011). While obtaining Cronbach’s alpha for reliability, the mean and standard deviation were also determined. The means of the items were relevant since there was a diverse degree of responses for each item collected from various respondents. The standard deviation, however, enabled the researcher to determine the extent to which the responses varied across the Likert scale. The planning and design parameters identified as those that influence stakeholders’ acceptance or non-acceptance of public transportation infrastructure were further considered to model the relationships among them. The interrelatedness between the factors could be determined through discussions among people with experience in the influence of the factors on one another. It therefore required a group discussion which focused on the interrelatedness to be able to model the relationships among planning and design parameters.

4.3.6 Group discussion of factors influencing stakeholders' attitude towards transportation infrastructure projects

Section 4.3.5 provides the use of questionnaires that enabled the identification of factors that influence stakeholders' acceptance or rejection of public transportation infrastructure. The choice of the characteristics of a design or planning factor is based on other factor. This shows that there is influence relationship among planning and design factors of transportation infrastructure. It is therefore important to examine the entire system of these factors even if a problem is identified with only one. This makes it necessary that experience transportation infrastructure project stakeholders across planning, design, research and operations share their opinions on the influence relationship among the factors during planning and design. Therefore, participants were randomly selected from transportation research, planning, design and operations who have at least five years of experience (Sachdeva, Sharma, Garg, and Singh, 2015). The random sampling enabled the identification of three academic staff in transportation research, one transportation planner, one member of infrastructure management staff and two taxi drivers. The concerned persons agreed to participate and a convenient day was chosen for the meeting to discuss the influence of the factors on each other for the planning and design of public transportation infrastructure. The focus group discussion was required given that the modelling of the factors relationships is the first step in ISM methodology (Shen, Song, Liao and Zhang, 2016).

The choice of ISM methodology enables the modelling of the complex structure of the public transportation infrastructure planning and design factors into simpler structures, showing their relationships (Sharma and Singh, 2012). The participants therefore met for the discussion. The researcher facilitated the session, beginning with self-introduction and an explanation of the purpose of the discussion. The printed copies of the factors presented in a matrix were shared among discussants. The discussants were further informed that their various opinions were expected to be respected by everyone while consensus opinion was sought. The discussants were told that the aim of the discussion was to identify the causal relationship between each pair of planning and design factors presented by the session facilitator. The nineteen identified factors from statistical analysis were discussed in pairs while the consensus decisions made by the group were noted. This was done with all paired factors and the group discussion ended after exhausting all pairs.

The data collection has made it possible to have various data required for the achievement of the objectives of the study. This is done by series of predetermined activities to obtain various data through stakeholders' opinions survey and physical observations and measurements. The available data, however, require further analysis for the purpose of improved scientific understanding (Zinzi, Capria, Palomba, Giommi and Antonelli, 2016). In this study, the analysis is therefore given in section 4.4 below.

4.4 Data analysis

The previous section 4.3 of this chapter has given the details of the relevant data and how they were collected. In this section it is important to illustrate how the collected data were used for meeting the objectives of the study research. The methods of the analyses of various data are explained in sub-sections of the data analysis.

4.4.1 Geometric parameters analysis and determination

The geometrical sizes of the parking lots, lanes and passengers' waiting areas were determined. Various mathematical equations were used to establish some geometric parameters that were not obtained from physical measurements. The models used for calculation of the minimum turning radius where the tangent length or horizontal curve was measured are given in equation 4.1, 4.2, 4.3 and 4.4.

$R_{min} = \frac{180C}{\pi\theta}$ - - - - 4.1 (Roess, Prassas and McShane, 2011)

Where R_{min} = minimum turning radius

C = length of road horizontal curve

π = 3.142

ϴ = angle between two tangent lines.

However, where lane and parking lot intersect at right angles, the tangent line for a turning curve between parking lot and lane is 90^0.

Therefore, $R_{min} = \frac{2C}{\pi}$= - - - 4.2

Considering the properties of an isosceles triangle from the geometry of the tangent lines and turning radius,

$R_{min} = T$ - - - - 4.3

$T = D - w$ - - - - 4.4

T is the length of the tangent line

D is the lane width and the minimum distance from the lane to the parking lot

w is lane width

From Figure 4.2, the driveway from M1 to M5 is 54.0m and the distance between M1 and M5 is 52.8m, the direction, ϴ between the two lines is

$\theta = \cos^{-1}\frac{52.8}{54.0}$ = 12^0 - - - 4.5

If x is distance from a passengers' waiting area to the driveway and 16.0m is offset from the base of passengers' waiting area into the parking lots,

Then x = btan12^0

b is the distance between the tangent line to a parking lot and L

tangent line, T = (16.0 – t) + x - - 4.6

t is the distance between offset point and tangent point along parking lot side line

From figure 4.2, <BOC = 39^0

$R_{min} = \mathrm{T}\frac{sin51^0}{sin39^0} = 1.235T$ - - - 4.7

4.4.2 Traffic data analysis

Further models in addition to geometric models for transportation infrastructure were used. These include equation 4.9 to equation 4.13. These equations are used to determine relevant traffic parameters of the case study public transportation facilities and the road sections that feed traffic into the facilities.

$N = \frac{L}{6.6}$ - - - 4.9 (Roess, Prassas and McShane, 2011)

N is the number of vehicles occupying a parking lot.

L is the length of parking lot

The various times spent by twenty (20) vehicles on a given road section were used to determine average speed. The time mean speed was adopted to calculate the average speed given that the researcher could conveniently time vehicles within a specified distance.

Speed of a vehicle, $V = \frac{distance}{time}$ - - - 4.10

Time mean speed, $V_t = \frac{\sum_1^n v}{n}$ - - - 4.11

n is the number of vehicles surveyed for speed

At signalised intersections

$Y_{min} = \emptyset + w + \frac{L}{U_0} + \frac{U_0}{2a}$ - - - 4.12

Y_{min} is the minimum yellow interval

$\emptyset$ = the driver's perception reaction time

w is the road width

L is the length of passenger car unit

a is the deceleration rate of vehicle (3.4 m/s^2)

U_0 is the design speed on an approach lane

Cycle length, C = Y + G + R - - 4.13

Y is the yellow interval of a traffic signal

G is the green interval of traffic signal

R is the red interval of a traffic signal

$Ct = s \times \frac{G}{C}$ - - - 4.14

Ct = traffic capacity of road

s = saturation volume (1500 veh/hr)

4.4.3 Evaluation of Likert scale data from questionnaire

Data analysis is aimed to synthesize a chunk of data collected for easier understanding and usage. The quantitative data collected were evaluated by using SPSS to determine the average weighted mean and standard deviation. The Likert scale-type data is evaluated in SPSS for descriptive statistics. For average weighted means and standard deviations, the 'Analyze' on the menu bar is selected to display options under it. Among the options, 'Frequencies' is a submenu of the descriptive statistics option. In the frequencies displayed with a dialogue box, the various factors for the evaluation are selected as variables for the descriptive statistical evaluation. In order to obtain the required data, the 'Statistics' option on the frequencies dialogue box is clicked and a number of the statistical options are displayed in a dialogue. Standard deviation and means are checked and run into the frequencies dialogue box for evaluation by selecting the 'OK' option. This is procedure is repeated for each of the thirty factors available for Likert scale evaluation.

The evaluation results showed the level stakeholders participation and engagement in transportation infrastructure projects and the level of agreement to the influence stakeholders' perception about factor under consideration. The most agree factors are therefore modelled for interrelatedness as discussed in section 4.4.4.

4.4.4 Structural modelling

The factors identified from the analysis of the questionnaire were presented to group of experts on public transportation infrastructure projects as discussed in section 4.3.6. The various relationships among the pairs of the factors were analysed by assigning codes for the respective direction of influence. In the modelling system, two factors such as A and B were coded according to, for instance, A influences B, A is influenced by B, both influence each other or none of them influences another. Various codes, V, A, X or O, were used to form a self-structured interaction matrix (SSIM) (Singh and Kant, 2008). This was done with the guidance of interpretive structural modelling principles. The coded relationships were given binary numbers by means of which 1 is coded for A and X while 0 is coded for A and O. The SSIM was transformed into reachability matrices using the binary numbers emanating from the SSIM. With the reachability matrices, the dependence power and driving power of each factor were determined by summing the columns and rows respectively for each factor. With the reachability matrices, the level partitioning is done in order to show the level at which each factor is dependent or drives others to develop a structure or framework. The details of the modelling by applying ISM in the study are discussed in Chapter six.

4.5 Conclusion

In this chapter, the research philosophy was discussed where various choices such as case study, mixed method of data collection and use of ISM methodology were given justification as regards the study. The target population and population sizes were also stated. All the relevant data collected and analysed enabled the achievement of a set of objectives such as identifying the planning and design factors that influence stakeholders' acceptance of transportation infrastructure projects, assessing stakeholders' engagement and participation in the planning and design processes of infrastructure projects in South Africa, developing models to establish the linkages between the control variables of stakeholders' acceptance and the planning and design variables of the public transportation infrastructure, and proposing a framework for the planning and design of transportation infrastructure based on the stakeholders' acceptance influencing parameters. All the results obtained are presented in Chapter five and they are used to discuss their implications for public transportation infrastructure sustainability..

CHAPTER FIVE: RESULTS, FINDINGS AND DISCUSSION

5.0 Introductions

Chapter four presented philosophy behind the choice of research methods, data collection and analysis. With the use of various empirical formulas, statistical analysis and interpretive structural model methods, different parameters such parking lots widths and lengths of transport facilities, the turning radii and understanding of stakeholders' perceptions were obtained to achieve the study objectives. In chapter five, the results and findings from the analysis are presented. The results are also discussed in details and the implications of the various findings are stated in this chapter.

5.1 Geometric characteristics of the case study public transport facilities

The geometric characteristics such as the parking facilities and turning radii of both the Mangaung Intermodal Transport Facility and the Interstate Busline Terminal are determined by using the various empirical equations. The results are presented in Tables 5.1 and 5.2 and discussed in the following subsections:

5.1.1 Parking facilities

Tables 5.1 and 5.2 show the geometric parameters of the MITF and IBLT parking lots respectively. These tables present the parameters determined from equations 4.2, 4.3 and 4.7 in Chapter 4. From Table 5.2, parking lots M1, M2, M3, M10, M11 and M12 as deduced from Figure 4.2 are each 7.0m wide. This means that two city buses (2.55 m wide) can be parked parallel to each other on each of the parking lots. Similarly, from Figure 4.2 and Table 5.2, the parking lots M4, M5, M6, M7, M8 and M9 that measure 4.0m wide can take one city bus within the width of the parking lots. The MITF which has three floors for parking facilities has these widths. The first floor parking lots A1 to A21 are 2.6m wide each, the second floor has lots of 2.6m each and the third floor has parking lots of 2.5m each. In Tables 5.1 and 5.2, these recommended minimum dimensions are presented in brackets and in red. It therefore means that any geometric feature that is less than its minimum can threaten the use of a public transport facility. This can also motivate a negative attitude of stakeholders towards the transport infrastructure project or asset. The width for all parking lots on the first, second and third floors of the MITF can allow the parking of passenger cars as recommended by the South African Institute of Civil Engineers (SAICE). The SAICE recommends a width of 2.5m for minibus and taxi parking facilities. The width of the parking lots of the IBLT is sufficient for both passenger car units and city buses with a width of 2.10m and 2.55m respectively. Garber and Hoel's (2018) recommendation of a width of 2.4m for parking lots for passengers' car unit agrees with the adequacy of both the IBLT and the MITF parking lots.

The lengths of the various parking lots in the MITF as presented in Table 5.1 are 42.0m each on the first and second floors whereas each of the parking lots on the third floor is 22.4m long. The parking lot of 42.0m can therefore accommodate six vehicles resulting in a total of 126 passenger cars on the first floor and 138 passenger cars with 23 parking lots on the second floor (Roess, Prassas and McShane, 2011). However, the SAICE gives an allowable space for each vehicle in the parking lot as 5.0m. In this case, each parking lot can be occupied by eight (8) vehicles, giving a total of 168 vehicles on the first floor and 184 vehicles on the second floor. The third floor parking lots CA1 to CA28, CB1 to CB11, CC1 to CC26 and CD1 to CD11 are 20.0m each with 2.3m pedestrian walkways between them, resulting in two of 10.0m for each parking lot. The 5.0m marked for vehicles on the floor is within the recommendation of SAICE which gives a total of 372 vehicle parking bays. The capacity of the MITF is therefore a total of 636 passenger cars.

However, the transport facility has only one entry lane and one exit lane. This means that there may be traffic congestion on the connecting road to the facility if there is traffic demand to its capacity. The Central Park IBLT is used for city buses to transport people in and out of the Bloemfontein CBD. Given that each city bus parking bay length is a minimum of 12.9m, M1 and M2 parking lots from the IBLT are adequate for two buses parked end to end. M6, M7, M8, M9, M10, M11 and M12 can accommodate three city buses while M3, M4 and M5 take four buses along the lengths of the parking lots. Therefore, the IBLT has a capacity of 57 city buses.

Table 5. 1: Geometric parameters of Intermodal Transport Facility floors

			Entry point			**Exit point**		
Parking lot	Length (m)	Width (m)	Tangent length (m)	Angle between tangent lines (^{0})	Turning radius (m)	Tangent length (m)	Angle between tangent lines (^{0})	Turning radius (m)
First floor								
A1 – A21	42.0	2.6 **(2.5)**	3.6	90	3.6 **(1.6)**	0.6	90	0.6 **(1.6)**
Second floor								
B1 – B13	42.0	2.6 **(2.5)**	0.6	90	0.6 **(1.6)**	3.6	90	3.6 **(1.6)**
B14 –B23	42.0	2.6 **(2.5)**	3.9	90	3.9 **(1.6)**	3.6	90	3.6 **(1.6)**
Third floor								
CA1 – 28	22.4	2.5 **(2.5)**	1.0	90	1.0 **(1.6)**	0.9	90	0.9 **(1.6)**
CB1 – 11	22.4	2.5 **(2.5)**	1.0	90	1.0 **(1.6)**	0.9	90	0.9 **(1.6)**
CC1 – 26	22.4	2.5	1.0	90	1.0	0.9	90	0.9

		(2.5)			(1.6)			(1.6)
CD1 - 11	22.4	2.5 (2.5)	1.0	90	1.0 (1.6)	0.9	90	0.9 (1.6)

Table 5. 2: Geometric parameters of IBLT

	Parking lot entry point		Parking lot exit point			
Parking lot	Tangent line (m)	Turning radius (m)	Tangent length (m)	Turning radius (m)	width (m)	Length (m)
M1	3.4	4.2 (12.8)	12.4	12.4(12.8)	7.0 (6.8)	31.3
M2	5.1	6.3 (12.8)	12.4	12.4 (12.8)	7.0 (6.8)	52.0
M3	10.7	13.2 (12.8)	12.4	12.4 (12.8)	7.0 (6.8)	52.0
M4	12.3	15.2 (12.8)	12.4	12.4 (12.8)	4.0 (2.5)	52.0
M5	10.5	10.5 (12.8)	12.4	12.4 (12.8)	4.0 (2.5)	52.0
M6	5.5	5.5 (12.8)	12.4	12.4 (12.8)	4.0 (2.5)	45.0

M7	5.5	5.5 **(12.8)**	12.4	12.4 **(12.8)**	4.0 **(2.5)**	45.0
M8	5.5	5.5 **(12.8)**	12.4	12.4 **(12.8)**	4.0 **(2.5)**	45.0
M9	5.5	5.5 **(12.8)**	12.4	12.4 **(12.8)**	4.0 **(2.5)**	45.0
M10	5.5	5.5 **(12.8)**	12.4	12.4 **(12.8)**	7.0 **(6.8)**	45.0
M11	5.5	5.5 **(12.8)**	12.4	12.4 **(12.8)**	7.0 **(6.8)**	45.0
M12	5.5	5.5 **(12.8)**	12.4	12.4 **(12.8)**	7.0 **(6.8)**	45.0

5.1.2 The turning radii of parking lots of transport facilities

The turning radius at the entry point into parking lots is 3.6m on the first floor for A1 to A21, 0.6m for B1 to B13 parking lots, and 3.9m for B14 to B23 parking lots. The entry points of the third floor parking lots are 1.0m. At the exit points of the parking lots in the transport facility, the turning radius as shown in Table 5.1 at the first floor for all parking lots is 0.6m, that for all parking lots for the second floor is 3.6m while the radii for the third floor are 0.9m each. At the IBLT, the turning radii at entry point into the parking lots are below the requirement of 12.8m, except parking lots M3 and M4 which are above the requirement. This shows that intercity buses entering the parking lots from the driveway must maintain a low speed to be able to enter. This is not applicable for parking lots M3 and M4 where movement is safe at its design speed.

The exit point turning radii of all the parking lots of the IBLT is 12.4m. According to Roess, Prassas and McShane (2011), the minimum turning radius for an intercity bus is 3.6m. Therefore, the buses out of the parking lots must maintain a minimum speed during their manoeuvring out of the parking lots. Table 5.1 shows the turning radii at the exit points of the MITF parking lots. It shows that all turning radii of the second floor parking lots are adequate for movement into driveway. However, the turning radius of 0.6m for the first floor and 0.9m for the third floor are not adequate for the manoeuvrability of passenger cars. It therefore implies that vehicles moving out of the parking lots on the second floor are safe; however, the first and third floors require care by drivers by ensuring a minimum speed while negotiating into the driveway.

5.1.3 The manoeuvrability on driveway

Every transport facility has a number of driveways through which vehicles move within and around it. The parking facilities are also connected to other facilities by means of a driveway. It is therefore important that linkages of transport facilities are adequate in terms of geometric parameters. These parameters include the width of driveway or lanes and the turning radius. Table 5.3 presents the turning radii and widths of driveways. The points shown in the table are from Figures 4.3, 4.4 and 4.5. From Table 5.3, points C, D, F, G and H are from Figure 4.3 and J is from Figure 4.4. The width of lanes of the driveways is measured 3.75m which is above the minimum requirement of 3.70m for road lane. This means all the lanes of the driveways are sizeable enough for the movement of vehicles. The table and figures show that some driveways have two lanes of which at the horizontal curve, there is an external lane and internal lane. The external lanes at points C, D, H, J and I are above the minimum 1.6m turning radius for passenger cars. On the other hand, the internal lanes at points C, D, H, J, I and entry and exit lanes at the third floor have turning radii below the minimum standard. This shows that the entry and exit of vehicles at the third floor as well as the movement of vehicles through the internal lanes at horizontal curves is challenging for a driver. Nevertheless, the external lanes offer adequate turning radii for the comfortable manoeuvrability of passenger car in the MITF.

These turning radii and road widths present the geometric characteristics of public transportation infrastructure. They influence the traffic parameters of a facility in terms of traffic volume and speed. Therefore, section 5.2 discusses the traffic characteristics of the case study facilities in MMM in South Africa.

Table 5. 3: Geometric characteristics of driveways in Intermodal Transport Facility

Point	Lane	Length of curve (m)	Tangent length (m)	Angle between tangent lines (^{0})	Minimum turning radius (m)	Width of lane (m)
First floor						
C	External lane	7.0	-	-	4.5 **(1.6)**	3.75 **(3.7)**
C	Internal lane	-	0.8	90	0.8 **(1.6)**	3.75 **(3.7)**
D	External lane	5.0	-	-	3.2 **(1.6)**	3.75 **(3.7)**
D	Internal lane	-	0.6	90	0.6 **(1.6)**	3.75 **(3.7)**
F		6.3	-	-	4.0 **(1.6)**	3.75 **(3.7)**
G		-	0.6	90	0.6	3.75

					(1.6)	**(3.7)**
Second floor						
H	External lane	-	3.6	90	3.6 **(1.6)**	3.75 **(3.7)**
H	Internal lane	-	0.6	90	0.6 **(1.6)**	3.75 **(3.7)**
I	Internal lane	8.0	-	-	5.1 **(1.6)**	3.75 **(3.7)**
J	External lane	7.2	-	-	4.6 **(1.6)**	3.75 **(3.7)**
J	Internal lane	-	0.7	90	0.7 **(1.6)**	3.75 **(3.7)**
Third floor						
	Entry lane		0.10	90	0.10 **(1.6)**	3.75 **(3.7)**
	Exit lane		0.30	90	0.30 **(1.6)**	4.00 **(3.7)**

5.2 Traffic characteristics on the case study transport facilities and connecting roads

Public transportation infrastructures facilitate the mobility of vehicles and people. They are designed and constructed to enhance effective movement. The quest to move gives rise to variations on traffic parameters such as average daily traffic, average hourly traffic, and average speeds as well as traffic control systems. In the case study of public transportation facilities, these parameters are determined to gain an understanding of traffic behaviour and its influence on stakeholders' perception of public transportation infrastructure projects (Kim, Park and Sang, 2008).

5.2.1 Average daily traffic (ADT)

The average daily traffic gives the estimate of the traffic volume on a section of a road. The understanding of traffic is beneficial for governments and their agencies in managing traffic situations and related challenges such as congestion. The daily traffic on Hanger and Harvey Streets which connect to transport facilities is presented in Table 5.4. The daily traffic on Hanger Street ranges between 12 092 and 13 396 vehicles on working days. This is, however, reduced over weekend. This is similar to Harvey Street; however, there is a lower traffic volume, namely from 11 082 to 11 998 vehicles per day on working days. The higher daily traffic volume on working days is associated with social activities that take place in schools and government departments and agencies. The reduced average daily traffic on weekends is as the result of minimal activities that take place on weekends to attract traffic demand. In this way, the two streets are congested with traffic on working days which causes congestion, increased delayed travel time and vehicle/pedestrian accidents at intersections at peak hours.

Table 5. 4: Traffic volumes on streets

	Hanger Street		**Harvey Street**	
Day	ADT (PCU)	AHT (PCU)	ADT (PCU)	AHT (PCU)
Monday	12298	1116	11126	927

Tuesday	12360	1088	11182	932
Wednesday	12092	1007	11082	924
Thursday	11163	930	11276	940
Friday	13396	1024	11998	916
Saturday	5764	480	5355	446
Sunday	889	74	935	78
Average weekly traffic	**9708**	**817**	**8993**	**737**

5.2.2 Average hourly traffic (AHT)

The average hourly traffic shows the average of traffic distribution over a day. This parameter gives a sense of the level of road saturation, especially at an intersection. The two streets shown in Table 5.5 and Figure 5.1 give a twelve-hour traffic distribution. This shows a morning peak hour (06:00 – 09:00) with highest average hourly traffic volume of 1 248 vehicles on Hanger Street and 726 vehicles on Harvey Street. During the afternoon peak hour (15:00 – 18:00) the highest average hourly traffic volume on Hanger Street is 908 vehicles and that of Harvey Street is 862 vehicles. It is also shown in Figure 5.1 that the off-peak hour on the streets is from 09:00 to 15:00. In both morning and afternoon peak hour traffic, the results show that streets will reach crash level soon. This is because Hanger Street, which is a three-lane road, has peak hour traffic reaching the maximum of 1500 veh/hr and the two-lane Harvey Street carries 862 vehicles which is close to its maximum of 1000 veh/hr (Martin, 2002). Therefore it is necessary to plan for alternative routes to support traffic growth or to put policies in place that will reduce traffic volume on the streets.

Table 5. 5: Average hourly traffic

	Hanger street	**Harvey Street**
Duration	**Average hourly traffic (PCU)**	**Average hourly traffic (PCU)**
6:00 – 7:00	1129	741
7:00 – 8:00	1248	815
8:00 – 9:00	1094	733
9:00 – 10:00	915	726
10:00 – 11:00	769	694
11:00 – 12:00	791	625
12:00 – 13:00	743	678
13:00 – 14:00	762	738
14:00 – 15:00	854	825
15:00 – 16:00	931	822
16:00 – 17:00	1063	862
17:00 – 8:00	860	765
Average daily traffic (pcu)	930	752

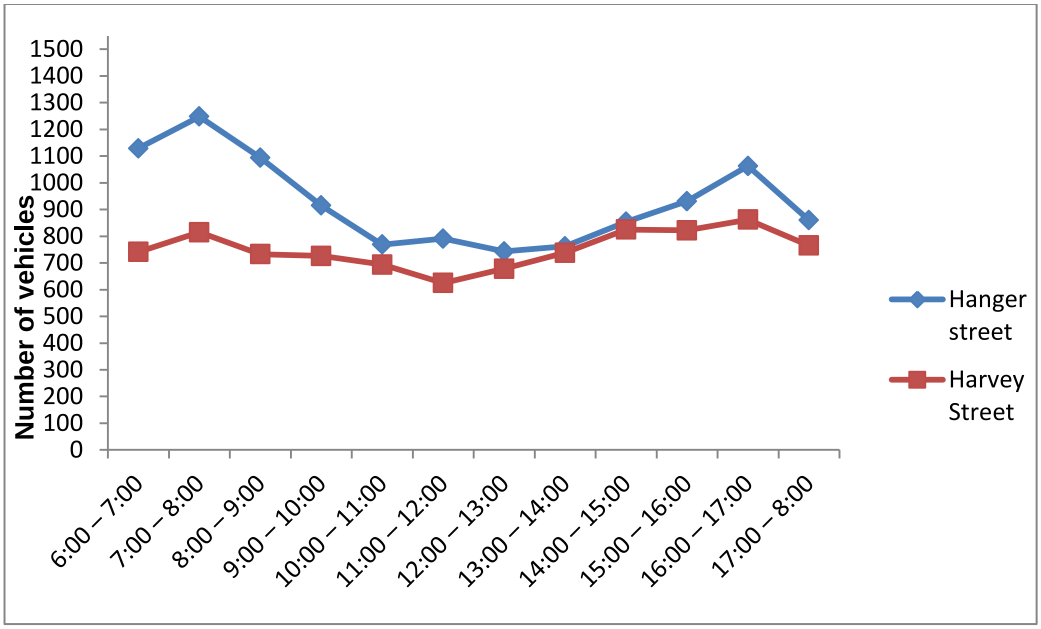

Figure 5. 1: Average hourly traffic (PCU) on Hanger Street and Harvey Street

5.2.3 Average traffic speed on driveway/roads

Traffic speed on a road is an important traffic parameter that gives the rate at which vehicles move along the road. This shows the flow rate of traffic which can determine the inflow of traffic into a transport facility. It also has an influence on traffic-related challenges such as congestion and accidents. When the speed of vehicles on a road is higher than the design speed, there is tendency of a high rate of road accidents. Traffic congestion also affects the average speed of traffic on road. In this study, Table 5.6 depicts the average traffic speed at the IBLT which gives the rate at which vehicles are discharged from or enter the transport facility. This varies with the time of day: peak or off-peak period. At the off-peak period, the average entry speed is 15.41km/hr and the average exit speed is 25.32km/hr. These speeds are above the posted speed limit of 10km/hr for the facility. This implies that there can be a traffic accident at any given time since the sight distance within the facility is not greater than 100m at any point. The peak period average speed on the entry driveway is 10.97km/hr and that of the exit driveway is 15.48km/hr. The average speeds at peak period are also above the posted speed limit.

Similarly, Table 5.7 represents average speeds on Hanger Street and Harvey Street. The speed at peak and off-peak periods varies significantly. At peak periods, the average speed on Hanger Street is 16.32km/hr while the Harvey Street average speed at peak periods is 14.09km/hr. The average speed on both streets encourages congestion at peak hours on urban roads. However, there is free traffic flow at off-peak hour with the speeds shown in Table 5.7.

Table 5. 6: Daily average speed of vehicles at IBLT

	Hanger Street		**Harvey Street**	
Day	Average speed (km/hr) Off-peak	Average speed (km/hr) Peak	Average speed (km/hr) Off-peak	Average speed (km/hr) Peak
Monday	15.55	12.26	24.44	10.24
Tuesday	15.88	10.94	26.06	12.19
Wednesday	15.55	10.87	25.38	11.63
Thursday	15.34	13.49	25.48	14.42
Friday	15.44	10.56	24.77	11.83
Saturday	14.94	15.12	25.70	23.26
Sunday	15.16	14.98	25.38	24.82
Average speed (km/hr)	15.41	12.60	25.31	15.48

Table 5. 7: Spot speed of vehicles on Hanger Street and Harvey Street

	Hanger Street		Harvey Street	
Day	Peak hour average speed (km/hr)	Off-peak hour Average speed (km/hr)	Peak hour average speed (km/hr)	Off-peak hour Average speed (km/hr)
Monday	16.54	19.87	10.43	20.84
Tuesday	16.95	20.80	11.81	19.67
Wednesday	17.22	22.39	11.78	18.36
Thursday	16.11	23.85	13.77	20.28
Friday	14.46	19.69	12.33	20.37
Saturday	17.84	22.07	18.94	22.96
Sunday	18.20	20.80	19.56	21.10

5.2.4 Signal timing at intersection

A signal timing at an intersection helps to control traffic flow on roads and to minimise conflicts. Therefore it is necessary to analyse the traffic control system at intersections where roads are connected with the case study public transport facilities to understand traffic behaviour. At the intersection of Hanger Street and the exit driveway from the IBLT, the signal timing and queue length are presented in Table 5.8. The effective green on the Hanger Street is 17.10s whereas the effective green on the IBL exit road is 35.50s. The Hanger Street effective green is lower than the IBLT road; however, it has three lanes. This enables it to discharge more vehicles within the green compared to the one-lane IBLT driveway. The effective red on IBL driveway is 21.60s and that of Hanger

Street is 17.10s. The exit driveway length of IBL is approximately 58m and the queue length at peak hours is usually higher than the clearance interval on the driveway.

The cycle length at the intersection is 60.60s which is within the allowable cycle length of 120s for the effective discharge of traffic at a road intersection. However, the capacity of Hanger Street is 1268 veh/hr and its AHT at peak hour is 1248 veh/hr. This means that there is a need for the optimization of the signal timing against growing traffic volumes in Bloemfontein City.

Table 5. 8: Hanger Street and Interstate Busline exit lane intersection signal timing

Hanger Street and Interstate Bus Line Terminal exit lane intersection						
Intersection type		Y-intersection				
Number of phases		2				
Signal control		Signalised				
	Hanger Street			**Interstate Bus Line Terminal exit lane**		
Road type	Collector			Collector		
Road category	Paved			Paved		
Carriageway	1-way			1-way		
Number of lanes	3			1		
Intersection exit	Through only			Through only		

Traffic sign	Road markings			No road markings		
Signal timing on Hanger Street						
Signal colour	**First test**	**second test**	**Third test**	**Fourth test**	**Fifth test**	**Light duration**
Green (s)	17.10	17.13	17.10	17.10	17.10	17.10
Yellow (s)	4.50	4.50	4.50	4.50	4.50	4.50
Red (s)	40.11	39.00	39.00	38.97	39.00	39.00
Signal timing on Interstate Bus Line Terminal exit lane						
Signal colour	**First test**	**second test**	**Third test**	**Fourth test**	**Fifth test**	**Light duration**
Green (s)	38.91	39.00	35.50	35.50	35.50	35.50
Yellow (s)	3.50	3.50	3.50	3.50	3.50	3.50
Red (s)	21.60	21.60	21.60	21.60	21.60	21.60
The cycle length						**60.60s**

The different traffic parameters discussed in this section affect the traffic characteristics of the transport facility. In this way, they have influence both public transportation infrastructure stakeholders' behaviour and their perception. Section 5.3 therefore discusses this as various public transportation infrastructure project planning and design factors are evaluated using a Likert scale.

5.3 Stakeholders' perception of public transportation infrastructure projects

Public transportation infrastructure projects are constructed for the purpose of public mobility. They are generally meant to be safe, accessible and affordable by the users without threat to their existence. Stakeholders' perceptions of such projects are influenced by the level of their engagement and involvement in the projects. The planning and design process and factors which determine certain characteristics of a public transportation infrastructure usually give stakeholders a sense or feeling about it. Therefore, this section discusses the engagement and involvement of stakeholders in public transportation infrastructure. It also discusses the influence of planning and design factors on stakeholders' perception and the implication for public transportation infrastructure projects. Table 5.9 shows the reliability of the questionnaire administered on respondents which presents the data measured in two constructs. The part of stakeholders' engagement and participation in public transportation infrastructure projects shows a reliability of 0.711 (71.1%). The other part measures respondents' opinions on stakeholders' perception about planning and design factors in relation to their acceptance of public transportation infrastructure. The questionnaire under this concept has a Cronbach alpha of 0.846 (84.6%) as reliability of the concept of measurement. The two reliability results are adequate for the questionnaire for statistical analysis to be carried out on the data (Bonnet and Wright, 2015; Gliem and Gliem, 2003; Tavakol and Dennik, 2011).

Table 5. 9: Reliability

Construct in questionnaire	Cronbach's alpha
Stakeholders' engagement and participation in transportation infrastructure project	0.711
Planning and design factors	0.846

5.3.1 Stakeholders' engagement and participation in public transportation infrastructure projects

The roles of public transportation infrastructure project stakeholders in the project cannot be overemphasized. This is because each activity or task is undertaken by someone to influence an outcome. It is important to engage stakeholders through identification and adequate consultation. On the other hand, the engagement and participation of stakeholders vary from one project to another. This gives different subjective assessments of being very good, good, fair, poor or very poor. This depends on the stakeholders' management strategies for the project for the purpose of successful delivery.

5.3.1.1 Stakeholders' involvement in transportation planning process

It is essential to note that stakeholders' engagement and involvement are critical for the sustainability of public transportation infrastructure projects (Reed and Marks, 2008). It is shown in Figure 5.2 that 36.7% of the respondents rated the engagement of stakeholders during planning as very poor, 46.8% of the respondents rate it poor, 7.1% of the respondents rate it fair, 8.4% of the respondents rate it good and only 1.0% of them rate it as very good. These responses give the Likert index mean of 1.92 as indicated in Table 5.10. This implies that the engagement of stakeholders in the MMM is poor. If they are involved in the process at the right time, there is an increased probability of achieving the project objectives and goal (Couix and Gonzalo, 2016). This does not agree with the integrated development plan of the MMM which shows that stakeholders are involved in the transportation infrastructure planning process. It can be inferred that the planning of public transportation infrastructure lacks adequate stakeholders' consultation for their contribution and participation in the planning process.

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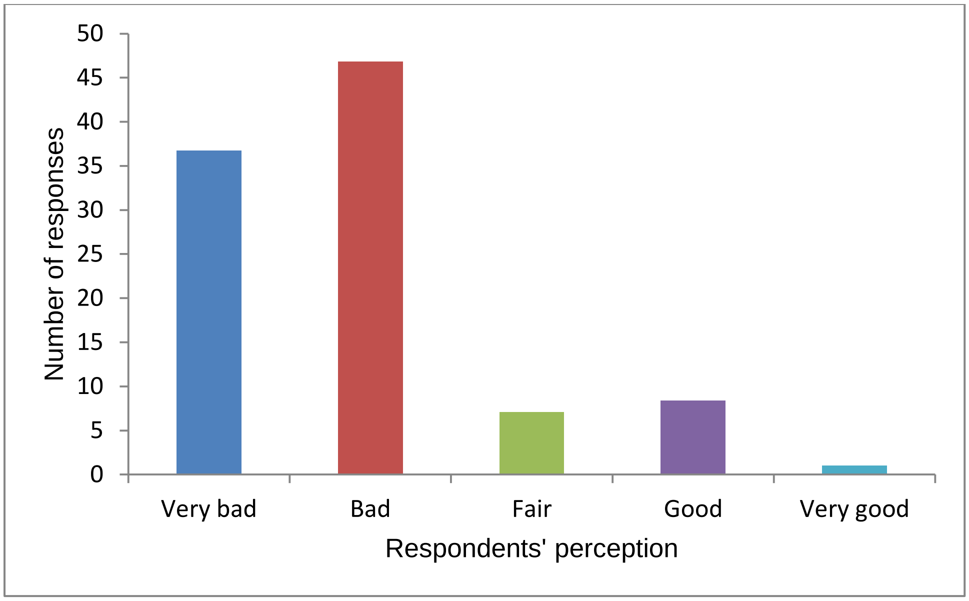

Figure 5. 2: Stakeholders' involvement in transportation facility planning process

5.3.1.2 Stakeholders' meetings during transportation infrastructure project

Transportation infrastructure projects require frequent meetings of stakeholders for the purpose of evaluation and sharing knowledge for successful delivery. Figure 5.3 shows the distribution of respondents regarding the assessment of stakeholders' meeting for project delivery. It shows that 32.5% of the respondents rate the practice in the course of delivery projects as good, followed by 28.2% who rated it as fair. In addition, 4.9% of the respondents rate stakeholders' meeting as being very bad. The responses therefore have a Likert index of 3.46 as shown in Table 5.10. The standard deviation of their responses is 1.11.

The results from Figure 5.3 and Table 5.10 imply that stakeholders involved in the project normally hold meetings to discuss project progress, assess performance and get and share information. The holding of meetings among the stakeholders can build good communication among them, improve interpersonal relationships and build team work which are key to project success (Abou-Senna, 2017).

Figure 5. 3: Stakeholders' meeting during transportation infrastructure project

5.3.1.3 Public transportation infrastructure project progress information to stakeholders

A transportation infrastructure project is a continuous process of coordinated activities carried out to ensure the mobility of people and goods. Stakeholders, either internal or external, in most cases expect adequate information about the progress of a project. From Figure 5.4, it can be seen that 37.4% of respondents consider that the rate of progress reports being given to them is bad, 27.4% respondents rate it very bad, and only 19.7% rated it fair. It is also found that 10.3% and 2.9% have rated giving progress information to stakeholders as good and very good respectively. The Likert index mean is 2.22 which shows that the respondents consider that inadequate project information is given to stakeholders. There are some stakeholders who always have to be kept informed about the project progress for its success (Olander and Landim, 2005). Quick (2011) also pointed out some stakeholders of public transportation infrastructure projects have good knowledge or experience of similar projects and must therefore be kept informed of a project's progress to avoid stakeholders' resistance (Amabile and Kramer, 2011).

Figure 5. 4: Information on progress report to stakeholders of public transportation infrastructure projects

5.3.1.4 Stakeholders' information on project outcomes and benefits during planning process

Every transportation infrastructure project is set out to achieve some objectives to solve social and economic problems. The interest of stakeholders in a project is influenced by the expected outcome or benefits. Therefore, it is important to know their knowledge of a project at the planning and design phase. Figure 5.5 shows that 28.8% of respondents rate this knowledge as good, 25.1% of respondents rate it as bad, 24.1% of them rate it as fair while 1.6% of them did not rate being informed of the knowledge of project outcomes or benefits at the early stage of project. The Likert index mean of 2.94 indicates the information is not given to them at the time of the planning for the project.

Figure 5. 5: Stakeholders' information on project outcomes and benefits during planning process

5.3.1.5 Stakeholders' contribution in public transportation infrastructure project

In every transportation infrastructure project, there are materials and other resources that facilitate the carrying out of activities. The various stakeholders have different roles and contributions to make to ensure the various processes involved are accomplished. In this study, 50.2% of respondents rate the stakeholders' contribution of materials and opinions as bad, 28.6% of the respondents rate it as very bad, 14.4% rate it as fair while 2.3% and 1.9% have rated it very good and good respectively as shown in Figure 5.6. Table 5.10 indicates that the Likert index mean is 1.96. The data from the figure and table shows that stakeholders do not contribute resources or opinions for the delivery of public transportation infrastructure projects. The absence of stakeholders' commitment to contribute resources and opinions can hinder interventions at time of conflict in the project (Gerardus, 2004). This finding shows agreement with the opinions of two Bloemfontein taxi drivers who said that from their experience of similar projects, infrastructure project contractors do not consider their opinions regarding construction. In this way, their contributions to such projects are not normally considered.

Figure 5. 6: Stakeholders' contribution to transportation infrastructure projects

5.3.1.6 Factors influence on stakeholders' participation in public transportation infrastructure projects

Figure 5.7 below shows the finding from respondents regarding challenges affecting stakeholders' active participation in transportation infrastructure projects. The figure shows that 33.8% of the respondents rate this in the MMM as good, 25.7% of them rate it as fair, while 19.9% of the respondents rate it as very good. The index mean of the distribution of the responses across the Likert scale is 3.46. These figures show that in the municipality, the participation of stakeholders in transportation infrastructure project depends on their distance from the location of the project, the money they have and their knowledge about the project. The stakeholders who reside some distance away may not have a role to play. It is also noted that nearness to a location of a transportation infrastructure initiates a negative attitude towards it by stakeholders, especially where it is perceived to threaten their existence (Bissonnette et al, 2018). The knowledge is also crucial since some stakeholders' participation is due to their professional knowledge or past experience (Soma et al, 2018; Zoellner, 2008).

Figure 5. 7: Distance, money and knowledge influence on stakeholders' participation

5.3.1.7 Stakeholders' participation in public transportation infrastructure projects

Figure 5.8 shows the respondents' assessment of the engagement of various stakeholder groups in the MMM. The findings presented in the figure show 36.3% of the respondents have rated the engagement as fair, 26.0% of the respondents rate it as good, 10.6% rate it as poor, 18.3% consider it is very good while 7.7% are of the opinion that it is very poor. These data give the Likert index mean of 3.37 which shows various stakeholders groups such as the contractors, clients, financiers, consultants and the community members are always involved in project implementation of transportation infrastructure.

Figure 5. 8: Stakeholders' participation in infrastructure projects

Table 5. 10: Stakeholders engagement and participation in public transportation infrastructure projects

S/No	Stakeholders' involvement factors	N	Likert index mean	Standard deviation
1	Stakeholders' involvement in transportation planning process	304	1.92	1.23
2	Stakeholders' meetings during transportation infrastructure project	308	3.46	1.11
3	Information on progress report to stakeholders	305	2.22	0.96
4	Stakeholders' information on project outcomes during planning	308	2.94	1.17

5	Stakeholders' contribution to transportation infrastructure project	308	1.96	1.31
6	Distance, money and knowledge influence stakeholders' participation	305	3.45	1.11
7	Stakeholders' participation in transportation infrastructure projects	308	3.37	0.98

5.3.1.8 Summary of stakeholders' engagement and participation

The engagement of stakeholders in a public transportation infrastructure project is one of the key elements for successful delivery. Their involvement and participation are a continuous process throughout the project life. In the case of the MMM as found from this study, the planning process for public transportation infrastructure does not involve most relevant stakeholders. However, the various stakeholders are actively involved in other activities of construction and operations. The participation is also challenged sometimes by certain factors such as the knowledge about the public transportation infrastructure project, distance from the location as well as money so that their participation can have the necessary impact on the project. The study also revealed that the stakeholders that are involved and participate in a transportation infrastructure project hold meetings at different stages of the project. This participation can further give them knowledge about the nature of the project, thereby influencing their perception.

5.3.2 Planning factors of public transportation infrastructure projects

Transportation infrastructure planning is essential for a successful infrastructure project delivery. This facilitates the organised and coordinated activities that enable a planner to have knowledge of critical questions surrounding transportation infrastructure (Antonson, Gustafsson and Angelstam, 2010). This calls for adequate commitment to the planning process to ensure that consultations are held, relevant stakeholders are timely engaged and factors that affect the project life of a public transportation infrastructure are identified (Axelsson and Granath, 2018; Wang, Ma, Wu, Lu, Gong and Chen, 2019). This subsection therefore discusses the findings on planning factors that influence stakeholders' perception regarding the acceptance or non-acceptance of public transportation infrastructure in the MMM.

5.3.2.1 Nearness of U-turn to transport facility

Public transportation infrastructure is expected to be easily accessed by both vehicle operators and pedestrians. In this research, Figure 5.9 shows the respondents' responses to the importance of a U-turn near to a transport infrastructure facility to enable the turn of moving vehicles in order to access it. The figure indicates that 38.9% of the respondents disagree that it does not influence their perception about a bus terminal. Of the total respondents, 23.5% of them strongly disagree that a U-turn is important while 18.0% demonstrate moderate agreement. The figure further shows that 15.4% and 3.5% of the respondents agree and strongly agree respectively. Given that the Likert index mean is 2.27 and the standard deviation is 1.10, it shows that the respondents do not consider the nearness of a U-turn to a transport facility such as a bus terminal as an important factor for accepting a public transport facility (Pannela and Bhuyan, 2017).

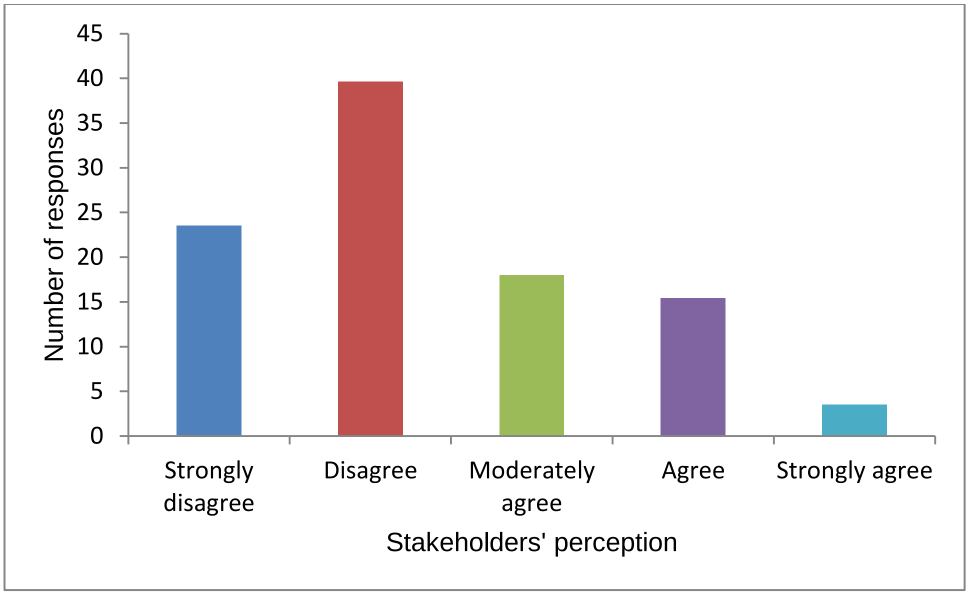

Figure 5. 9: Nearness of U-turn to transport facility

5.3.2.2 Pavement marking on public transport facility

Pavement markings are markings done on the surface of road pavement in order to guide traffic movement and reduce the possibility of traffic accidents on highways or junctions. This parameter gives transportation infrastructure users more of a sense of safety. This is demonstrated in the responses of the respondents to the stakeholders' survey. Figure 5.9 shows 22.8% of the respondents disagree, 22.5% respondents agree, 21.5% of respondent strongly agree, 15.8% of the respondents moderately agree and 15.4% of them strongly disagree with its influence on the stakeholders' perception about transportation infrastructure.

The Likert index mean of 3.12 from Table 5.11 shows a moderate agreement to the parameter's influence whereas the standard deviation of 1.40 shows high consistency in the responses around the mean value. This means that the pavement marking increases a sense of safety among users and their willingness to use such a public transportation infrastructure. Additionally, roads without pavement markings account for more road accidents in developing countries (Adedeji, Abejide, Monts'l and Hassan, 2019; Rehman and Duggal, 2015). The pavement marking on road sections or parking facilities gives transportation infrastructure users, a sense of guidance on its usability. This guidance helps to minimize conflicts that can cause accidents among public transportation users.

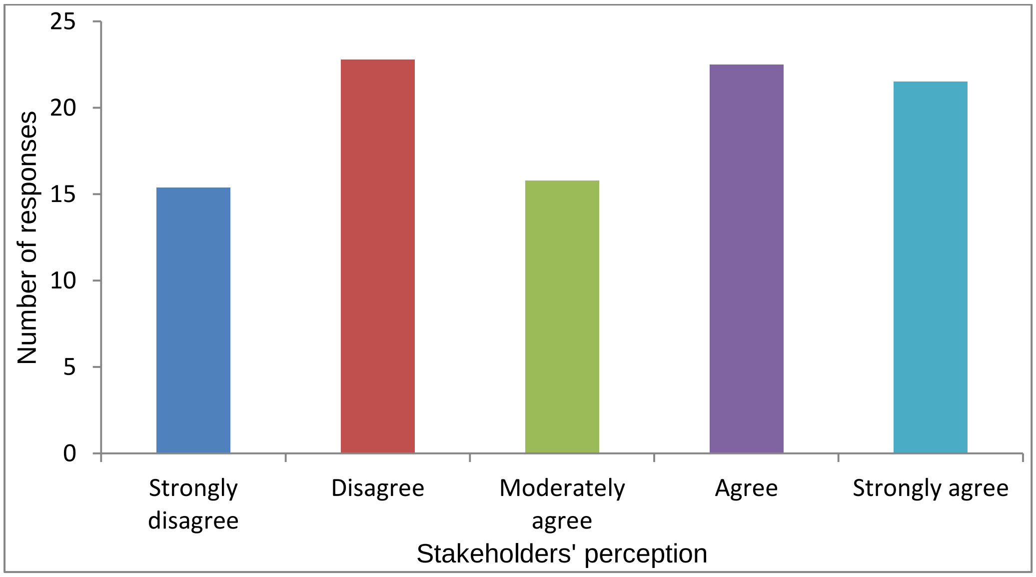

Figure 5. 10: Pavement marking on public transport facility

5.3.2.3 Walking distance to public transport facility

Accessibility of public transportation infrastructure is critical to stakeholders. During the planning process of such infrastructure, its nearness to residences, offices and business centres is taken into account. The stakeholders' survey as shown in Figure 5.11 indicates that 41.3% of the respondents strongly agree with the influence of distance to transportation infrastructure on their perception, 34.9% of the respondents agree, 12.2% moderately agree, 9.0% of the respondents disagree and 1.0% strongly disagree that the walking distance influences their perception about their acceptance of public transportation infrastructure.

The Likert index mean of 4.08 shows an agreement of its influence to their perception. The standard deviation of 1.0 shows a very close distribution of their responses. This finding is an indication that public transportation infrastructure must be as close as possible to the locations of the users who make use of the facility. Otherwise, there will be resistance to the use of public transportation infrastructure projects due to the long distances from the stakeholders' locations (He, Mol and Lu, 2016; Bashingi, 2016; Zoellner, Scheizer-Ries and Wemheuer, 2008). It is common that the proximity of public transportation infrastructures to the public motivates active participation in economic activities, reduces travel time and encourages local industries.

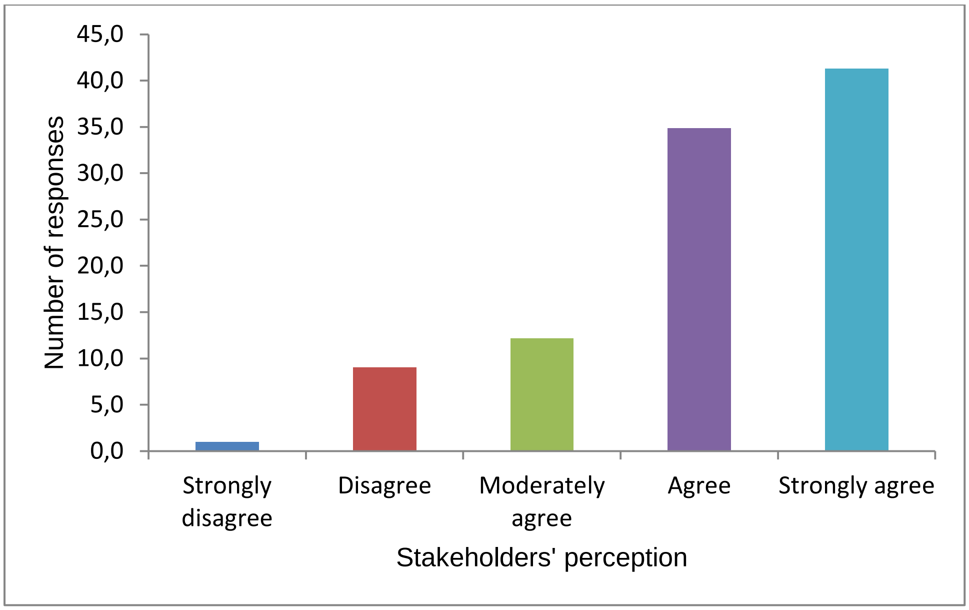

Figure 5. 11: Walking distance to public transport facility

5.3.2.4 Vehicle waiting time at transport facilities

Vehicle waiting time at a public transportation facility is required to be as short as possible. This parameter in the planning for public transportation infrastructure is important in reducing the congestion on roads due to illegal parking by drivers. It is indicated in Figure 5.12 that 36.9% of the respondents agree, 23.1% of the respondents strongly agree, 24.0% of the respondents moderately agree and 9.0% of them disagree on its influence on stakeholders' perception about public transportation infrastructure.

The Likert index mean of 3.63 shows that the respondents agree that vehicle waiting time at public transport facility influences stakeholders' perception for acceptance. This shows that bus and taxi drivers as well as passengers prefer those public transport facilities that offer a short waiting time for passengers and with a real-time vehicle schedule (Zheng, Zheng, Chatzimisios, Xiang and Zhou, 2015).

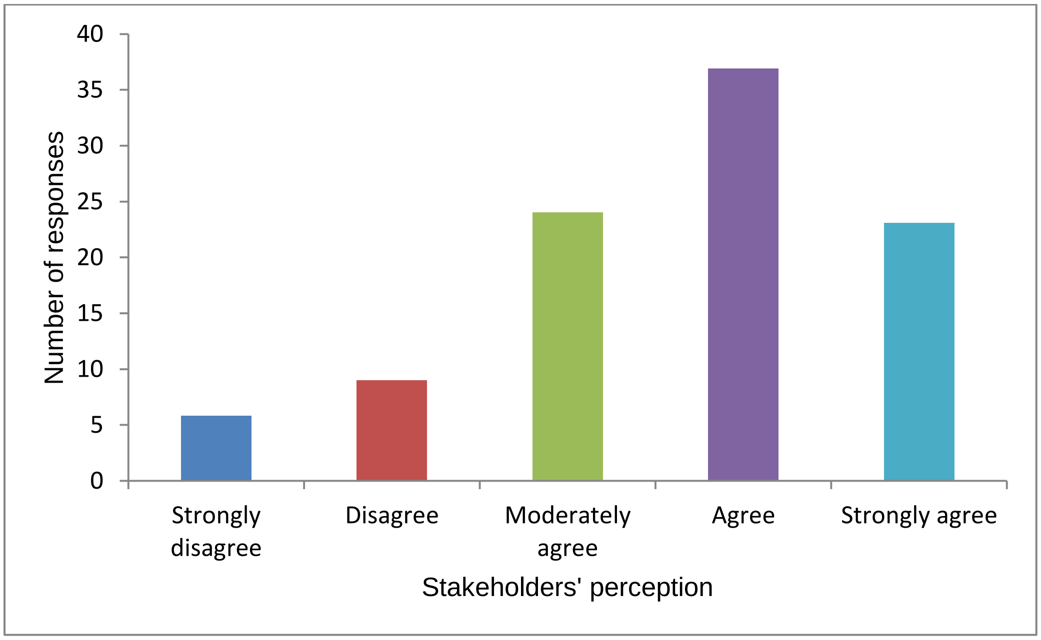

Figure 5. 12: Vehicle waiting time at transport facilities

5.3.2.5 Vehicle parking type at public transport facility

The type of vehicle parking at public transport facilities is one of the factors that facilitate easy movement in a facility. This is demonstrated in the responses of the respondents to the questionnaire. Figure 5.13 shows that 37.8% of the respondents agree, 26.3% of the respondents strongly agree, and 17.6% of them moderately agree. Furthermore, 10.3% and 6.7% of the respondents strongly disagree and disagree respectively.

The Likert index mean of 3.64 from Table 5.11 shows an agreement on the influence of the vehicle parking type on stakeholders' perception. The standard deviation of 1.23 from the same table shows consistency in the distribution of the responses. This means that there should be a well-defined parking arrangement at a public transport facility which does not hinder vehicle movement.

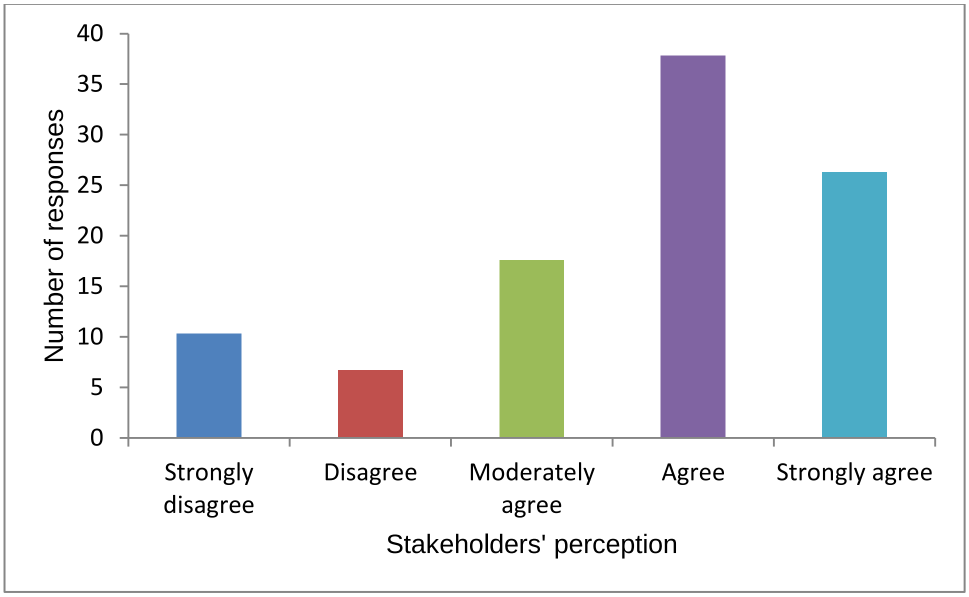

Figure 5. 13: Vehicle parking type at public transport facility

5.3.2.6 Traffic signal at road intersection

Traffic signals at road intersections facilitate movement with minimised traffic conflict at an intersection. This parameter ensures safety to road users. In this case, Figure 5.14, shows that 39.7% of the respondents moderately agree, 36.9% of the respondents agree, and 13.8% of the respondents strongly agree that traffic signals have an impact on their feeling about road intersections.

Table 5.11 shows the Likert index mean of 3.56 which is in agreement on the influence of the traffic signal on stakeholders' perception. The 0.86 standard deviation value shows a high consistency in respondents' responses. The mean and consistency are indications that traffic management at intersections by using traffic signals has a positive impact on stakeholders' perception or behaviour towards public transportation infrastructure (Lenne, Ruddin-Brown, Navarro, Edguist, Trotter and Tomasevic, 2011).

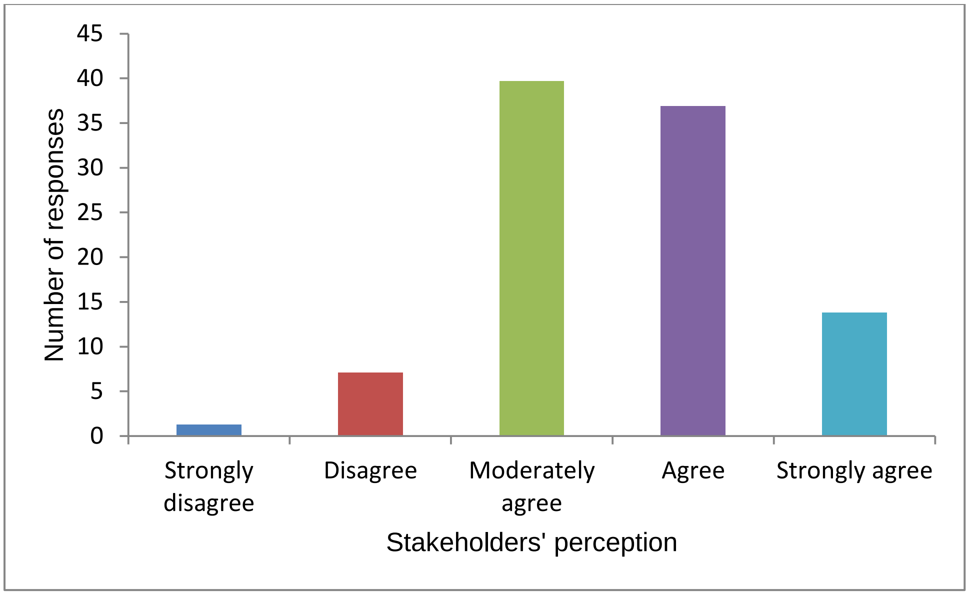

Figure 5. 14: Traffic signal at road intersection

5.3.2.7 Presence of security operatives at public transport facility

The safety of life and properties of public transportation infrastructure stakeholders is one of the aspects that people consider in their choice of transport services. The influence of security operatives at public transportation infrastructure is assessed in Figure 5.15. This figure indicates that 28.5% of the respondents agree, 25.3% moderately agree and 4.5% of the respondents strongly agree that the presence of security operatives at public transportation infrastructure has an influence on their perception of its usability. From Figure, it can be seen that 19.6% of the respondents strongly disagree and 10.9% of them disagree on its influence on stakeholders' perception.

The Likert index mean of 2.97 from Table 5.11 is in disagreement with its influence on stakeholders' perception to accept public transportation infrastructure projects. This finding contradicts the belief that citizens prefer using private vehicles for movement as a result of crime around public transport facilities (Rundmo, Nordfjærn, Iversen, Oltedal and Jorgensen, 2011)

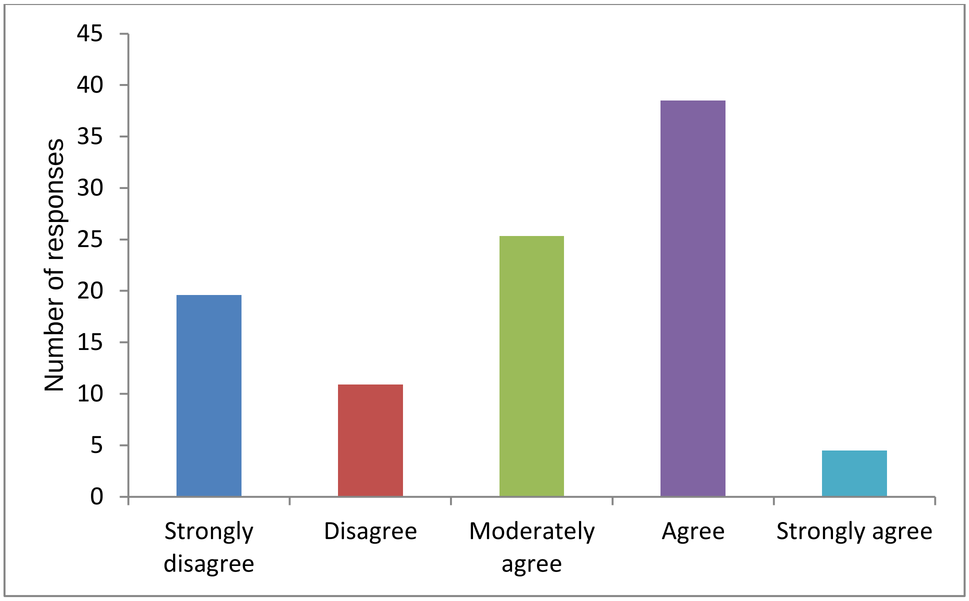

Figure 5. 15: Presence of security operatives at public transport facility

5.3.2.8 Passengers' waiting time at public transport facility

Passengers' waiting time at public transport facility is a factor that contributes to the travel time of passengers. The respondents' responses on its influence on stakeholders' perception is presented in Figure 5.16. This shows that 38.8% of the respondents moderately agree, 11.7% of respondents agree and 8.4% of them strongly agree that have influence on stakeholders' behaviour towards transportation infrastructure projects. It also shows that 34.0% of the respondents disagree and 6.1% strongly disagree that the passengers' waiting time influences stakeholders' perception about public transportation infrastructure.

The mean value from the Likert index shown in Table 5.11 is 2.82, indicating that the respondents moderately agree that this planning parameter can influence stakeholders' perception about public transportation infrastructure. This shows that the choice of the use of public transport facility depends on the time they spend waiting for services (Vansteenwegen and Oudheusden, 2005).

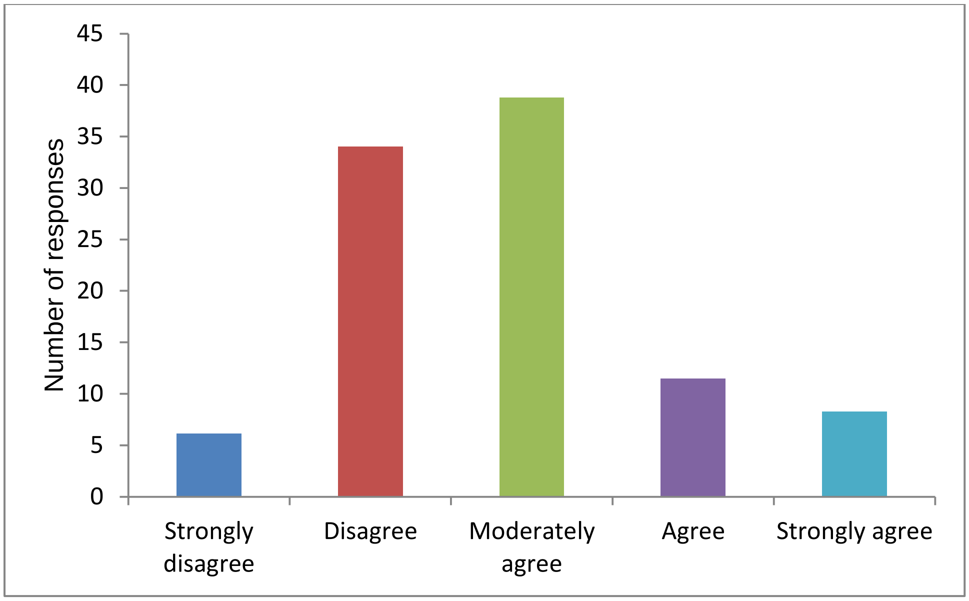

Figure 5. 16: Passengers' waiting time at public transport facility

5.3.2.9 Vehicle boarding time

Public transport facility users are usually interested in the time it takes a vehicle to board to continue a journey. The factor is assessed from respondents to understand their feeling about boarding time. Figure 5.17 indicated that 29.2% of respondents moderately agree, 38.1% of the respondents agree and 26.0% of the respondents who answered the question strongly agree. It also shows that 2.2% of the respondents disagree while 3.2% of the respondents disagree to the factor's influence on stakeholders' perception to usability of public transportation infrastructure.

This perception of stakeholders is shown in the respondents' responses reflected in Table 5.11. This shows the Likert index mean for the factor as 3.82 with a high level of consistency of responses with a standard deviation of 0.95. The findings are an indication that the boarding time of vehicles should be short in order to encourage public transportation infrastructure stakeholders to use the facilities. Reduced travel time has a positive correlation with stakeholders' behaviour (Lenne, Ruddin-Brown, Navarro, Edguist, Trotter and Tomasevic, 2011).

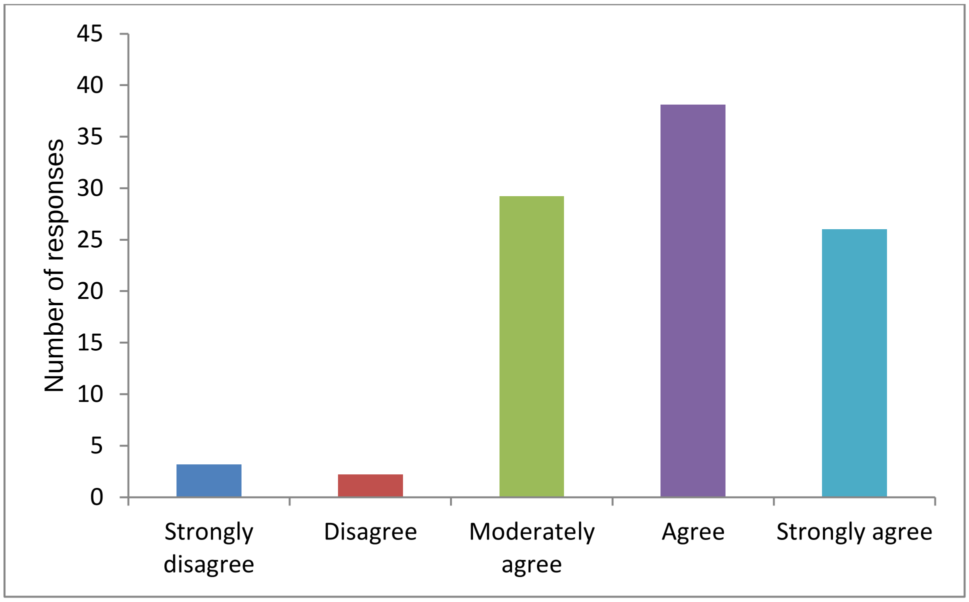

Figure 5. 17: Vehicle boarding time

5.3.2.10 Shelter at passengers' waiting area

Shelter or shields at public transport facilities provide protection of stakeholders against environmental elements such as rainfall and direct sunshine. Figure 5.18 presents the respondents' opinions which indicate that 22.1% of them moderately agree, 35.6% of them agree and 35.3% of the respondents strongly agree that shelter has an influence on their willingness to use a public transport facility. It further shows that 4.8% of the respondents disagree and 1.0% of the respondents strongly disagree on its influence on stakeholders.

Table 5.11 shows that the shelter at passengers' waiting areas has a Likert index mean of 4.01 and the consistency in respondents' responses has a standard deviation of 0.93. This indicates that stakeholders are prepared to use public transportation facilities that offer shelter against the elements of weather (Goshayeshi, Zaky, Fairuz and Khafi, 2013).

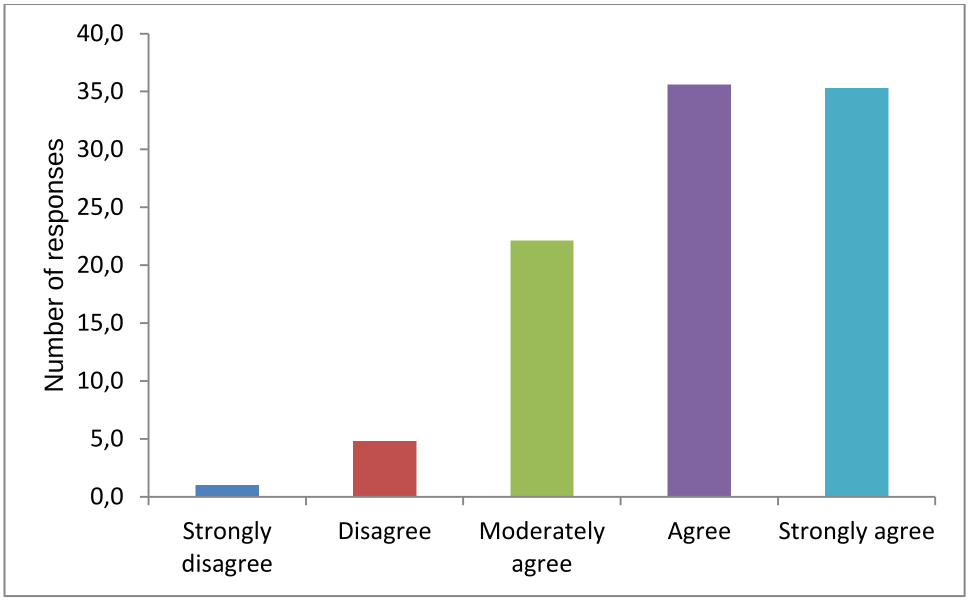

Figure 5. 18: Shelter at passengers' waiting area

5.3.2.11 Job opportunity creation or availability of business opportunities

Transportation infrastructure is essential for economic development and this also provides job opportunities in services. Public transportation infrastructure draws people from their different locations to it. In this way, stakeholders usually consider the economic benefit of the infrastructure and this contributes to their perception. It is shown in Figure 5.19 that 9.6% of the respondents moderately agree, 42.6% of the respondents agree and 40.1% of the respondents strongly agree on the availability of job opportunity influencing stakeholders' perception. However, 4.2% of the respondents disagree and 0.6% of the respondents disagree.

Table 5.11 has Likert index mean of 4.21 which shows agreement to its influence on stakeholders' perception about the acceptance of public transportation infrastructure. The standard deviation of 0.83 shows a high level of consistency in response distribution. This shows that public transportation infrastructure project stakeholders are highly interested in having activities that can generate an income for them. This must therefore be at the centre of planning for public transportation infrastructure because it draws people to reside or carry out business activities around its location (Chen, Bai and Zhang, 2019; Mejía Dorantes, Paez and Vassallo Magro, 2010).

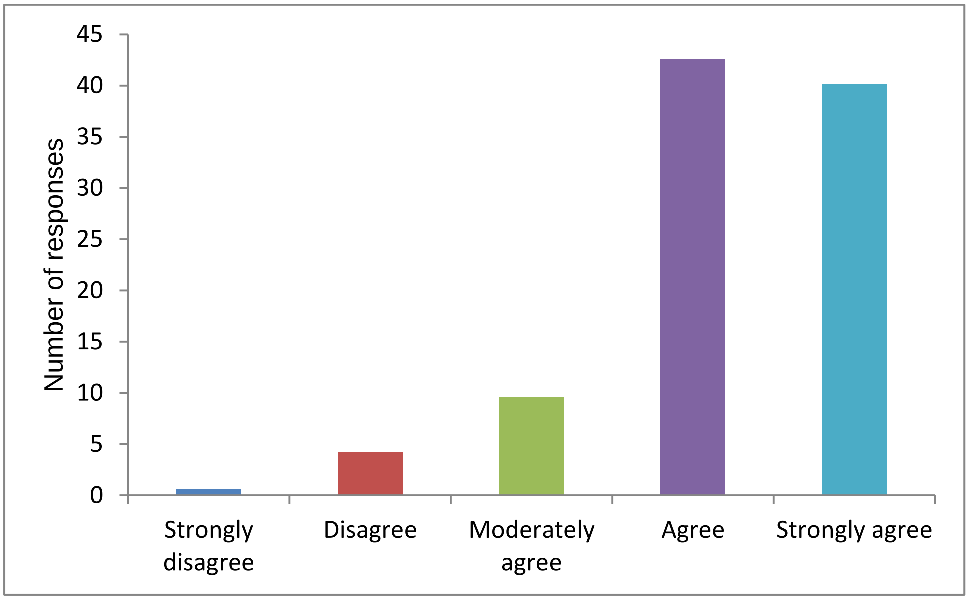

Figure 5. 19: Shelter at passengers' waiting area

5.3.2.12 Vehicle restrictions to the use of public transportation infrastructure

Vehicles are of different kinds and perform varying services of movement of goods and people. The restrictions to the use of public transportation infrastructure could be applied to height or axle load. This limitation which restricts some stakeholders is capable of initiating opposition to the existence of such infrastructure. Figure 5.20 shows that 22.1% of the respondents moderately agree, 21.4% of the respondents agree and 15.3% of them strongly agree that vehicle restrictions is a motivator of stakeholders' perceptions about public transportation infrastructure projects. Furthermore, 34.7% of the respondents disagree and 6.5% of the respondents disagree with this assumption.

The Likert index mean of 2.95 and the standard deviation of 1.22 indicated in Table 5.11 show that the respondents disagree with the claim that vehicle restriction influences stakeholders' attitude towards a public transportation infrastructure project in

South Africa. The restrictions which can be associated with time, period, distance, weight of vehicles or height (Hanna, Kreindler and Olken, 2017) do not affect public infrastructure acceptance by stakeholders.

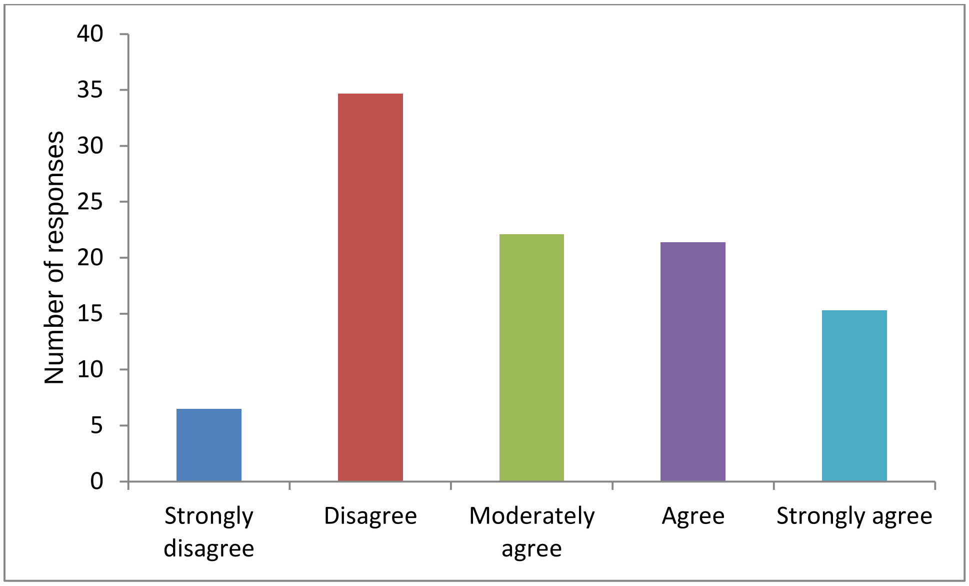

Figure 5. 20: Vehicles restrictions at public transportation infrastructure

Table 5. 11: Public transportation infrastructure project planning factors

S/No	Planning factors	Total respondents	Likert index mean	Standard deviation
1	Nearness to U-turn to public transport facility	301	2.2	1.10
2	Pavement marking to guide movement	307	3.12	1.40
3	Walking distance to public transport facility	308	4.08	0.99

4	Vehicle waiting time at public transport facility	299	3.63	1.11
5	Vehicle parking type	306	3.64	1.23
6	Vehicle restrictions on the use of public transport facility	308	2.95	1.22
7	Traffic signals	305	3.56	0.86
8	Security operatives at public transport facility	308	2.97	1.21
9	Passengers' waiting time	304	2.89	1.01
10	The boarding time of vehicles	301	3.82	0.95
11	Shelter at passengers waiting area	302	4.01	0.93
12	Availability of business opportunities	303	4.21	0.83

5.3.2.13 Summary of planning public transportation infrastructure planning factors

One of the objectives of public transportation infrastructure projects is to provide mobility to the public with minimal cost. This is evidence in the findings here that the infrastructure projects must be within walkable distance from residences or places of work. This increases accessibility by the public to travel within the shortest possible time. In order to make public transportation infrastructure attractive, the boarding time of vehicles at bus stations, bus terminals or taxi ranks should be short so that journey time will not be unnecessarily long for stakeholders to oppose its use. It is also found that public transportation infrastructure projects are expected to create jobs to reduce unemployment and to provide opportunities for business activities for stakeholders' acceptance. Other planning factors that are revealed in the study that influence stakeholders' perception for the acceptance or non-acceptance are the availability of shelter for waiting passengers, availability of traffic signals at road intersections and well-defined type of parking at public transport facilities. Some planning factors that influence stakeholders' perception can have a causative effect on design factors. These are discussed in section 5.2.3 below.

5.2.3 Design factors of public transportation infrastructure projects

The planning of public transportation infrastructure is a phase in project delivery linked with design. This is because the choices and planning decisions influence the design aspect. The design of public transportation infrastructure is usually intended to provide safe services to the public without being harmful to its environment (Sudret, 2013). This means that the stakeholders of public transportation infrastructure projects, especially planners and design engineers, should ensure that such infrastructure does not threaten human existence in any way. In this way, the stakeholders' acceptance is improved. This is demonstrated in the findings from the stakeholders' survey as discussed in this section.

5.2.3.1The available space between parked vehicles

The available space between vehicles at a transportation infrastructure contributes to the perceived comfort of public transportation project stakeholders, especially during the operation phase. This study seeks to understand the influence this space has on stakeholders' perception. Figure 5.21 shows that 19.9% of the respondents moderately agree, 37.5% of the respondents agree and 26.6% of the respondents strongly agree to its influence on stakeholders' perception. The figure also shows that 10.3% of the respondents disagree and 4.5% of them strongly disagree.

The Likert index mean of 3.72 from Table 5.12 indicates respondents' agreement on its influence on stakeholders' perception. This implies that the parking lots of public transport facilities must be planned with at least 1.5m between parked vehicles to allow for the free movement of people and the taking off of vehicles (Naude, 2015).

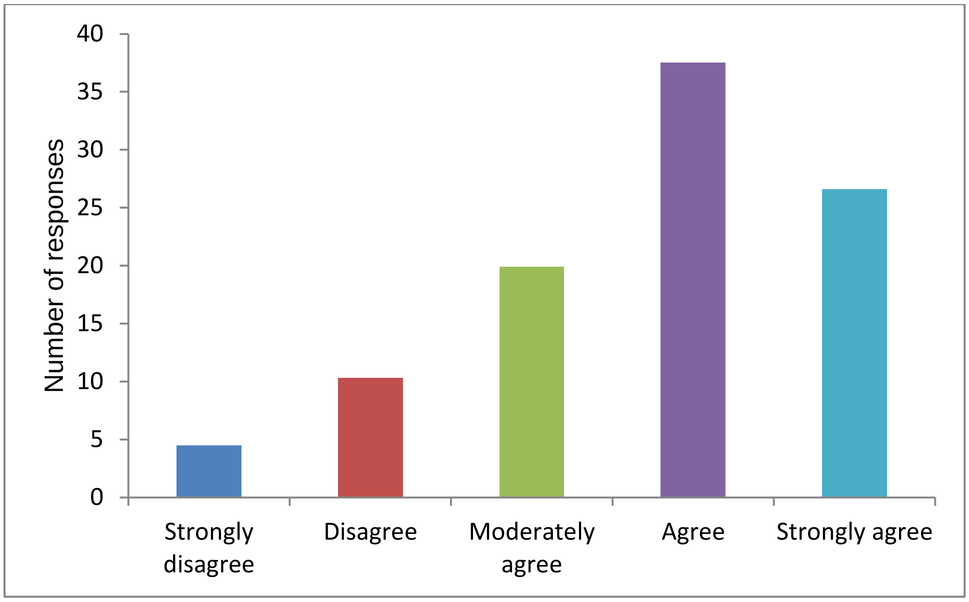

Figure 5. 21: The available space between parked vehicles

5.2.3.2 Parking bay size

The size of parking lots at public transport facility determines the comfort of vehicle operators as well as the safety of vehicles. The length and width of a parking lot is important to stakeholders as a design factor. Figure 5.22 indicates that 11.5% of the respondents moderately agree, 33.0% of the respondents agree and 25.3% of the respondents strongly agree that parking lot size influences stakeholders' perception. Figure 5.21 further shows that 19.2% of the respondents disagree while 9.0% of the respondents strongly disagree about its influence on stakeholders.

Table 5.12 also shows the mean index of 3.47 indicating respondents' agreement on the influence of parking bay size on stakeholders' attitude. A high consistency of the responses is found to be 1.30 as standard deviation of the data distribution. It is important that the minimum parking bay width is 2.3m for the safety of the vehicle (Bester and Da Silva, 2012; Damen and Huband, 2006). Inadequacy in parking bay size can cause damage to a vehicle and motivate negative behaviour among users.

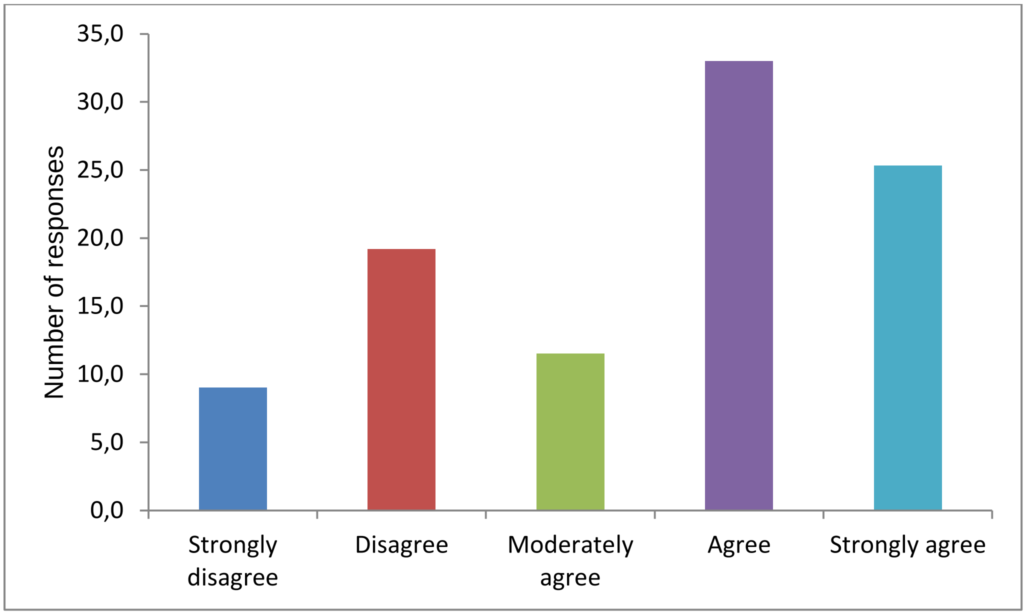

Figure 5. 22: Parking lot or bay size

5.2.3.3 Size of passengers' waiting area

A passengers waiting area is required for passengers to feel comfortable while waiting to board a vehicle. This has to be adequate to accommodate the maximum number of waiting passengers when there is no available vehicle for boarding. Figure 5.23 shows 27.9% of the respondents moderately agree, 40.4% of them agree and 14.1% of the respondents strongly agree that a passengers' waiting area does influence stakeholders' perception of a public transportation infrastructure in the MMM. Only 9.1% of the respondents disagree and 7.1% of the respondents strongly disagree to it.

The respondents have shown that a passengers' waiting area or space with seats is needed at public transport facilities. In the case study facilities, the IBLT has a passengers' waiting area with seats between parking lots while the MITF does not have many of these, especially on the third floor. A passengers waiting area needs to be adequate for passengers to enable positive social behaviour during waiting and boarding at a station (Yang, Yang, Xue, Zhang, Pan, Kang and Wang, 2019).

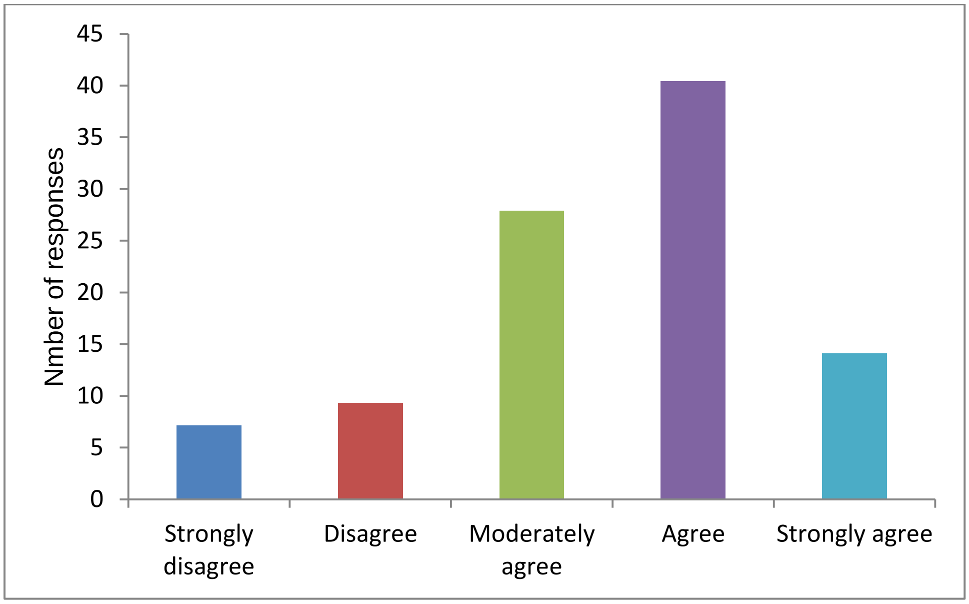

Figure 5. 23: Passengers' waiting area size

5.2.3.4 Vehicle turning radius in public transport facility

The vehicle turning radius in a transport facility gives the horizontal curve through which a vehicle moves. The manoeuvrability over a curve has to be safe for a moving vehicle and gives comfort to an operator. Figure 5.24 indicates the various responses by respondents regarding their perception about turning radii. The figure shows that 20.2% of the respondents moderately agree, 38.1% of the respondents agree and 5.8% of the respondents strongly agree that turning radii at various horizontal curves affect stakeholders' feelings about public transport. Of the total number of respondents, 31.4% of them disagree and 2.9% strongly disagree as to its influence on stakeholders' perception.

Table 5.12 shows a Likert index mean of 3.13 and the consistency of responses as 1.02 which shows the respondents agree that turning radii at horizontal curves affect stakeholders' attitude toward public transportation infrastructure projects. The turning radii are expected not to be smaller than the minimum turning radius for unimpeded vehicular movement (Savkin and Teimoori, 2010).

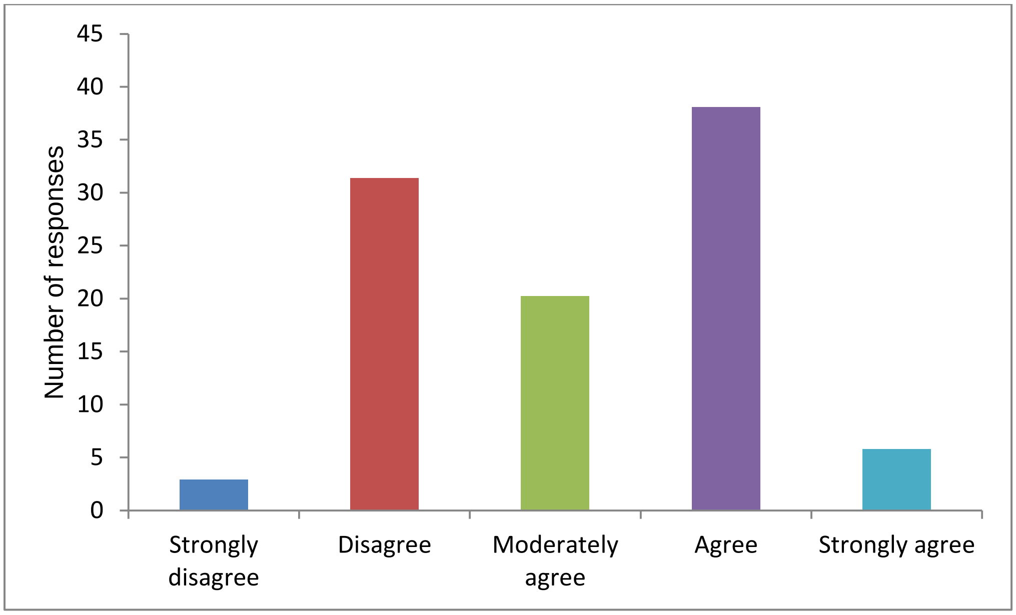

Figure 5. 24: Vehicle turning radius in public transport facility

5.2.3.5 Sight distances within public transport facility

Figure 5.25 shows the various response percentages of respondents relating to stakeholders' perception of sight distances on public transportation infrastructure such as bus terminals or highways. It indicates that 31.8% of the respondents moderately agree, 30.2% of the respondents agree and 16.9% of the respondents strongly agree that sight distance affects stakeholders' perception.

The responses which are presented in Figure 5.25 have a Likert index mean of 3.36 and response consistency of 1.13 as indicated in Table 5.12. These show that the respondents agree on the influencing effect of sight distance on stakeholders' feelings about public transportation infrastructure. Sight distance such as stopping sight distance is critical to the safety of moving vehicles and people at public transport facilities. This has to be adequate to bring a moving vehicle to a standstill in case of unexpected obstacles. Long sight distances assure stakeholders of safety at public transportation infrastructure and minimise accidents. This encourages their commitment to use it (De Santos-Berbel, Castro, Medina and Paréns-González, 2014).

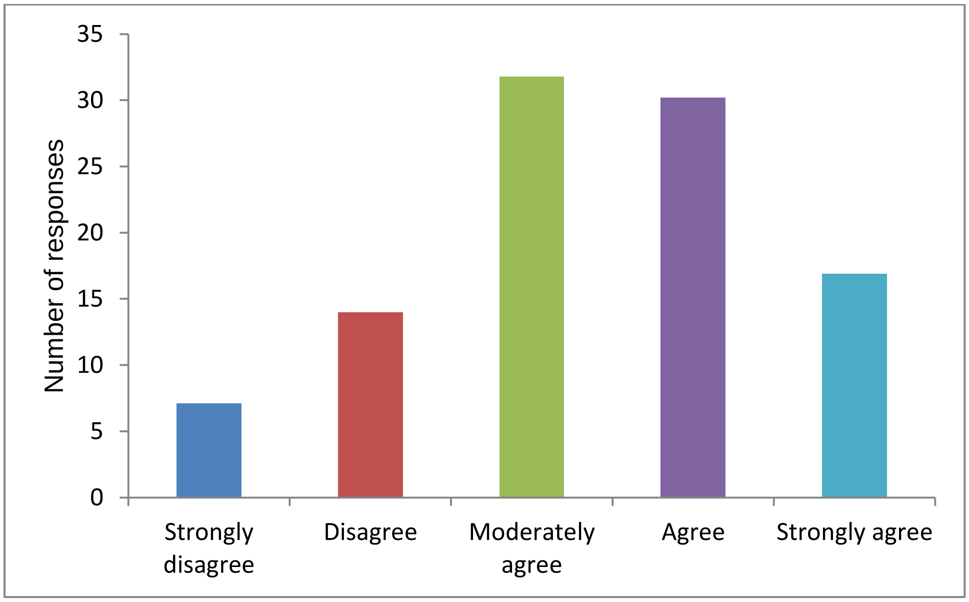

Figure 5. 25: Sight distances on public transport facility

5.2.3.6 Road width at public transport facility

The width of a road section is determined by the number of lanes and this has an influence on the number of vehicles that can move into a public transport facility within a given time. Figure 5.26 indicates that 37.0% of the respondents moderately agree, 32.1% of the respondents agree and 14.9% of the respondents strongly agree that road width to a public transport facility has an influence on stakeholders' perception of its usability. Only, 13.6% of the respondents disagree and 2.3% of the respondents strongly disagree to this assumption.

In general, Table 5.12 presents the Likert index mean of 3.44 and standard deviation of 0.97 which implies that the respondents agree that road width has an influence on stakeholders' perception of public transportation infrastructure. The transport facility capacity is one of the determinant factors of road width to minimise congestion on adjacent roads (Eniola, Njoku, Seun and Okoko, 2013; Olagunju, 2015). This is the case with the Central Park IBL terminal in Bloemfontein during peak hour.

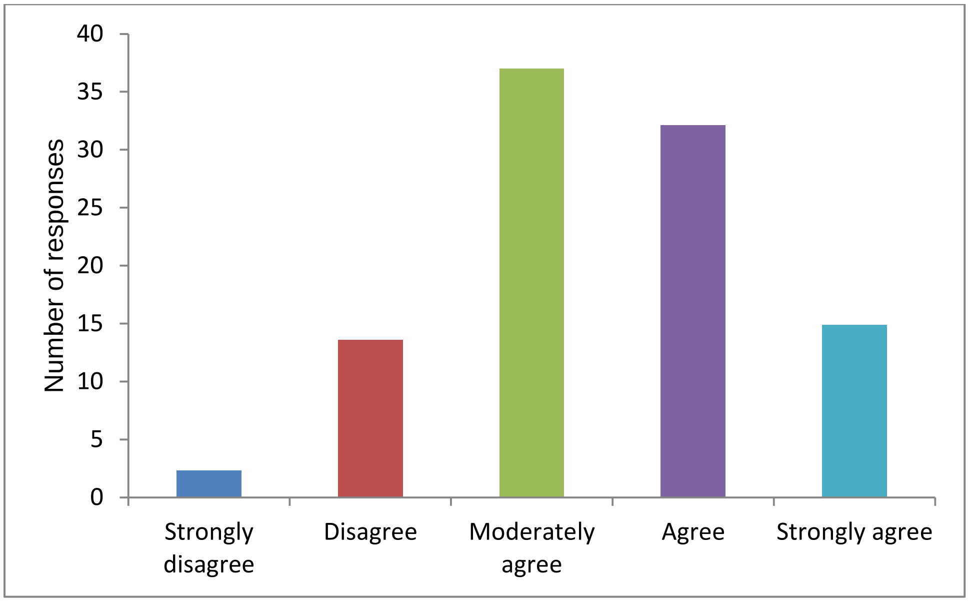

Figure 5. 26: Road with at entry or exit point of public transport facility

5.2.3.7 Road grade/steepness

A road grade is a critical parameter in accessing public transportation infrastructure. This is because, gradient along a road section can cause fatigue to pedestrian or failure in movement by climbing vehicles. The parameter affects transportation infrastructure project stakeholders' attitude towards it. Figure 5.27 shows that 19.8% of the respondents moderately agree, 39.9% of the respondents agree while 12.0% of the respondents strongly agree that road grade influences stakeholders' perception of using a public transport facility. The same figure shows that 26.9% of the respondents and

1.3% of the respondents disagree and strongly disagree respectively about the influence of the road grade on stakeholders' perception.

The Table 5.12 shows the Likert index mean of 3.34 and consistency in the distribution of the responses as 1.04. This implies that the respondents agree that the road grade affects their attitude towards public transportation infrastructure. Increased slope in climbing or descending a road section affects stakeholders' decision to use the public transportation infrastructure (Bauer and Harwood, 2013).

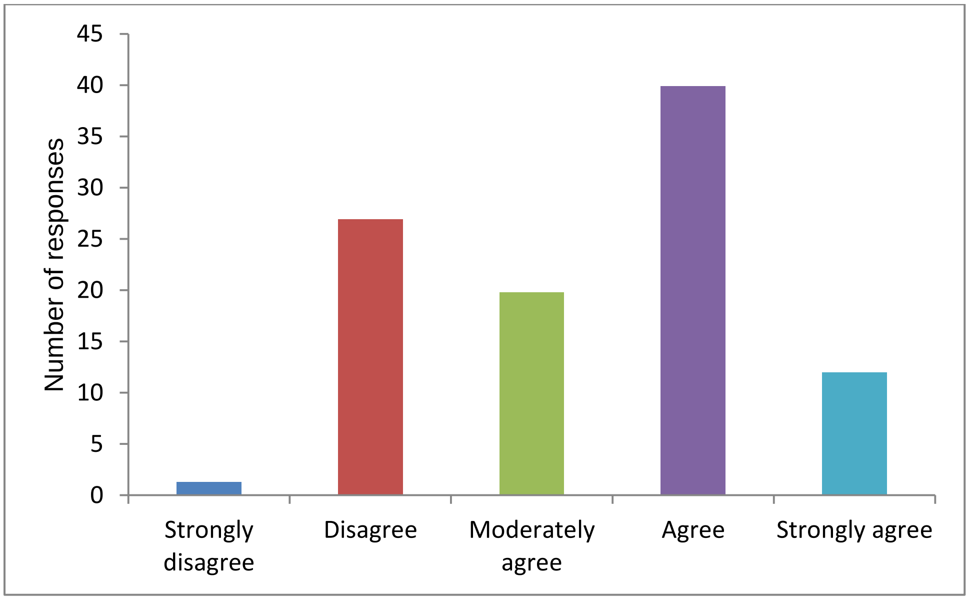

Figure 5. 27: Road grade or steepness

5.2.3.8 Number of vehicles waiting for passengers at public transport facility

The number of vehicles that wait for passengers at the same time can be a factor that motivates public transportation infrastructure project stakeholders to use the facility. A situation where a there is large number of vehicles that wait for passengers, there is a tendency that some vehicle operators will be unwilling to use a transport facility due to rare patronage by passengers. Figure 5.28 shows the various responses of the respondents in this regard. The figure shows that 25.0% of the respondents moderately agree, 18.5% of the respondents agree whereas 6.2% of the respondents strongly agree that the number of vehicle that wait for passengers at the same time influences stakeholders' perception of a public transportation infrastructure project. It also presents 46.4% of the respondents and 3.9% of the respondents who disagree and strongly disagree respectively.

The above responses give the Likert index mean of 2.77 and standard deviation of responses distribution of 1.00. These are indications that the respondents disagree that the number of vehicles waiting for passengers at the same time at a public transportation infrastructure does affect their decision for its use (Kim, 2012).

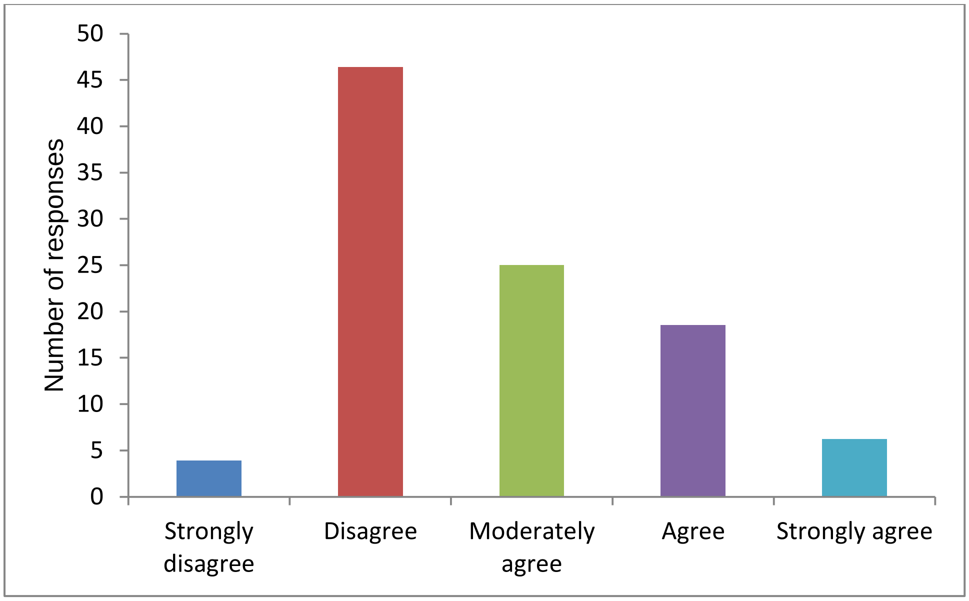

Figure 5. 28: Number of vehicles waiting for passengers at public transport facility

5.2.3.9 Accessibility of facility by disabled and aged people

The social well-being of public transportation infrastructure project stakeholders is important to any society. The aged and disabled people require special facilities to support them to access public transportation infrastructure for travel needs. As shown in Figure 5.29, 14.3% of the respondents moderately agree, 29.5% of the respondents agree and 33.4% of the respondents strongly agree that the method or facilities available for physically challenged people to have access to a transport facility is critical. However, 16.2% and 6.5% of the respondents disagree and strongly disagree respectively.

The responses from Figure 5.29 give the Likert index mean of 3.67 and the consistency of the responses as 1.26. These show that the respondents agree that the attitude of public transportation infrastructure project stakeholders can be affected by the available facilities to support physically challenged people to access facilities (Bromley, Matthews and Thomas, 2007; Soltani, Sham, Awang and Yaman, 2012).

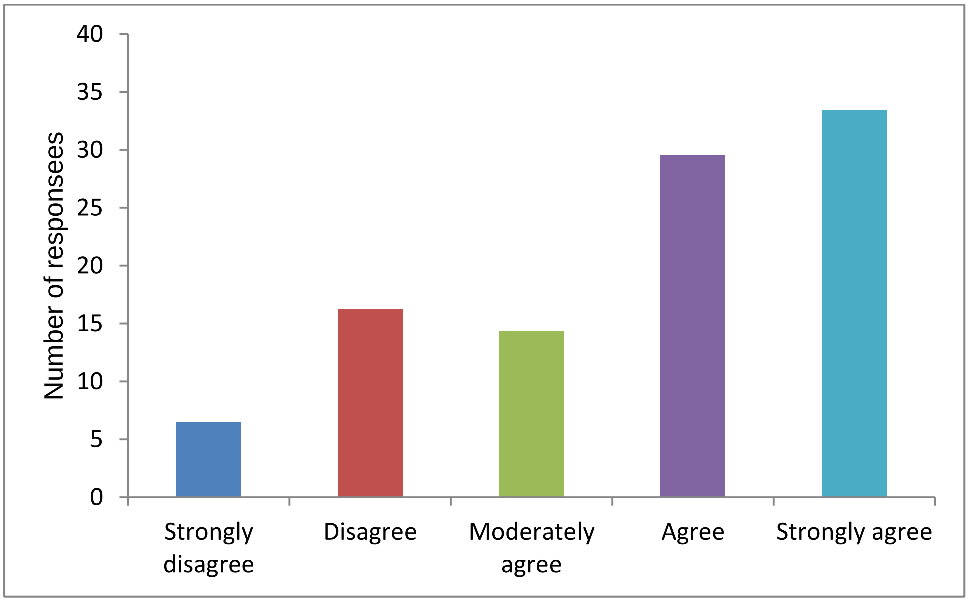

Figure 5. 29: Accessibility by disabled and aged people

5.2.3.10 Traffic sign on public transportation infrastructure

Traffic signs help public transportation infrastructure project stakeholders to be guided on their use. This is especially helpful to someone who is not very conversant with a public transport facility. It implies that traffic signs are essential for the effective use of a facility. The relevance of this parameter of transportation planning can be seen in Figure 5.30. Figure 5.30 shows that 21.8% of the respondents moderately agree, 39.6% of the respondents agree and 24.0% of the respondents strongly disagree that traffic signals have an impact on stakeholders' perceptions of a public transportation infrastructure project or asset. On the other hand, 11.0% of the respondents disagree and 3.6% of the respondents strongly disagree that it influences stakeholders' perceptions.

Table 5.12 shows the Likert index mean of 3.69 and standard deviation of 1.06, which is an indication that traffic signals do influence stakeholders' perception of a public transport facility. This shows that the absence of traffic signs can cause confusion and traffic conflict on public transportation infrastructure (Trifunovic, Pesic, Cicevic and Antic, 2017)

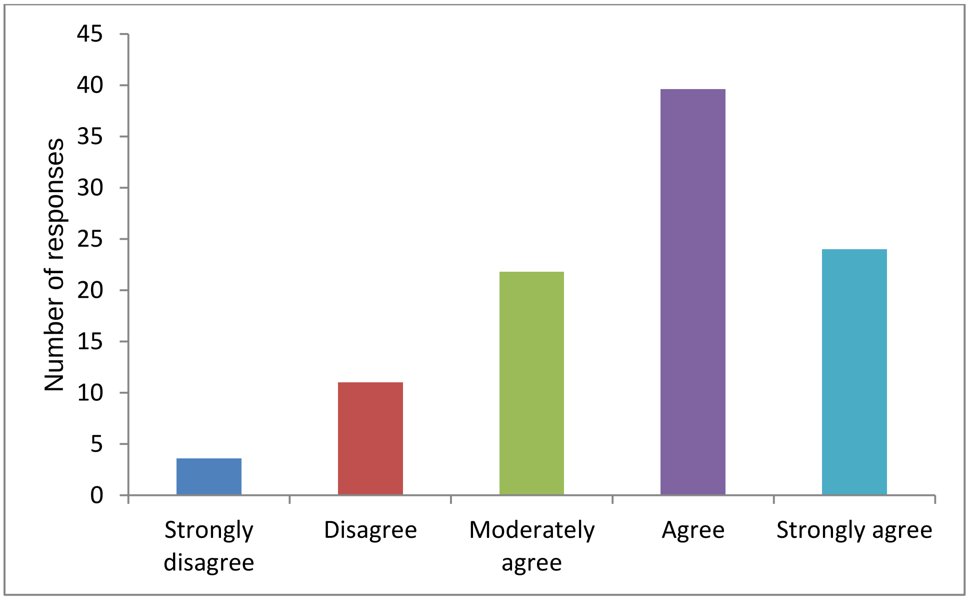

Figure 5. 30: Traffic sign on public transportation infrastructure

5.2.3.11 Public transportation infrastructure capacity

The public transportation infrastructure capacity relates to the number of vehicles that it can accommodate at the same time. This is mostly to manage traffic volume at peak hour. Figure 5.31 shows the opinions of the respondents regarding the influence of transportation infrastructure capacity. The figure indicates that 40.9% of the respondents moderately agree, 32.1% of the respondents agree while 10.1% of the respondents strongly agree as to the influence of the infrastructure capacity. Only, 9.4%

of the respondents disagree and 7.5% strongly disagree to this assumption. The collective opinions of the respondents are given in Table 5.12.

As indicated on Table 5.12, the Likert index mean of the responses is 3.28 and the standard deviation is 1.02. This shows that the respondents agree to the influence of the public transportation infrastructure capacity on stakeholders' perceptions. It is important to note that an increasing number of travellers require increased public transportation infrastructure capacity for them to continue appreciating and using the infrastructure (Sun and Cui, 2018).

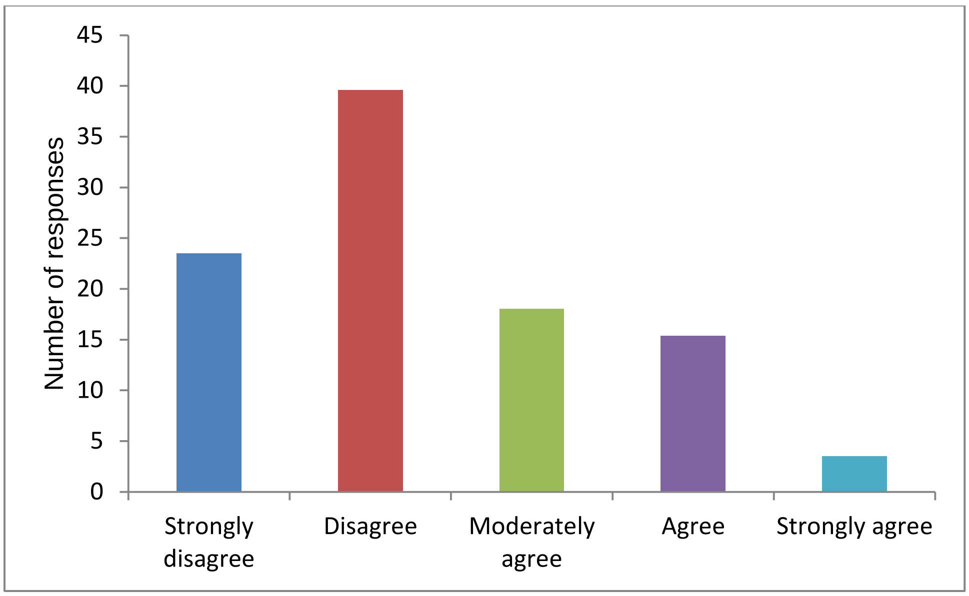

Figure 5. 31: Public transportation infrastructure capacity

Table 5. 12: Public transportation infrastructure design parameters

S/No	Design parameters	Total respondents	Likert index mean	Standard deviation
1	Available space between parked vehicles	301	3.72	1.10
2	Size of parking lot or parking bay	302	3.47	1.30

3	Size of passengers' waiting area	308	3.46	1.07
4	Vehicle turning radius	303	3.13	1.02
5	Sight distances	308	3.36	1.10
6	Road width	308	3.44	0.97
7	Road grade/steepness	307	3.34	1.04
8	Traffic capacity	307	3.59	1.21
9	Number of vehicles waiting for passengers	306	2.77	1.00
10	Method for aged and disabled people to access public transport facility	308	3.67	1.26
11	Traffic signs	306	3.56	0.86

5.2.3.12 Summary of design factors affecting stakeholders' perception

The previous sections in this chapter five discussed the findings from the research study. The chapter has that the sizes of the various parking lot facilities are larger than 2.4m which is the minimum value that can accommodate vehicles. The parking lots lengths are not less than 5.0m in MITF and 13.0m for IBL. These lengths are adequate for vehicles parking in each case public transport facilities. The manoeuvrability which is influenced by turning radii are large enough for easier manoeuvring. However, MITF has some turning radii that require vehicle movement on slow speed in the course of manoeuvring through the horizontal curve.

In addition to the geometric characteristics of the transportation facilities, the traffic characteristics of the area were discussed. Given that it is a business district, the average hourly traffic volume is high between 7hr00 and 9hr00 and also between

15hr00 and 17hr00. This is associated with the time when most people transit to and from their places of social and economic activities. This causes traffic congestion at peak hours. It is also evident from the results that some traffic signals at the road intersections in the area cannot discharge all traffic on queue since it has reached its designed average traffic volume.

The factors that can influence stakeholders' perception of their acceptance of public transportation infrastructure projects were discussed in this section. It was found that parking facilities, turning radii, and road widths must not compromise the professional standards of design of the parameters. It is also noted from the results that the design of public transport facilities to accommodate disabled or aged people is critical for stakeholders' acceptance. This is because the absence of designing with the mobility of disabled or aged people in mind amounts to social negligence of these people in society.

Table 5. 13: Planning and design factors influencing stakeholders' perception of public transportation infrastructure projects

S/No	Factors	N	Mean	Sd	Rank
1	Availability of business opportunities	303	4.21	0.83	1
2	Walking distance to public transport facility	308	4.08	0.99	2
3	Shelter at passengers' waiting area	302	4.01	0.93	3
4	The boarding time of vehicles	301	3.82	0.95	4
5	Available space between parked vehicles	301	3.72	1.10	5
6	Method for aged and disabled people to access public transport facility	308	3.67	1.26	6
7	Vehicle parking type	306	3.64	1.23	7
8	Vehicle waiting time at public transport facility	299	3.63	1.11	8
9	Traffic capacity	307	3.59	1.21	9
10	Traffic signals	305	3.56	0.86	10
11	Traffic signs	306	3.56	0.86	11
12	Size of parking lot or parking bay	302	3.47	1.30	12

13	Size of passengers' waiting area	308	3.46	1.07	13
14	Vehicle restrictions on the use of public transport facility	308	3.44	1.22	14
15	Road width	308	3.44	0.97	15
16	Sight distances	308	3.36	1.10	16
17	Road grade/steepness	307	3.34	1.04	17
18	Vehicle turning radius	303	3.13	1.02	18
19	Pavement marking to guide movement	307	3.12	1.40	19
20	Security operatives at public transport facility	308	2.97	1.21	20
21	Passengers' waiting time	304	2.89	1.01	21
22	Number of vehicles waiting for passengers	306	2.77	1.00	22
23	Nearness to U-turn to public transport facility	301	2.26	1.10	23

5.3 Conclusion

This chapter has discussed the findings and results from the research. It has stated the various planning and design parameters which the study has identified that influence stakeholders' acceptance of public transportation infrastructure in the study area of the MMM. Certain public transportation infrastructure planning and design parameters such as the accessibility by disabled or aged people, parking lot size, and walking distance to public transportation facility as depicted in Table 5.13 require critical attention for the adequate planning and design of the infrastructure. It is also indicated in the results that certain design parameters such as a turning radius, parking lot length or size are not adequate for every element. However, the lane width of every driveway is determined to be adequate for all vehicles accessing the transportation infrastructure under study. Whether these planning and design parameters are adequate or not, they are found to have an influence on stakeholders' perceptions of a public transportation infrastructure.

The way stakeholders regard public transportation infrastructure planning and design parameters depends on its contribution to the services of mobility of people and goods. These are assessed in terms of safety, affordability, accessibility and their contributions to the economic and social growth of stakeholders and regions. The perception of stakeholders using these as indicators of the parameters motivates their acceptance or non-acceptance. The Likert index mean analysis of the parameters are presented and ranked in Table 5.13. The table shows that nineteen planning and design parameters have a Likert index mean greater than 3.0, implying that respondents have agreed that they influence stakeholders' perceptions. These nineteen parameters are therefore used in Chapter six to determine which are most or less critical in terms of influencing relationships using ISM methodology.

CHAPTER SIX: INTERPRETIVE STRUCTURAL MODEL (ISM)

6.0 Interpretive structural model methodology

Stakeholders' acceptance of public transportation infrastructure has been an issue affecting the delivery and sustainability of such infrastructure, particularly transit facilities. The problem in most cases is connected with stakeholders' perception and feeling about some of the planning and design parameters. The interrelatedness of these planning and design parameters makes the non-acceptance of transportation infrastructure as the result of one or more parameters a complex issue. The interdependences planning and design parameters and their driving-influence on one another can influence stakeholders' perception of a transportation infrastructure project. ISM model is a good methodology that shows the relationships and the level of influence of the various identified factors affecting a system.

The interpretive structural model methodology enables a collective understanding of the parameters and their relationships through its framework. This methodology involves a number of steps that begin with the identification of factors and end with an ISM model as given from section 6.1 to 6.6 (Singh and Kant, 2008).

6.1 Step 1: Structural self-interaction matrix (SSIM)

ISM requires the identification of variables that are involved in the problem or issue. It is therefore essential that such variables which are associated with a concept are drawn for modelling. In this case, the planning and design factors that influence stakeholders' perception about public transportation infrastructure identified from section 5.2 are used. According to respondents' responses, these factors can influence stakeholders' perception or behaviour regarding the acceptance or non-acceptance of public transportation infrastructure projects. There are 19 factors which are accordingly numbered from 1 to 19 for use in matrices and tables of ISM methodology as stated below:

1. Distance between parked vehicles

2. Size of parking lot or bay
3. Pavement marking
4. Passengers’ waiting area
5. Vehicle turning radius
6. Sight distances
7. Road width
8. Road steepness
9. Walking distance to transport facility
10. Infrastructure traffic capacity
11. Vehicle parking type
12. Vehicle restrictions
13. Accessibility by disabled or aged people
14. Traffic signs
15. Traffic signals
16. Vehicle waiting time
17. Vehicle boarding time
18. Shelter for waiting passengers
19. Economic activities.

6.2 Reachability matrices

The ISM methodology requires the knowledge of experienced people in the management of a system to develop good contextual relationship networks between the various parameters. The nineteen (19) parameters are subjected to the development of a self-structured-interaction matrix by three academics, one transportation planner, two drivers and one management staff member of a public transport service company that constituted a focus group.

Considering all the planning and design parameters, the relationships between any two parameters (denoted i and j) were discussed among participants who unanimously agreed to establish a relationship between the parameters. Four relation dimensions are used between i and j. These dimensions are i influences j denoted as V; i is influenced by j, denoted as A; i and j influence each other as denoted by X; and parameter i and j have no influence on either of them as denoted by O. The various contextual relationships obtained in the focus group discussion further developed a SSIM presented in Table 6.1 with i on the rows and j on the columns.

Table 6. 1: Self structure-interaction matrix

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
1	1	A	A	V	O	O	O	O	O	X	A	A	O	O	O	O	O	O	O
2		1	X	X	V	O	O	O	O	V	X	X	O	O	O	O	O	O	O
3			1	O	A	O	O	O	O	A	X	O	O	O	O	O	O	O	O
4				1	O	O	O	O	O	V	O	O	O	O	O	X	V	O	X
5					1	O	A	A	O	O	X	V	O	O	O	O	O	O	O
6						1	A	O	O	O	A	O	O	V	O	O	O	O	O
7							1	O	O	X	O	V	O	V	V	V	O	O	V
8								1	O	V	O	O	O	V	O	O	O	O	O
9									1	O	O	O	V	O	O	O	V	O	V
10										1	O	O	O	O	O	V	A	V	X
11											1	O	O	O	O	O	O	O	O
12												1	O	X	O	O	O	O	O
13													1	V	O	O	V	O	O
14														1	A	O	O	O	O
15															1	V	O	O	O
16																1	O	V	V
17																	1	O	O
18																		1	V
19																			1

Step 2: Reachability matrix (RM)

It is customary to develop a reachability matrix from the SSIM. A reachability matrix exists in two forms: an initial reachability matrix and a final reachability matrix. The initial reachability matrix is developed by substituting V, A, X and O letters from SSIM with 0s and 1s. The guiding principles of the substitution are that (1) if the (i, j) entry in SSIM is V, then (i, j) entry in initial RM is 1 and (j, i) entry is 0; if t

he (i, j) entry in SSIM is A, then (i, j) entry in initial RM is 0 and (j, i) entry is 1; if the (i, j) entry in SSIM is X, then both (i, j) and (j, i) entry are 1 and if the (i, j) entry in SSIM is O, then both (i, j) and (j, i) entries are 0. The initial reachability matrix is presented in Table 6.2.

Table 6. 2: Initial reachability matrix

	1	**2**	**3**	**4**	5	**6**	**7**	**8**	9	**10**	**11**	**12**	13	**14**	**15**	**16**	17	**18**	**19**
1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
2	1	1	1	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0
3	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
4	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1
5	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0
6	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
7	0	0	0	0	1	1	1	0	0	1	0	1	0	1	1	1	0	0	1
8	0	0	0	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	0
9	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	1
10	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0	1	1
11	1	1	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
12	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0
14	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0

15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
16	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
17	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
19	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1

After the development of the initial RM substituting the various relationships with binary numbers, the final RM is then developed through the incorporation of transitivity. The transitivity is checked by using the opinions of participants as depicted in Table 6.1. Transitivity concept is a situation where if parameter A influences parameter B and parameter B influences parameter C, then it implies that parameter A influences parameter C. In this case, a 0 in the intersection cell of parameter A and C is replaced with 1. The intersection cell is replaced with 1 because A equally influences C through B. The initial reachability matrix after removal of the transitivity links forms the final reachability matrix as presented in Table 6.3.

Table 6. 3: Final reachability matrix

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**DP**
1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	0	1	1	1	1	**10**
2	1	1	1	1	1	1	0	0	0	1	1	1	0	1	0	1	1	1	1	**14**
3	1	1	1	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	**9**
4	1	1	1	1	0	0	1	0	0	1	1	1	0	0	0	1	1	1	1	**12**
5	1	1	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	**7**
6	1	1	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	**5**
7	1	0	0	1	1	1	1	0	0	1	0	1	0	1	1	1	0	1	1	**12**
8	1	0	1	0	1	0	1	1	0	1	1	1	0	1	0	1	0	1	1	**12**
9	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	1	0	1	**6**
10	1	0	1	0	1	1	1	0	0	1	0	1	0	1	1	1	0	1	1	**12**
11	1	1	1	1	1	1	0	0	0	1	1	1	0	1	0	0	0	0	0	**10**
12	1	1	1	1	1	0	0	0	0	1	1	1	0	1	0	0	0	0	0	**9**

13	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	0	0	**5**
14	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	**4**
15	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	1	0	**5**
16	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	**7**
17	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	1	1	1	**8**
18	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	**3**
19	1	0	1	1	0	0	1	0	0	1	0	0	0	0	0	1	0	1	1	**8**
D	**14**	**10**	**11**	**9**	**8**	**6**	**7**	**1**	**1**	**15**	**7**	**13**	**2**	**12**	**3**	**10**	**7**	**11**	**11**	**158**

6.3 Level partitioning

The final reachability matrix is used to determine the reachability sets and antecedent sets. A reachability set is a set of parameters containing itself and other parameters that it may influence while an antecedent set is a set of parameters containing itself and parameters that may influence it. After the determination of the reachability set and antecedent set for all the parameters, an intersection set for each of the parameters is generated. The parameter for which the reachability set and intersection set are equal sets occupies the first and top level. In this case, the parameter 18 has an equal reachability set and intersection set; hence, it occupies the first and top-most level in ISM. The number 18 is therefore removed from the list of parameters under consideration. The process is repeated until the level of every parameter has been determined from the level partitioning process. Tables 6.4 to 6.13 show the iterations which determine the various levels of each parameter in the ISM structure.

Table 6. 4: First iteration of planning and design parameters

	Reachability set	Antecedent set	Intersection set	Level
1	1, 2, 3, 4, 7, 10, 16, 17, 18, 19	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14, 17, 19	1, 2, 3, 4, 7, 10, 17, 19	
2	1, 2, 3, 4, 5, 6, 10, 11, 12,	1, 2, 3, 4, 5, 6, 11, 12, 14, 16	1, 2, 3, 4, 5, 6,	

	14, 16, 17, 18, 19		11, 12, 14, 16	
3	1, 2, 3, 4, 5, 6, 10, 11, 12	1, 2, 3, 4, 5, 8, 10, 11, 12, 17, 19	1, 2, 3, 4, 5, 10, 11, 12	
4	1, 2, 3, 4, 7, 10, 11, 12, 16, 17, 18, 19	1, 2, 3, 4, 7, 11, 12, 16, 19	1, 2, 3, 4, 7, 11, 12, 16, 19	
5	1, 2, 3, 5, 11, 12, 14	2, 3, 5, 7, 8, 10, 11, 12	2, 3, 5, 11, 12	
6	1, 2, 6, 12, 14	2, 3, 6, 7, 10, 11	2, 6	
7	1, 4, 5, 6, 7, 10, 12, 14, 15, 16, 18, 19	1, 4, 7, 8, 10, 17, 19	1, 4, 7, 10, 19	
8	1, 3, 5, 7, 8, 10, 11, 12, 14, 16, 18, 19	8	8	
9	9, 10, 13, 14, 17, 19	9	9	
10	1, 3, 5, 6, 7, 10, 12, 14, 15, 16, 18, 19	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19	1, 3, 7, 10, 12, 16, 18, 19	
11	1, 2, 3, 4, 5, 6, 10, 11, 12, 14	2, 3, 4, 5, 8, 11, 12	2, 3, 4, 5, 11, 12	
12	1, 2, 3, 4, 5, 10, 11, 12, 14	2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 10, 11, 12, 14	
13	10, 12, 13, 14, 17	9, 13	13	
14	1, 2, 12, 14	2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 12, 14	
15	12, 14, 15, 16, 18	7, 10, 15	15	

16	2, 4, 10, 16, 17, 18, 19	1, 2, 4, 7, 8, 10, 15, 16, 17, 19	2, 4, 10, 16, 17, 19	
17	1, 3, 7, 10, 16, 17, 18, 19	1, 2, 4, 9, 13, 16, 17	1, 16, 17	
18	**10, 18, 19**	**1, 2, 4, 7, 8, 10, 15, 16, 17, 18, 19**	**10, 18, 19**	**I**
19	1, 3, 4, 7, 10, 16, 18, 19	1, 2, 4, 7, 8, 9, 10, 16, 17, 18, 19	1, 4, 7, 10, 16, 18, 19	

Table 6. 5: Second iteration of planning and design parameters

	Reachability set	Antecedent set	Intersection set	Level
1	1, 2, 3, 4, 7, 10, 16, 17, 19	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14, 17, 19	1, 2, 3, 4, 7, 10, 17, 19	
2	1, 2, 3, 4, 5, 6, 10, 11, 12, 14, 16, 17, 19	1, 2, 3, 4, 5, 6, 11, 12, 14, 16	1, 2, 3, 4, 5, 6, 11, 12, 14, 16	
3	1, 2, 3, 4, 5, 6, 10, 11, 12	1, 2, 3, 4, 5, 8, 10, 11, 12, 17, 19	1, 2, 3, 4, 5, 10, 11, 12	
4	1, 2, 3, 4, 7, 10, 11, 12, 16, 17, 19	1, 2, 3, 4, 7, 11, 12, 16, 19	1, 2, 3, 4, 7, 11, 12, 16, 19	
5	1, 2, 3, 5, 11, 12, 14	2, 3, 5, 7, 8, 10, 11, 12	2, 3, 5, 11, 12	
6	1, 2, 6, 12, 14	2, 3, 6, 7, 10, 11	2, 6	
7	1, 4, 5, 6, 7, 10, 12, 14, 15, 16, 19	1, 4, 7, 8, 10, 17, 19	1, 4, 7, 10, 19	

8	1, 3, 5, 7, 8, 10, 11, 12, 14, 16, 19	8	8	
9	9, 10, 13, 14, 17, 19	9	9	
10	1, 3, 5, 6, 7, 10, 12, 14, 15, 16, 19	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 16, 17, 19	1, 3, 7, 10, 12, 16, 19	
11	1, 2, 3, 4, 5, 6, 10, 11, 12, 14	2, 3, 4, 5, 8, 11, 12	2, 3, 4, 5, 11, 12	
12	1, 2, 3, 4, 5, 10, 11, 12, 14	2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 10, 11, 12, 14	
13	10, 12, 13, 14, 17	9, 13	13	
14	1, 2, 12, 14	2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 12, 14	
15	12, 14, 15, 16	7, 10, 15	15	
16	**2, 4, 10, 16, 17, 19**	**1, 2, 4, 7, 8, 10, 15, 16, 17, 19**	**2, 4, 10, 16, 17, 19**	**II**
17	1, 3, 7, 10, 16, 17, 19	1, 2, 4, 9, 13, 16, 17	1, 16, 17	
19	1, 3, 4, 7, 10, 16, 19	1, 2, 4, 7, 8, 9, 10, 16, 17, 19	1, 4, 7, 10, 16, 19	

Table 6. 6: Third iteration of planning and design parameters

	Reachability set	Antecedent set	Intersection set	Level
1	**1, 2, 3, 4, 7, 10, 17, 19**	**1, 2, 3, 4, 5, 6, 7, 8, 10, 11,**	**1, 2, 3, 4, 7, 10,**	**III**

		12, 14, 17, 19	**17, 19**	
2	1, 2, 3, 4, 5, 6, 10, 11, 12, 14, 17, 19	1, 2, 3, 4, 5, 6, 11, 12, 14	1, 2, 3, 4, 5, 6, 11, 12, 14	
3	1, 2, 3, 4, 5, 6, 10, 11, 12	1, 2, 3, 4, 5, 8, 10, 11, 12, 17, 19	1, 2, 3, 4, 5, 10, 11, 12	
4	1, 2, 3, 4, 7, 10, 11, 12, 17, 19	1, 2, 3, 4, 7, 11, 12, 19	1, 2, 3, 4, 7, 11, 12, 19	
5	1, 2, 3, 5, 11, 12, 14	2, 3, 5, 7, 8, 10, 11, 12	2, 3, 5, 11, 12	
6	1, 2, 6, 12, 14	2, 3, 6, 7, 10, 11	2, 6	
7	4, 5, 6, 7, 10, 12, 14, 15, 19	1, 4, 7, 8, 10, 17, 19	4, 7, 10, 19	
8	1, 3, 5, 7, 8, 10, 11, 12, 14, 19	8	8	
9	9, 10, 13, 14, 17, 19	9	9	
10	1, 3, 5, 6, 7, 10, 12, 14, 15, 19	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 17, 19	1, 3, 7, 10, 12, 19	
11	1, 2, 3, 4, 5, 6, 10, 11, 12, 14	2, 3, 4, 5, 8, 11, 12	2, 3, 4, 5, 11, 12	
12	1, 2, 3, 4, 5, 10, 11, 12, 14	2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15	2, 3, 4, 5, 10, 11, 12, 14	
13	10, 12, 13, 14, 17	9, 13	13	
14	1, 2, 12, 14	2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 12, 14	

15	12, 14, 15	7, 10, 15	15	
17	1, 3, 7, 10, 17, 19	1, 2, 4, 9, 13, 17	1, 17	
19	1, 3, 4, 7, 10, 19	1, 2, 4, 7, 8, 9, 10, 17, 19	1, 4, 7, 10, 19	

Table 6. 7: Fourth iteration of planning and design parameters

	Reachability set	Antecedent set	Intersection set	Level
2	2, 3, 4, 5, 6, 10, 11, 12, 14, 17, 19	2, 3, 4, 5, 6, 11, 12, 14	2, 3, 4, 5, 6, 11, 12, 14	
3	2, 3, 4, 5, 6, 10, 11, 12	2, 3, 4, 5, 8, 10, 11, 12, 17, 19	2, 3, 4, 5, 10, 11, 12	
4	2, 3, 4, 7, 10, 11, 12, 17, 19	2, 3, 4, 7, 11, 12, 19	2, 3, 4, 7, 11, 12, 19	
5	2, 3, 5, 11, 12, 14	2, 3, 5, 7, 8, 10, 11, 12	2, 3, 5, 11, 12	
6	2, 6, 12, 14	2, 3, 6, 7, 10, 11	2, 6	
7	4, 5, 6, 7, 10, 12, 14, 15, 19	4, 7, 8, 10, 17, 19	4, 7, 10, 19	
8	3, 5, 7, 8, 10, 11, 12, 14, 19	8	8	
9	9, 10, 13, 14, 17, 19	9	9	
10	3, 5, 6, 7, 10, 12, 14, 15, 19	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 17, 19	3, 7, 10, 12, 19	
11	2, 3, 4, 5, 6, 10, 11, 12, 14	2, 3, 4, 5, 8, 11, 12	2, 3, 4, 5, 11, 12	

12	**2, 3, 4, 5, 10, 11, 12, 14**	**2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15**	**2, 3, 4, 5, 10, 11, 12, 14**	**IV**
13	10, 12, 13, 14, 17	9, 13	13	
14	**2, 12, 14**	**2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15**	**2, 12, 14**	**IV**
15	12, 14, 15	7, 10, 15	15	
17	3, 7, 10, 17, 19	1, 2, 4, 9, 13, 17	17	
19	3, 4, 7, 10, 19	2, 4, 7, 8, 9, 10, 17, 19	4, 7, 10, 19	

Table 6. 8: Fifth iteration of planning and design parameters

	Reachability set	**Antecedent set**	**Intersection set**	**Level**
2	2, 3, 4, 5, 6, 10, 11, 17, 19	2, 3, 4, 5, 6, 11	2, 3, 4, 5, 6, 11	
3	2, 3, 4, 5, 6, 10, 11	2, 3, 4, 5, 8, 10, 11, 17, 19	2, 3, 4, 5, 10, 11	
4	2, 3, 4, 7, 10, 11, 17, 19	2, 3, 4, 7, 11, 19	2, 3, 4, 7, 11, 19	
5	**2, 3, 5, 11**	**2, 3, 5, 7, 8, 10, 11**	**2, 3, 5, 11**	**V**
6	**2, 6**	**2, 3, 6, 7, 10, 11**	**2, 6**	**V**
7	4, 5, 6, 7, 10, 15, 19	4, 7, 8, 10, 17, 19	4, 7, 10, 19	
8	3, 5, 7, 8, 10, 11, 19	8	8	
9	9, 10, 13, 17, 19	9	9	
10	3, 5, 6, 7, 10, 15, 19	1, 2, 3, 4, 7, 8, 9, 10, 11, 13, 17, 19	3, 7, 10, 19	

11	2, 3, 4, 5, 6, 10, 11	2, 3, 4, 5, 8, 11	2, 3, 4, 5, 11	
13	10, 13, 17	9, 13	13	
15	**15**	**7, 10, 15**	**15**	**V**
17	3, 7, 10, 17, 19	1, 2, 4, 9, 13, 17	17	
19	3, 4, 7, 10, 19	2, 4, 7, 8, 9, 10, 17, 19	4, 7, 10, 19	

Table 6. 9: Sixth iteration of planning and design parameters

	Reachability set	Antecedent set	Intersection set	Level
2	2, 3, 4, 10, 11, 17, 19	2, 3, 4, 11	2, 3, 4, 11	
3	**2, 3, 4, 10, 11**	**2, 3, 4, 8, 10, 11, 17, 19**	**2, 3, 4, 10, 11**	**VI**
4	2, 3, 4, 7, 10, 11, 17, 19	2, 3, 4, 7, 11, 19	2, 3, 4, 7, 11, 19	
7	**4, 7, 10, 19**	**4, 7, 8, 10, 17, 19**	**4, 7, 10, 19**	**VI**
8	3, 7, 8, 10, 11, 19	8	8	
9	9, 10, 13, 17, 19	9	9	
10	**3, 7, 10, 19**	**1, 2, 3, 4, 7, 8, 9, 10, 11, 13, 17, 19**	**3, 7, 10, 19**	**VI**
11	2, 3, 4, 10, 11	2, 3, 4, 8, 11	2, 3, 4, 11	
13	10, 13, 17	9, 13	13	
17	3, 7, 10, 17, 19	1, 2, 4, 9, 13, 17	17	

19	3, 4, 7, 10, 19	2, 4, 7, 8, 9, 10, 17, 19	4, 7, 10, 19	

Table 6. 10: Seventh iteration of planning and design parameters

	Reachability set	Antecedent set	Intersection set	Level
2	2, 4, 11, 17, 19	2, 4, 11	2, 4, 11	
4	2, 4, 11, 17, 19	2, 4, 11, 19	2, 4, 11, 19	
8	8, 11, 19	8	8	
9	9, 13, 17, 19	9	9	
11	**2, 4, 11**	**2, 4, 8, 11**	**2, 4, 11**	**VII**
13	13, 17	9, 13	13	
17	17, 19	1, 2, 4, 9, 13, 17	17	
19	**4, 19**	**2, 4, 8, 9, 17, 19**	**4, 19**	**VII**

Table 6. 11: Eighth iteration of planning and design parameters

	Reachability set	Antecedent set	Intersection set	Level
2	2, 4, 17	2, 4	2, 4	
4	2, 4, 17	2, 4	2, 4	
8	**8**	**8**	**8**	**VIII**
9	9, 13, 17	9	9	
13	13, 17	9, 13	13	

17	**17**	**1, 2, 4, 9, 13, 17**	**17**	**VIII**

Table 6. 12: Ninth iteration of planning and design parameters

	Reachability set	Antecedent set	Intersection set	Level
2	**2, 4**	**2, 4**	**2, 4**	**IX**
4	**2, 4**	**2, 4**	**2, 4**	**IX**
9	9, 13	9	9	
13	**13**	**9, 13**	**13**	**IX**

Table 6. 13: Tenth iteration of planning and design parameters

	Reachability set	Antecedent set	Intersection set	Level
9	**9, 13**	**9**	**9**	**X**

6.4 Categories of planning and design parameters

The reachability sets, antecedent sets and intersection sets presented in Tables 6.4 to Table 6.13 are used and the various levels of levels of each planning and design parameter in the system of parameters influencing stakeholders' acceptance of public transportation infrastructure are determined. Like levels' partitioning, the final reachability matrix is used to obtain the driving power and dependence of each planning and design parameter. The driving power is the sum of 1s in a row for a given parameter whereas the dependence is the sum of 1s in a column for the same parameter. The driving power (DP) and dependence (D) of all the nineteen planning and design parameters are shown in Table 6.3. The driving power-dependence relationships of the parameters are plotted in Figure 6.1.

Figure 6.1 is divided into four quarters. These quarters are drivers, linkages, autonomy and dependence. The planning and design parameters that are drivers of the system are passengers' waiting area (4), road width (7), road steepness (8) and vehicle parking type (11). The linkages are distance between parked vehicles (1), size of parking lot or bay (2) and infrastructure traffic capacity (10). The linkages are parameters in the system that has high driving power and dependency. These two characteristics make the parameters unstable in the sense that any change in any of them affects other parameters and themselves. Therefore, they must be critically planned and designed for the successful and sustainable delivery of public transportation infrastructure. Those which are dependences consist of pavement marking (3), vehicle restrictions (12), traffic signs (14), vehicle waiting time (16) and shelter for waiting passengers (18). The remaining parameters such as vehicle turning radius (5), sight distances (6), walking distance to transport facility (9), and accessibility by disabled or aged people (13), traffic signals (15) and vehicle boarding time (17) are categorised as autonomy parameters. The autonomous parameters have little or no influence on other parameters. These can be disconnected from the parameters that influence the entire system of transportation infrastructure for acceptance or non-acceptance. Given that each parameter has driving power and dependency power in the system, the relationships are shown in Figure 6.2.

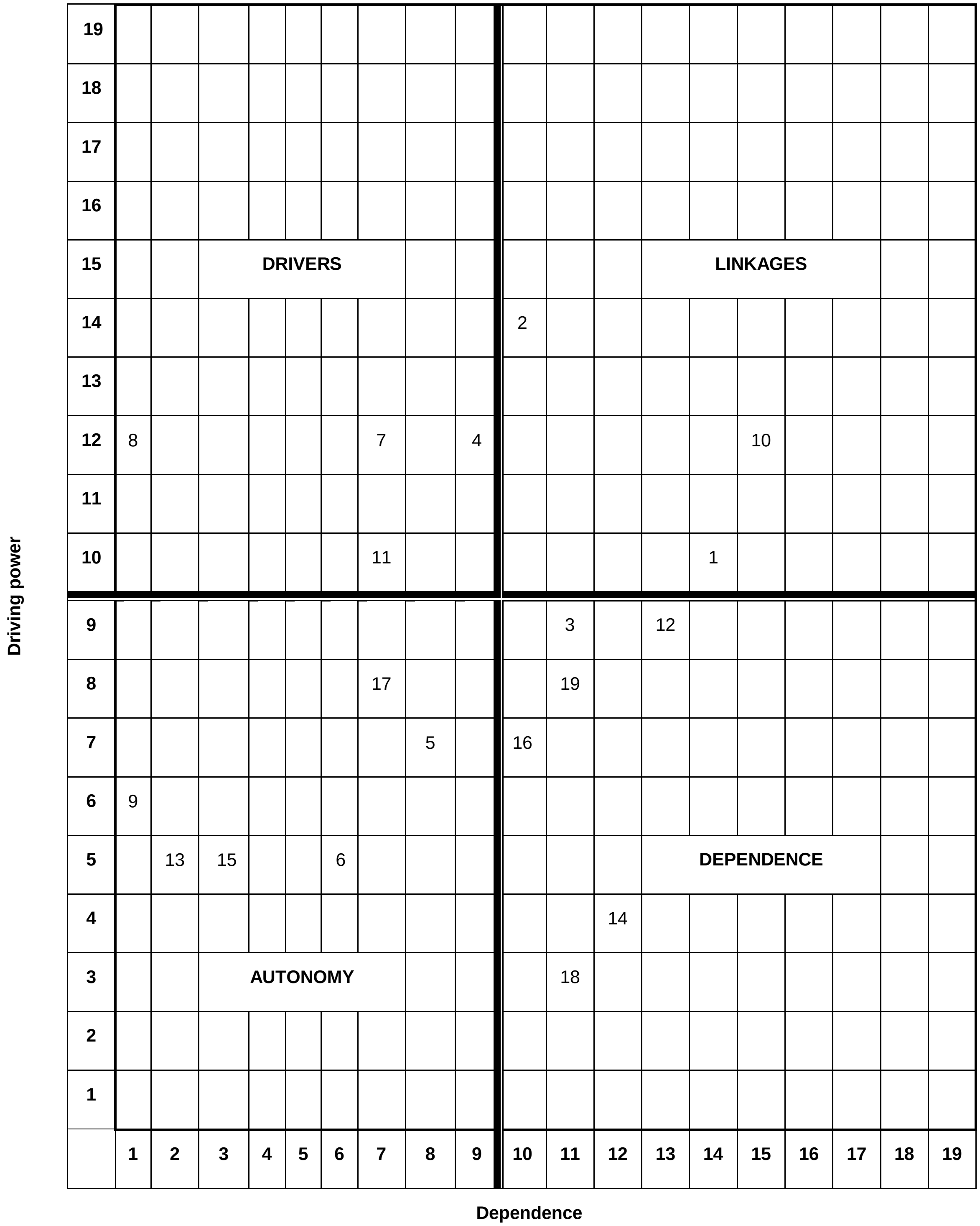

Figure 6.1: Driving powers-dependences relationships diagram

6.5 Interdependencies of parameters

The digraph is a preliminary framework of ISM, showing the relationships of different planning and design parameters. The digraph is a graphical representation of the interdependencies of the parameters which shows the direction which one parameter influences or is influenced. The planning and design parameters are modelled through ISM methodology to determine their relationships. Figure 6.2 is the modelled relationships among the parameters and shows that the parameters at the bottom of the diagram influence those above them. However, the arrows indicate that some of them have a bi-directional relationship which means that a change in one affects the other or vice versa. The modelled structural relationships among the planning and design parameters have formed the interpretive structural model (ISM) framework (Attri, Dev and Sharma, 2013).

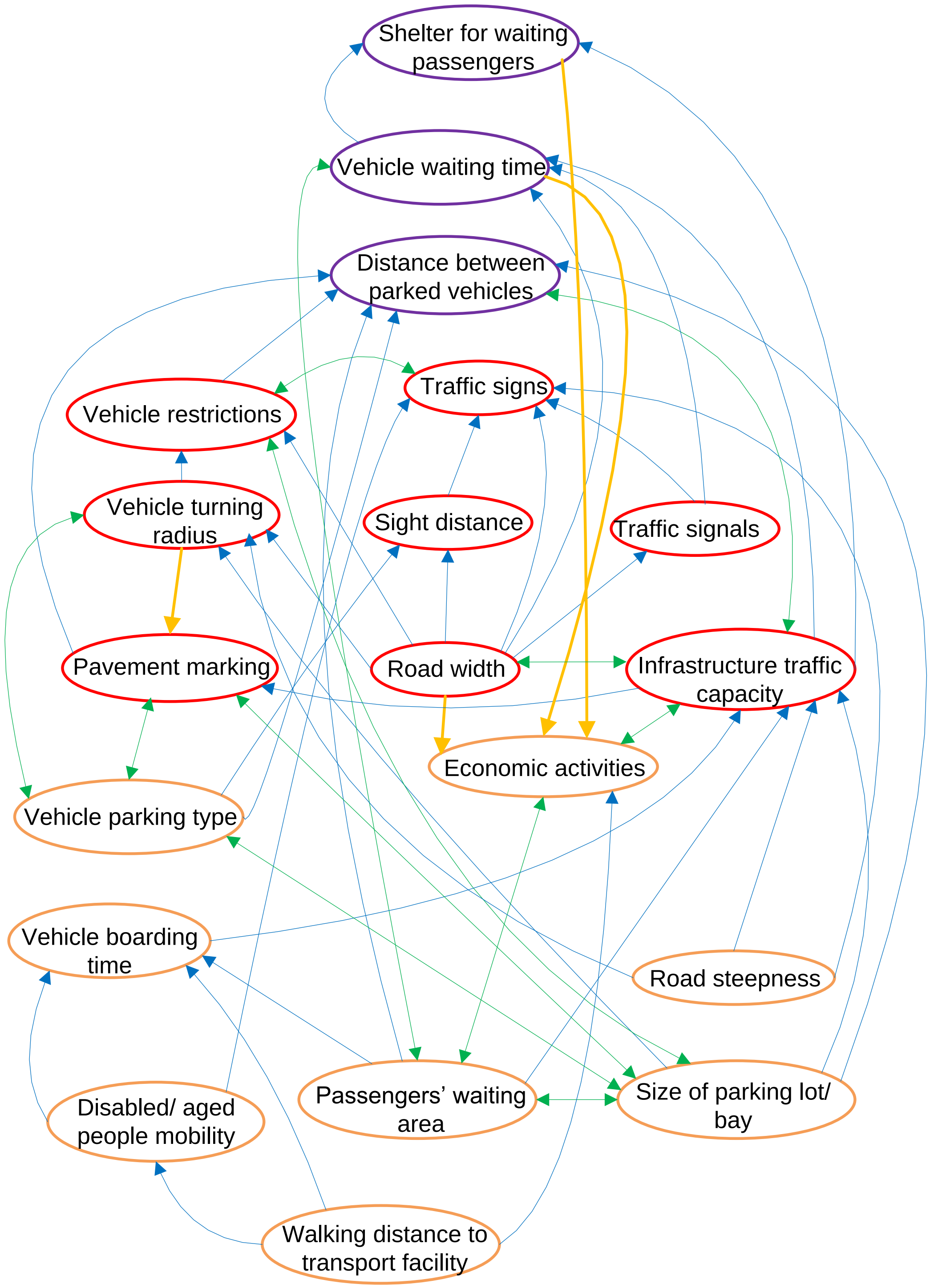

Figure 6.2: Directed graph of planning and design factors influencing stakeholders' acceptance of public transportation infrastructure

6.6 ISM framework

In the transportation planning and design process, the factors that are considered critical are shown in Figure 6.3. These factors are various planning and design parameters that are identified as those that can influence stakeholders' acceptance or non-acceptance of transportation infrastructure, especially a transit facility. The ISM in Figure 6.3 shows the ten levels of parameters from the bottom to the top. An ISM model shows factors which have the greatest influence on other factors at the bottom whereas those that have less influence on others but are influenced by them are at the top of the model. The direction of arrows connecting these parameters of different levels shows that the influence is a bottom-up relationship in the framework.

Level ten, which is at the bottom, consists of walking distance to transport facility (9). Level nine comprises the size of parking lot or parking bay (2), passengers' waiting area (4) and accessibility by disabled or aged people. Level eight consists of planning and design parameters such as road steepness (8) and vehicle boarding time (17). Level seven of the ISM structure is made up of vehicle parking type (11) and economic activities (19). Figure 6.3 further shows pavement markings (3), road width (7) and infrastructure traffic capacity at level six while vehicle turning radius (5), sight distances (6) and traffic signals (15) are parameters that occupy the fifth level of the ISM model. Level four of planning and design parameters has vehicle restrictions (12) and traffic signs (14). At level three, there is only distance between parked vehicles (1), level two is vehicle waiting time (16) and the topmost level which is level one has shelter for waiting passengers and planning and design parameters in the ISM model.

The planning and design parameters influencing stakeholders' acceptance or non-acceptance of public transportation infrastructure are grouped into three levels: the lower levels, intermediate levels and the upper levels. The lower level parameters in the structural framework are essential in the system because they have an influencing relationship on the intermediate and upper parameters in the system. This means that a change on any of the parameters at the lower level group will affect the other parameters and the entire system of the framework. This ISM model of the parameters show that the acceptance of an entire public transportation infrastructure by stakeholders decreases upward along the framework. The cumulative effect of lower level parameters such as walking distance, aged/ disabled means of mobility, passengers' waiting time and size of parking lot on other parameters increases or decreases acceptance of an infrastructure by stakeholders. It is important to note that these lower level parameters are the challenging parameters in the course of planning for public transportation infrastructure projects. However, the model also suggests that the parameters on the top level such as shelter for passengers, vehicle waiting time and vehicle parking type have no or little influence on stakeholders' perception for acceptance of public transportation infrastructure in MMM.

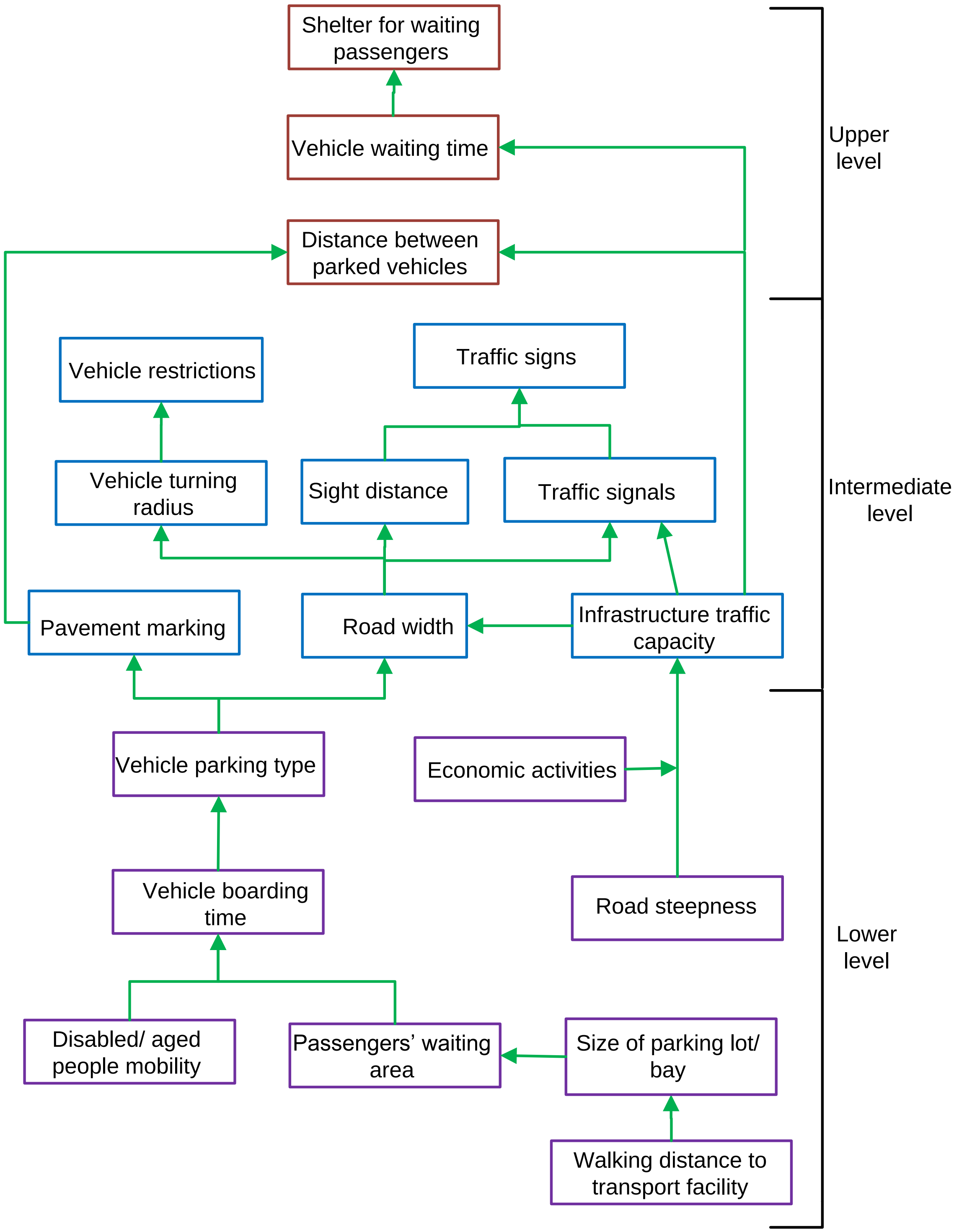

Figure 6.3: ISM framework of planning and design parameters influencing stakeholders' acceptance of public transportation infrastructure

The different groups of the ISM levels are based on the degree of influence that the parameters within the group have on an entire transportation infrastructure project. According to Figure 6.3, the lower levels of the ISM structure from are level ten, level nine, level eight and level seven. These levels consist of the planning and design parameters that have an influence on all the other parameters above them. This means that there are dependencies between the parameters of groups of levels above them as indicated in the diagram by means of an arrow of relationships. The intermediate group is made up of level six, level five and level four planning and design parameters. Finally, the upper group of parameters are level three, level two and level one planning and design parameters. The driving powers of the planning and design parameters in the entire system decrease from the lower group to the upper group whereas the dependencies increase from the lower group to the upper group.

It is found from the ISM structure obtained from its modelling that the walking distance to a public transportation facility is critical in the planning and design for stakeholders' acceptance. Such facilities should be as close as possible to places of residence, as well as those of social and economic activities. In the case of the IBL and MITF, they are located in the Bloemfontein CBD where government departments and agencies as well as shopping malls or centers are located. As illustrated in Figure 6.3, the study also considers the criticality of parking lot size, disabled or aged people's mobility facility, passengers' waiting area and vehicle boarding time in the planning and design for stakeholders' acceptance. The parking lot size of the IBL and MITF are adequate. There are passengers' waiting areas for every parking lot in IBL, unlike the MITF. However, there is no boarding time schedule and adequate elevator for lifting people to the facilities. This can motivate a negative attitude from stakeholders. The study has also revealed in the ISM structure that transport infrastructure capacity, road steepness and economic activities at public transport facilities are critical determinants in the choice of other parameters' characteristics. These parameters have a high driving influence in the planning and design process of public transportation infrastructure. Therefore, they have to be critically assessed, adequately estimated and properly planned and designed for the purpose of improving stakeholders' acceptance of an entire public transportation infrastructure project or asset.

6.7 Framework for improving stakeholders' acceptance of public transportation infrastructure

The ISM framework in Figure 6.3 shows the relationship between the various planning and design parameters that influence stakeholders' perceptions. These parameters are also presented according to their level of criticality in the system of the relationships. Based on the ISM framework, the public transportation infrastructure projects' acceptance by stakeholders can be improved by managing the parameters at the planning and design phase according to their level of criticality. This can be done by considering activities as illustrated in Figure 6.4 below. From the Figure 6.4, it is expected that public transportation infrastructure projects or assets be located within a radius of 500m to residences, work places or business centres. The public transportation infrastructure projects should also be provided with facilities such as ramps, elevators or hoists to support disabled or physically challenged people to access public transportation services. It further considers the provision of shopping malls or centres where stakeholders can buy and sell while making using of public transportation infrastructure. This can contribute to the livelihood and household empowerment/well-being? of people. Additionally, the gradient of roads and driveways is expected to be as low as possible as given in standards for construction to ensure the smooth climbing of vehicles. It implies that the parameters at the bottom of the ISM model should be given priority in planning and design of transportation infrastructure for improved stakeholders' acceptance. The ISM model and framework for improving stakeholders' acceptance of public transportation infrastructure using planning and design parameters is summarised in section 6.8.

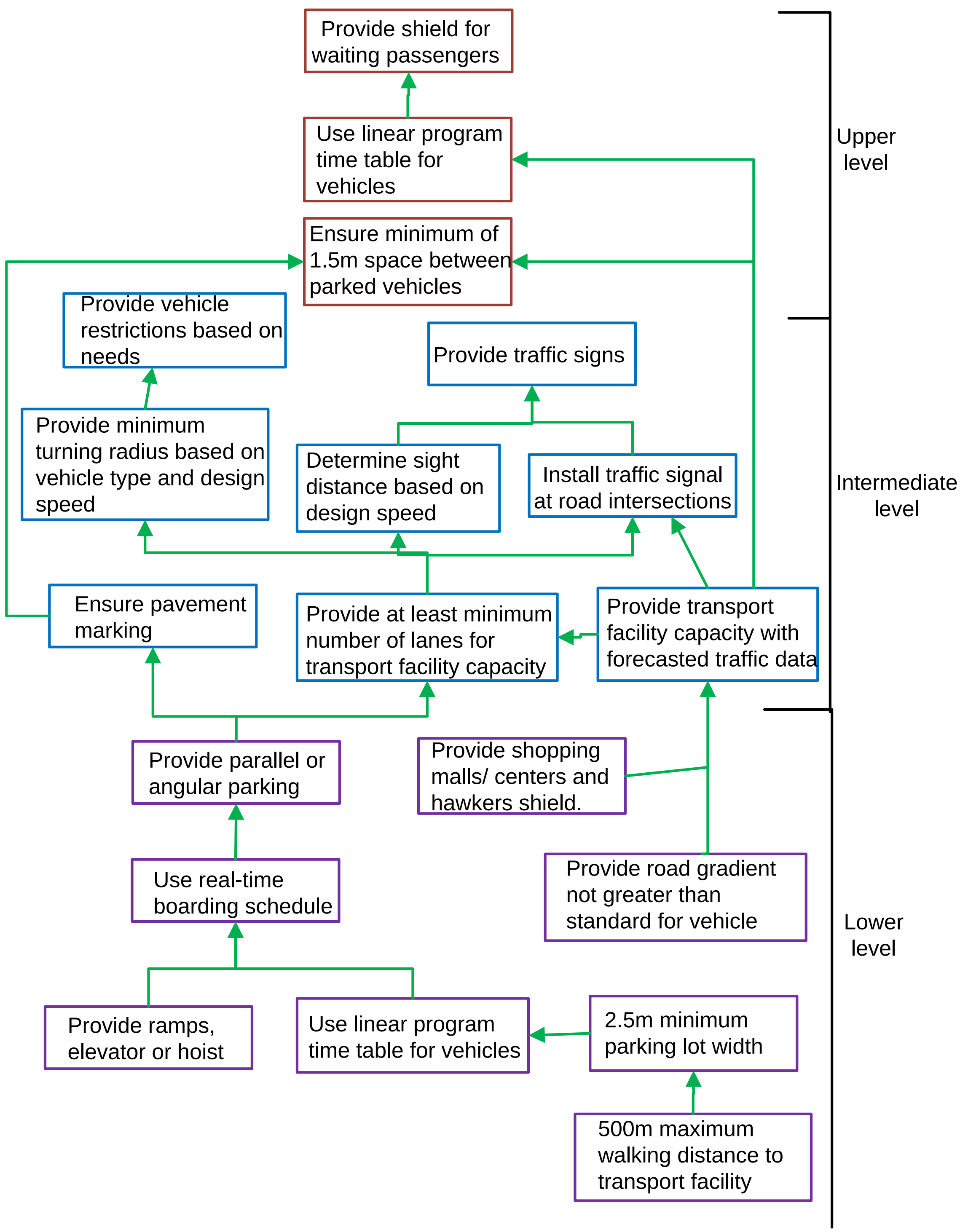

Figure 6.4: Framework for improving stakeholders' acceptance of public transportation infrastructure based on planning and design parameters

6.8 Conclusion

ISM was used to model the interrelatedness of nineteen planning and design parameters that were found to motivate stakeholders' attitude towards a public transportation infrastructure in the MMM in South Africa. The developed model depicts how these parameters are related in terms of influencing one another. The model identified that walking distance to transport facility, disabled or aged people mobility, passengers' waiting area, size of parking lot, road steepness, economic activities and transport facility capacity are critical in influencing stakeholders' perceptions. These can motivate acceptance or non-acceptance of public transportation infrastructure (Rangarajan, Long, Tobias and Keister, 2013). The framework proposed from the model is a guide on how the management of public transportation infrastructure projects should be handled at the phase of planning and design to ensure the improved acceptance of such infrastructure. With the achievement of the aim of the study through proposed framework, the study therefore draws its conclusions and recommendations are presented in chapter seven.

CHAPTER SEVEN: FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

7. INTRODUCTION

This research set out to assess stakeholders' engagement and involvement in the planning and design process of public transportation infrastructure projects in South Africa. It has used a questionnaire for a stakeholders' survey for gathering data on the opinions of stakeholders of public transportation infrastructure projects in the MMM. It is revealed in the study that relevant stakeholders are not always involved in the planning and design of transportation infrastructure project. It is also found that South African public transportation infrastructure project stakeholders' meetings are normally held during implementation. However, the project outcomes or benefits and the information about its progress are not shared with the public. The inadequate information shared with stakeholders can lead to distrust and cause stakeholders' opposition to public transportation infrastructure projects.

In addition to the above, the research set out to identify factors influencing stakeholders' acceptance of transportation infrastructure projects during the planning and design phases. In order to achieve this, the study used a quantitative research method in which several factors identified from a literature review and discussion were used to design a questionnaire. The designed questionnaire was used to seek stakeholders' opinions and perceptions regarding each factor's influence on stakeholders' acceptance or non-acceptance of transportation infrastructure projects. A five-point Likert scale was used for respondents to rate their perceptions of each planning and design parameter. Following the analysis of the set of parameters from the questionnaire using SPSS 16.0, nineteen planning and design parameters were found to influence stakeholders' perceptions regarding the acceptance or non-acceptance of public transportation infrastructure.

Another objective was to examine and model the linkage between the control variable of stakeholders' acceptance and the planning and design variables of public transportation infrastructure. The geometrical characteristics of the two cases study transport facilities were physically observed and measured. The traffic parameters of the facilities were also obtained through physical survey. The data obtained from both geometric and traffic were analysed and comparisons were made with design standards and specifications. The analysis and examination of physical parameters showed adequacy or inadequacy with some design parameters that could motivate stakeholders' acceptance or non-acceptance of public transportation infrastructure projects or assets. Such parameters which have indicated an influence on stakeholders' perceptions of the usability of public transportation infrastructure are further used in the study to develop a framework of their interdependencies using ISM methodology. Based on the results and findings, the research study has made the following recommendations:

7.1 Findings

The critical findings emanated from this study are as follows:

- Walking distance to public transport facilities, public transport facility capacity, disabled or aged people's access to facilities and business opportunities are critical factors that have influencing relationship with other factors that influence stakeholders' acceptance of transportation infrastructure in MMM. This is found from the ISM model that factors at the bottom of it are critical in the relationship that exists among the factors.
- The characteristics of geometric parameters of public transportation infrastructure affect the drivers' efficiency while using such infrastructure. The turning radius for instance, that is less than 1.6m is found to be inadequate for efficient manoeuvrability by drivers in MITF.
- The turning radii on MITF either above or below the minimum turning radius of 1.6m required for the transport facility. The turning radii values for IBTL which is for intercity buses are also either above or below the minimum of 12.8m standard value.
- The traffic signal timing at Y-junction of Hanger Street and IBLT exit road has found to be 98% of its saturation capacity. This implies that the intersection is at its saturation, which vehicles speed of about 10km/hr can affect the effectiveness of discharging vehicles on queue during green interval.

- The case study's public transport facilities are in the Bloemfontein CBD where most of the social and business activities are carried out. This shows appropriate location of the public transportation infrastructure to meet the travel needs of people.
- Stakeholders' satisfaction is critical to successful public transportation infrastructure projects. It is found from the literatures that some transportation infrastructure projects in the world have been abandoned or not adequately used. This is as the result of perceived inconvenience from some factors such as air pollution, road width, the location and integrity of project developer.
- Management of public transportation infrastructure project stakeholders enhances the identification of risks and provides an opportunity to mitigate them for the success of a project. The ability of the management team and the competence of the team members, especially the project manager is a great deal. The management has to ensure that stakeholders are consulted and engaged for participation in the project. Such participation enhances transportation infrastructure project delivery success.
- Public transportation infrastructure projects' acceptance is associated with adequate forecasting of traffic needs and appropriate choice of design parameters.
- There is inadequate engagement of public transportation infrastructure project stakeholders in planning process.

Some findings obtained from the study require recommendations for the purpose of improving public transportation infrastructure project planning and design.

7.2 Recommendations

The findings from section 7.1 above show that some of them need further action for improvement.

- There is a need for stakeholders' participatory planning and development of evaluation tools for public transportation infrastructure projects.
- The traffic signal timing at Y-junction of Hanger Street and Central Park IBLT exit road needs optimisation to meet the growing traffic needs.
- There is a need to increase some vehicle turning radii in the MITF.

7.3 Limitations to the study

There are limitations to this study that affect the generalisation of the findings and reports. One of them is the selected sample of respondents. The respondents considered for the research were drivers and passengers as a sample population for public transportation infrastructure project stakeholders. The research has not included other stakeholders such as clients, contractors and consultants. This is because stakeholders' objections to the use of the case study public transportation infrastructure are identified as its users. The choice of the Central Park IBLT and the MITF as a cases study has neglected other types of public transportation infrastructure such as public railway stations, seaports, tunnels, roads and airports. The inability to extend this study to other public transport facilities is attributed to limited resources and a tight time frame.

Apart from the above, there was limited accessibility to the case study's public transport facilities. This was to ensure the safety of the research equipment and survey assistants. Therefore, all physical observation and measurements were carried out between 06:00 and 18:00.

7.4 Further Scope of the Research

It is established in this study that the framework of public transportation infrastructure project planning and design factors can be used to identify critical planning and design parameters for the improved stakeholders' acceptance of projects. Given that this study has been conducted on two cases, it is recommended that a similar study be done on other public transport facilities such railway stations or other geographic and cultural context. Also, developing the framework by using quantitative structural equation modelling principles will provide further insights to the challenges and policy interventions, which is another scope for further research.

7.5 Conclusion

This study has established that planning and design factors have an influence on stakeholders' attitude towards the use public transportation infrastructure in the MMM. It is evidenced in the study that factors such as the walking distance to public transport facilities, available economic activities, vehicle turning radii and vehicle boarding times are capable of affecting stakeholders' acceptance of such infrastructure. However, the use of ISM model has identified essential factors that must be critically examined during the planning and design. Such essential factors are the distance from residences or work places, accessibility facilities, transport infrastructure capacity, road grade and employment opportunities. This must be in accordance with the South African standards and norms. On the aspect of stakeholders' engagement and participation in public transportation infrastructure, the study reveals that public transportation infrastructure users are not involved in the planning and design of the infrastructure project or asset.

Given the findings from the study, it is evident that an ISM model can be used to make decisions for the effective management of public transportation infrastructure projects. It can therefore be applied to manage planning and design process of public transportation infrastructure projects and assets effectively by locating public transportation infrastructure projects close to living or work places, providing facilities to support mobility by the disabled and ensuring the provision of business activities around such facilities.

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APPENDICE

Appendix A

Central University of Technology, Free State

FACULTY OF ENGINEERING AND INFORMATION TECHNOLOGY
Department of Civil Engineering

20 President Brand Street
Private Bag X20539
Bloemfontein

To: **Whom it may concern**

From: **Prof DK Das,**
Associate Professor: Civil Engineering

Date: 2018-11-22

Priority: Normal

Subject: REQUEST FOR ASSISTANCE

I write to kindly request your assistance to Mr Innocent Shima Azege (Student Nr 218011343). He is a Master of Engineering student in the Department of Civil Engineering at Central University of Technology, Free State on Research Studies.

In view of the above, he has proceeded on field survey of some public transportation infrastructures in Mangaung Metropolitan Municipality. May you give him the necessary cooperation and supports he may need from you to facilitate his studies.

Thanks for anticipated cooperation. In the meantime, accept assurances of my highest esteem.

Kind regards,

Dillip Kumar Das.

Prof Dillip Kumar Das

Central University of Technology, Free State
Dept of Civil Engineering
2018 -11- 22
Private Bag X20539
Bloemfontein
9300

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Appendix B

MANGAUNG
METRO MUNICIPALITY
METRO MUNISIPALITEIT
LEKGOTLA LA MOTSE

DIRECTORATE
HUMAN SETTLEMENTS &
HOUSING

Ref: Adv NN Mofokeng/avm

5/12/2018

TO : MAFOKO SECURITY
INTERMODAL TRANSPORT FACILITY

SUBJECT : REQUEST TO HAVE ACCESS TO THE MANGAUNG INTERMODAL FACILITY FOR THE SURVEY OF SOME PUBLIC TRANSPORTATION INFRASTRUCTURE IN THE CITY

Permission is hereby granted to Mr. Innocent Shima Azege (Student Nr: 218011343), a Master of Engineering Student in the Department of Civil Engineering at Central University of Technology to enter the Mangaung Intermodal Transport Facility for the survey which forms part of his studies.

Confirmation from Prof. DK Das of Civil Engineering is hereto attached.

Yours Faithfully

Adv. NN MOFOKENG
GM:LAND DEVELOPEMENT AND PROPERTY MANAGEMENT

PO Box 3704, Bloemfontein 9300 Room ###, #th floor, Bram Fischer Building, Cnr Nelson Mandela & Markgraaff Street
Tel: +27 51 ### #### Fax: +27 51 ### #### E-Mail: name@mangaung.co.za Website: www.manguang.co.za

Central University of Technology, Free State

Central University of Technology, Free State

APENDIX C

5 December, 2018

TO WHOM IT MAY CONCERN

Re: Mr Innocent Azege's Master of Engineering studies

This is to introduce the Master of Engineering in Civil Engineering student, Mr Innocent Azege at Central of University of Technology, Free State. His research study is aimed to propose a framework for improving stakeholders' acceptance of public transportation infrastructure projects in the Mangaung Metropolitan Municipality, South Africa.

In view of the above, he is expected to conduct a survey of public opinions on the stakeholders' engagement and participation in public transportation infrastructure projects. He is also required to seek stakeholders' opinions about planning and design factors that influence their perception for acceptance or non-acceptance of public transportation infrastructure projects in the metropolitan municipality through administering questionnaires.

The researcher will ensure that confidentiality of opinions of respondents and other ethics in research will be upheld. Therefore, you are at liberty to contact me, Prof DK Das, the supervisor of the research study on ddas@cut.ac.za .

Thank you for anticipated cooperation.

Kind regards

Prof. DK Das

Central University of
Technology, Free State

Appendix D

RESEARCH QUESTIONNAIRE

A FRAMEWORK FOR IMPROVING STAKEHOLDERS' ACCEPTANCE OF PUBLIC TRANSPORTATION INFRASTRUCTURE IN MANGAUNG METROPOLITAN MUNICIPALITY, SOUTH AFRICA

INTRODUCTION

This research is a survey of stakeholders' opinions about causes of acceptance or non-acceptance of public transportation infrastructure. This is done in Mangaung Metropolitan Municipality of South Africa. The research is meant for academic purposes and it is aimed at improving stakeholders' acceptance of public transportation projects. Therefore, your responses to these questions will be helpful for the study. In this regard, your responses are going to be treated with confidentiality. You are also free to decline from responding to any or all the questions in this questionnaire.

This questionnaire has three sections: Your responses to the questions by ticking (√) will be highly appreciated.

Section 1: DEMOGRAPHIC DATA

Kindly tick in a space beside an option that is applicable to you in the table below.

Gender	
Female	
Male	
Mode of transportation	

Private transport	
Public transport	
Age	
19 – 24 years	
25 – 34 years	
35 – 65 years	
Above 65 years	

Central University of Technology, Free State

Section 2: Stakeholders' engagement and participation in public transportation infrastructure projects

How do you rate the level of stakeholders' engagement and participation in transportation infrastructure projects in Mangaung Municipality? Please rate 1 for very bad to 5 for very good.

	Item	**1**	**2**	**3**	**4**	**5**
1	Most people are involved in transportation project planning					
2	There is always a meeting of people involved in projects					
3	People from different groups are always informed of the project progress					

4	People are told of project benefits at the time of planning					
5	Different people contribute materials or ideas during planning of a transportation project.					
6	Some people are not to be able to participate in a planning process for various reasons					
7	During construction of public transportation, people assist in various ways for project success					

Central University of
Technology, Free State

Section 3: Influence of planning and design factors on stakeholders' perception about public transportation infrastructure projects

Kindly rate the **influence** of the following factors for **acceptance** of public transportation facility projects. Your acceptance of a taxi rank or bus terminal is based on the factors in the tables below. **Note: 1 – Strongly disagreed; 2 – Disagreed; 3 - Moderately Agreed, 4 – Agreed;**

5 – Strongly agreed

S/No	Factors	1	2	3	4	5
1	There is a nearby U-turn on a road for vehicles to turn to the direction of bus terminal or taxi rank					
2	The available space between two parked vehicles					
3	The size of the vehicle parking area					
4	The line markings to guide the use of facilities.					
5	The space for waiting passengers					
6	The turning space for vehicles					
7	Distance to see anything in front of moving vehicle					
8	Road width in public transport facilities					
9	Walking distance from house or place of work to public transport facility					
10	The steepness of climbing into transportation facility					

11	Vehicle waiting time for passengers at public transport					
12	The number of vehicles that have to use a facility when there are many cars or many people are travelling					
13	The vehicle parking arrangement or type					
14	Restrictions on the use of public transport facility					
15	The number of vehicles that wait for passengers					
16	Facilities for aged or disabled people to access public transport facility					
17	Traffic signs at public transport facilities					
18	Traffic control system at junctions					
19	Presence of security operatives at public transport facility					
20	The time for passengers to wait for vehicles					
21	The vehicle boarding time at public transport facility					
22	Availability of shelter or shield at passengers waiting area					
23	Available business or job opportunity from a facility					