AN INVESTIGATION ON NON-MOTORISED TRANSPORT IN SMALL- AND MEDIUM-SIZED TOWNS IN NAMIBIA: PLANNING AND POLICY PARADIGM SHIFT

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Abstract

Non-Motorised Transport (NMT), including walking and cycling, is an important yet underdeveloped mode of transportation in many developing countries, including Namibia. Small- and medium-sized towns in Namibia, such as Tsumeb and Walvis Bay, lack the planning and policies required to promote NMT, despite its potential to improve sustainability, safety, and mobility. This study aims to investigate the current state of NMT provision, challenges, and opportunities to improve its availability in Tsumeb and Walvis Bay. A mixed methods approach was adopted to thoroughly assess NMT infrastructure conditions, user experiences, and planning tools and approaches by policy makers in Tsumeb and Walvis Bay. Primary data was collected through NMT infrastructure assessments, engagements and user surveys with policy makers, and stakeholder interviews with NMT users, while secondary data was sourced from existing policy documents and academic literature. Descriptive analysis was conducted to assess NMT infrastructure and user trends, and a thematic analysis of the qualitative data from interviews with NMT users in Tsumeb and Walvis Bay was conducted to identify challenges and potential solutions. Quantitative data from policy maker surveys were analysed using the Analytical Hierarchy Process (AHP) to understand the planning and implementation perceptions, policies, and strategies in the study towns. The study findings reveal inconsistent and poorly maintained NMT infrastructure in both towns, including unpaved sidewalks, obstructed pathways, and a lack of designated bike lanes. These limitations forced NMT users to share roadways with motorised vehicles, raising safety concerns. Inadequate policy support, funding limitations, and poor implementation of traffic laws further intensified these challenges. The study recommends a phased strategy by developing NMT facilities that prioritise accessibility, inclusivity, and safety. Improved stakeholder engagements and strong policy frameworks are required to create sustainable and equitable transportation systems in Namibian towns. This study offers useful insights for policy makers and planners on strategies to effectively incorporate NMT into urban mobility policies in Namibia.

Keywords: Non-motorised transport, Small- and medium-sized towns, NMT infrastructure, NMT policies, Namibia

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Dedication

This thesis is dedicated to my beloved family, whose endless love and sacrifices have served as my foundation; to my mentors, for their invaluable guidance and inspiration; and to my friends and colleagues, whose constant support and encouragement have been a source of strength throughout my academic journey.

List of publications and conference proceedings

A list of publications and conference presentations by the student, that were part of their study, are listed in this section.

i. Publications during candidature

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Table of Contents

Abstract i
Acknowledgements ii
Dedication iii
List of publications and conference proceedings iv
i. Publications during candidature iv
ii. Conference proceedings iv
List of Figures x
List of Tables xiv
List of Acronyms xvi
Declaration xviii
CHAPTER 1: INTRODUCTION 1
1.1. General introduction 1
1.2. Background of study 1
1.3. Problem statement 3
1.4. Research objectives 5
1.5. Key research questions 5
1.6. Research significance 6
1.7. Scope of study 7
1.8. Thesis layout 7
CHAPTER 2: LITERATURE REVIEW 9
2.1. Introduction 9
2.2. Current state of NMT in Africa 9
2.3. Current state of NMT in Namibia 10
2.3.1. NMT infrastructure in Namibia 11
2.3.2. NMT policy environment in Namibia 14
2.3.2.1. Sustainable urban transport masterplan for the City of Windhoek 14
2.3.2.2. City of Windhoek non-motorised transport strategy 15
2.3.2.3. Master plan for sustainable transport for the four northern central regions 16
2.4. NMT infrastructure and design 19
2.4.1. General design parameters and criteria 20
2.4.2. Capacity 22
2.4.2.1. Walkway capacity 22

2.4.2.2. Waiting areas 22
2.4.3. Width of sidewalks and cycle ways 23
2.4.4. Separation 25
2.4.5. Traffic calming 26
2.4.6. Technology and lighting 26
2.4.6.1. Surveillance cameras 27
2.4.6.2. Lighting 27
2.4.7. Drainage designs 27
2.4.8. Road signs and markings 28
2.4.9. Universal access 28
2.4.9.1. Ramps and dropped kerbs 29
2.4.9.2. Pedestrian pushbuttons 30
2.4.9.3. Level of pedestrian crossings 30
2.4.9.4. Alignment of pedestrian crossings 31
2.5. Safety and risk factors 31
2.6. Benefits of NMT 32
2.6.1. Health benefits 32
2.6.2. Environmental sustainability 33
2.7. Mode choice and behaviour 33
2.7.1. Geography and weather 33
2.7.2. Socio-economic factors 34
2.7.3. Urban form 35
2.7.4. The built environment 36
2.7.5. Attitudes and perceptions 36
2.8. Case studies of NMT policies and interventions: Global perspective 37
2.8.1. Pabna Municipality, Bangladesh 38
2.8.1.1. Introduction 38
2.8.1.2. Study area and research design 38
2.8.1.3. Research findings 39
2.8.1.4. conclusions and recommendations 40
2.8.2. Ang Mo Kio (AMK) Town, Singapore 40
2.8.2.1. Introduction 40
2.8.2.2. Methodology 41
2.8.2.3. Interventions 41
2.8.2.4. Results and challenges 41

2.8.2.5. Conclusions ... 42
2.9. Case Studies of NMT Policies and Interventions: African Perspective ... 42
2.9.1. Kisii Town, Kenya ... 42
2.9.1.1. Introduction ... 43
2.9.1.2. Methodology ... 43
2.9.1.3. Research findings ... 43
2.9.1.4. Conclusion and recommendations ... 44
2.9.2. Thaba Nchu, South Africa ... 44
2.9.2.1. Background and challenges ... 44
2.9.2.2. Interventions ... 45
2.10. Research gaps and future directions ... 46
2.11. Key conclusions from literature studies ... 48
CHAPTER 3: RESEARCH METHODOLOGY ... 51
3.1. Introduction ... 51
3.2. Research design ... 51
3.3. Study population ... 52
3.4. Study setting ... 52
3.5. Sampling approach ... 52
3.6. Research instruments ... 54
3.7. Research procedures ... 54
3.7.1. Selection of study towns ... 55
3.7.2. Identification of guidelines and reports ... 57
3.7.3. NMT stakeholder mapping and analysis ... 58
3.7.4. Development of innovative NMT stakeholder engagement tools ... 59
3.7.5. Development of NMT infrastructure audit tools ... 59
3.8. Data collection ... 60
3.9. Data analysis ... 61
3.9.1. Graphical Information System (GIS) ... 61
3.9.2. Microsoft Excel ... 62
3.9.3. Statistical Packages for the Social Sciences (SPSS) ... 62
3.9.4. Analytical Hierarchy Process (AHP) – statistical method ... 62
3.10. Research ethics ... 65
CHAPTER 4: STUDY AREAS ... 66
4.1. Introduction ... 66
4.2. Tsumeb ... 67

4.3. Walvis Bay 68
CHAPTER 5: RESULTS AND DISCUSSIONS 71
5.1. Introduction 71
5.2. Evaluation of NMT networks 71
5.2.1. NMT infrastructure overview 71
5.2.2. Level of NMT activities 73
5.3. NMT infrastructure audit 75
5.3.1. Tsumeb 75
5.3.1.1. Central business district 78
5.3.1.2. Informal settlement 80
5.3.1.3. High-income areas 82
5.3.2. Walvis Bay 84
5.3.2.1. Central business district 84
5.3.2.2. Kuisebmond 89
5.3.2.3. Naraville 94
5.4. NMT user safety and perceptions 98
5.5. Evaluation of NMT planning 113
5.5.1. Policy makers planning tools (approaches) and perceptions 113
5.5.2. NMT Analytical Hierarchy Process – policy makers survey 114
CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS 118
6.1. Introduction 118
6.2. Evaluation of NMT networks 118
6.3. NMT infrastructure audits 119
6.3.1. Tsumeb 119
6.3.2. Walvis Bay 120
6.4. NMT user safety and perceptions 121
6.4.1. Tsumeb 121
6.4.2. Walvis Bay 122
6.5. NMT planning and provision 122
6.6. NMT proposed strategy 123
6.7. Recommendations for further research 124
REFERENCES 126
APPENDICES 130
A. Ethical clearance certificate 130
B. NMT volume counts 131

C. NMT infrastructure audit 132
D. NMT user interviews – survey 145
D.1. Survey questions (Questionnaire) 145
D.2. Survey responses 146
D.2.1. Tsumeb 146
D.2.2. Walvis Bay 149
E. NMT policy maker interviews – survey 152
E.1. AHP survey 152
E.2. AHP results 155

List of Figures

Figure 2.1: Existing NMT network in Windhoek, adopted from (MWT *et al*., 2013) 12
Figure 2.2: Pedestrian attempting to cross a double-left turn slip lane, adopted from (ITS and BP consulting engineers, 2018) 13
Figure 2.3: Vehicles on sidewalks, adopted from (ITS and BP consulting engineers, 2018) 13
Figure 2.4: The four northern central regions of Namibia, adopted from (MWT and GIZ GmbH, 2017) 17
Figure 2.5: Pedestrian ramp details, adopted from (SANRAL and ITS, 2017) 29
Figure 2.6: Pedestrian and cyclist audible and vibro-tactile traffic signal, adopted from (SANRAL and ITS, 2017) 30
Figure 2.7: Level median crossing, adopted from (SANRAL and ITS, 2017) 31
Figure 2.8: Study area (Pabna Municipality), adopted from (Fahim *et al*., 2022) 39
Figure 2.9: Upgrade of NMT facilities on Brand Street, adopted from (Mokitimi and Vanderschuren, 2017) 45
Figure 2.10: Upgrade of pedestrian crossing at a school in Thaba Nchu, adopted from (Mokitimi and Vanderschuren, 2017) 46
Figure 2.11: Upgrade of pedestrian access roads and walkways, adopted from (Mokitimi and Vanderschuren, 2017) 46
Figure 3.1: Stepwise process of stratified random sampling 53
Figure 3.2: Research approach 55
Figure 3.3: Towns with population greater than 15,000, adopted from (NSA, 2024) 56
Figure 3.4: Top 10 Namibian towns by frequency of NMT crashes, adopted from NRSC 56
Figure 3.5: Stakeholder influence vs interest matrix 59
Figure 3.6: Data collection process 60
Figure 4.1: Study towns 66
Figure 4.2: Study locations in Tsumeb 67
Figure 4.3: Assessed routes (streets) in Tsumeb 68
Figure 4.4: Study locations in Walvis Bay 69
Figure 4.5: Assessed routes (streets) at the CBD – Location 1 69
Figure 4.6: Assessed routes (streets) at the informal settlements – Location 2 70
Figure 4.7: Assessed routes (streets) at Naraville – Location 3 70

Figure 5.1: Availability of NMT infrastructure in Tsumeb 72
Figure 5.2: Availability of NMT infrastructure in Walvis Bay 73
Figure 5.3: Level of pedestrian and cyclist activities in Tsumeb 74
Figure 5.4: Level of pedestrian and cyclist activities in Walvis Bay 75
Figure 5.5: Lack of dropped kerbs 76
Figure 5.6: Inappropriate vehicle access on land use 76
Figure 5.7: Obstructions (poles) along sidewalks 76
Figure 5.8: (a) Poor visibility of road markings at intersections; (b) Drivers ignoring pedestrians waiting to cross the road 79
Figure 5.9: (a) Pedestrians sharing the sidewalk with cyclists; (b) Lack of crossing facilities along pedestrian desired crossing lines 79
Figure 5.10: (a) Poor NMT infrastructure conditions; (b) Unpaved sidewalks 80
Figure 5.11: (a) Sidewalk obstructed by existing infrastructure; (b) Street vendors along sidewalks 80
Figure 5.12: (a) Accessibility issues caused by drainage on the sidewalk; (b) Cyclist using vehicle routed due to poor accessibility on the sidewalk 81
Figure 5.13: (a) Pedestrians and cyclists sharing sidewalk; (b) Gap between crosswalk and sidewalk at crossing point 81
Figure 5.14: (a) Pedestrians underutilising existing sidewalk; (b) Lack of crosswalk or pedestrian marking at midsection 82
Figure 5.15: (a) Fragmented NMT infrastructure – Ilse Schatz Street; (b) Poor NMT conditions – Ilse Schatz Street 83
Figure 5.16: (a) Non-functional pushbuttons – Ilse Schatz Street; (b) Poor visibility of crosswalk marking – Ilse Schatz Street 83
Figure 5.17: (a) Pedestrian and cyclist sharing a sidewalk – Ilse Schatz Street; (b) Lack of NMT infrastructure (sidewalks) on 1st Avenue Road.............. 84
Figure 5.18: Absence of lowered kerbs at intersections 85
Figure 5.19: (a) Poor crosswalk visibility; (b) Lack of crosswalks on pedestrian-desired crossing lines; (c) Drivers failing to yield at pedestrian crosswalks 87
Figure 5.20: (a) Obstructions on sidewalk; (b) Poles installed after crosswalk......... 87
Figure 5.21: (a) Poor NMT infrastructure conditions; (b) Poor crosswalk visibility. 88
Figure 5.22: (a) Obstructions on NMT pathway; (b) Poor NMT infrastructure; (c) Poor crosswalk visibility 88

Figure 5.23: Poor NMT infrastructure along Hage Geingob Street 89
Figure 5.24: (a) Obstructions on NMT pathways – Agaat Street; (b) Street vendors operating on NMT pathways – Nathaniel Maxuilili Avenue 90
Figure 5.25: (a) Disabled person sharing roadway with vehicles – Agaat Street; (b) Pedestrians sharing roadway with vehicles – Nathaniel Maxuilili Avenue.. 91
Figure 5.26: (a) Lack of lowered kerbs – Agaat Street; (b) Lack of lowered kerbs – Nathaniel Maxuilili Avenue 91
Figure 5.27: (a) Drivers ignoring traffic signals at pedestrian crossings; (b) Poor crosswalk visibility 93
Figure 5.28: (a) Non-functional pedestrian pushbuttons; (b) Poorly designed crossing (access) facility... 93
Figure 5.29: (a) Fragmented NMT facility; (b) Poor NMT infrastructure conditions94
Figure 5.30: Poor maintenance of NMT facilities 95
Figure 5.31: Poor crosswalk visibility 96
Figure 5.32: (a) Gaps at crossing point – Sam Nujoma Avenue; (b) Absence of lowered kerbs – Sam Nujoma Avenue 97
Figure 5.33: (a) Fragmented NMT facilities – Namib Street; (b) Poor accessibility on NMT facilities – Namib Street 97
Figure 5.34: (a) Obstructions on NMT facilities – Namib Street; (b) Absence of lowered kerbs – Caesar Martin Street 97
Figure 5.35: Users understanding of NMT in Tsumeb... 98
Figure 5.36: Users understanding of NMT in Walvis Bay.. 99
Figure 5.37: Users view of NMT infrastructure conditions in Tsumeb 100
Figure 5.38: Users view of NMT infrastructure conditions in Walvis Bay 101
Figure 5.39: Users' responses on NMT dominant spaces in Tsumeb 102
Figure 5.40: Users' responses on NMT dominant spaces in Walvis Bay................. 103
Figure 5.41: Users' view on the role of NMT in Tsumeb 104
Figure 5.42: Users' view on the role of NMT in Walvis Bay 105
Figure 5.43: NMT challenges in Tsumeb.. 106
Figure 5.44: NMT challenges in Walvis Bay 107
Figure 5.45: Measures to address NMT challenges from Tsumeb Town Council ... 108
Figure 5.46: Measures to address NMT challenges from Walvis Bay Town Council109
Figure 5.47: Importance of NMT provision in Tsumeb 110

Figure 5.48: Importance of NMT provision in Walvis Bay 110
Figure 5.49: Participants perspectives on benefits of NMT in Tsumeb 111
Figure 5.50: Participants perspectives on benefits of NMT in Walvis Bay 112

List of Tables

Table 1.1: Overview of road safety in SSA, adopted from (Jones *et al*., 2020)........... 4

Table 2.1: Regional characteristics and transport issues by area or topic, adapted from (MWT and GIZ GmbH, 2017).. 17

Table 2.2: Project objectives per intervention area, adapted from (MWT and GIZ GmbH, 2017).. 19

Table 2.3: Design criteria for NMT infrastructure, adapted from (SMEC and UCT, 2014)... 20

Table 2.4: South African road classification, adapted from (SMEC and UCT, 2014)21

Table 2.5: Walkway and sidewalk LOS criteria, adapted from (SMEC and UCT, 2014) 22

Table 2.6: LOS criteria for pedestrians and queuing areas, adapted from (SMEC and UCT, 2014)... 22

Table 2.7: Cycle Lane widths, adapted from (SANRAL and ITS, 2017) 24

Table 2.8: Types, applications, and impacts of traffic calming, adapted from (SMEC and UCT, 2014) 26

Table 2.9: Warning sign location, adapted from (SANRAL and ITS, 2017) 28

Table 2.10: Key findings and identified gaps from reviewed literature..................... 47

Table 2.11: Summary of key empirical studies on NMT: primary variables and modelling techniques.. 50

Table 3.1: Criteria for stakeholder engagement 52

Table 3.2: Crash rate per population 57

Table 3.3: Foundational Saaty scale, adapted from (Leal, 2020).............................. 63

Table 5.1: Tsumeb infrastructure assessment results 77

Table 5.2: Walvis Bay infrastructure assessment results at Location 1...................... 85

Table 5.3: Walvis Bay infrastructure assessment results at Location 2...................... 91

Table 5.4: Walvis Bay infrastructure assessment results at Location 3...................... 94

Table 5.5: Potential benefits of NMT in Tsumeb 112

Table 5.6: Potential benefits of NMT in Walvis Bay 113

Table 5.7: AHP Average Weights and Ranking of NMT Indicators in Tsumeb 115

Table 5.8: AHP Average Weights and Ranking of NMT Indicators in Walvis Bay . 116

Table 6.1: Tsumeb NMT proposed roadmap 123

Table 6.2: Walvis Bay NMT proposed roadmap 124

Table B.1: Pedestrian and cyclist volume count in Tsumeb 131
Table B.2: Pedestrian and cyclist volume count in Walvis Bay 131
Table D.1: Responses on users understanding of NMT in Tsumeb 146
Table D.2: Responses on NMT infrastructure conditions in Tsumeb 146
Table D.3: Responses on NMT dominant spaces in Tsumeb 146
Table D.4: Responses on the role of NMT in Tsumeb 147
Table D.5: Responses on NMT challenges in Tsumeb 147
Table D.6: Responses on measures put in place by Tsumeb Town Council to address NMT challenges 148
Table D.7: Responses on importance of NMT in Tsumeb 148
Table D.8: Responses on benefits of NMT in Tsumeb 148
Table D.9: Responses on users understanding of NMT in Walvis Bay 149
Table D.10: Responses on NMT infrastructure conditions in Walvis Bay 149
Table D.11: Responses on NMT dominant spaces in Walvis Bay 149
Table D.12: Responses on the role of NMT in Walvis Bay 150
Table D.13: Responses on NMT challenges in Walvis Bay 150
Table D.14: Responses on measures put in place by Walvis Bay Town Council to address NMT challenges 151
Table D.15: Responses on importance of NMT in Walvis Bay 151
Table D.16: Responses on benefits of NMT in Walvis Bay 151
Table E.1: Numerical scale (Saaty's scale) 152
Table E.2: Crosswalk – Five (5) main intersections and midblock crossing assessment indicators 153
Table E.3: Sidewalk - Five (5) main sidewalk assessment indicators 154
Table E.4: Bikeway (if not shared with sidewalk) – Four (4) main bikeway assessment indicators 155
Table E.5: Tsumeb AHP results 155
Table E.6: Walvis Bay AHP results 157

List of Abbreviations and Acronyms

AHP	Analytical Hierarchy Process
AMK	Ang Mo Kio Town
AU	African Union
BE	Built Environment
CBD	Central Business District
CCTV	Closed-Circuit Television
CGOK	County Government of Kisii
CoW	City of Windhoek
ELECTRE	Elimination and Choice Expressing Reality
FGDs	Focus Group Discussions
GIS	Geographical Information System
GIZ	Deutsche Gesellchaft für Internationale Zusammenarbeit GmbH
iRAP	International Road Assessment Program
ITS	Intelligent Transport Solutions
LA	Local Authorities
LOS	Level of Service
LTA	Land Transport Authority
LTS	Long Term Strategies
MCDA	Multi-Criteria Decision Analysis
MRT	Mass Rapid Transit
MTM	Motorised Transport Modes
MURD	Ministry or Urban and Rural Development
MVA	Motor Vehicle Accident
MWT	Ministry of Works and Transport
NDCs	National Determined Contributions
NMT	Non-Motorised Transport
NRSC	National Road Safety Council
NSA	Namibia Statistic Agency
PCA	Principal Component Analysis
PIARC	Permanent International Association of Road Congress
PIET	Pedestrians (and cyclists) Infrastructure Evaluation Tool
PMDs	Personal Mobility Devices

PROMETHUS	Preference Ranking Organization Method for Enrichment of Evaluations
PWDs	People With Disabilities
RCs	Regional Councils
RTDs	Road Traffic Deaths
SDGs	Sustainable Development Goals
SPSS	Statistical Package for the Social Sciences
SSA	Sub-Saharan Africa
SUTMP	Sustainable Urban Transport Master Plan
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
TRH	Technical Recommendations for Highway
UN	United Nations
VRU	Vulnerable Road Users
WHO	World Health Organization

Declaration

I, Kevin Sebastien Chomore, hereby declare that this study is my own work and is a true reflection of my research, and that this work – conducted in the Namibian towns of Tsumeb and Walvis Bay – or any part thereof has not been submitted for a degree at any other institution. Wherever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature. No part of this thesis may be reproduced, stored in any retrieval system, or transmitted in any form, or by any means (e.g. electronic, mechanical, photocopying, recording, or otherwise) without the prior permission of the author, or The University of Namibia in that behalf.

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Kevin Chomore................................. Date: October 2025
(Student)

CHAPTER 1: INTRODUCTION

This chapter presents the introduction, the background of the study, and the research problem. Furthermore, study objectives, key research questions, research significance, scope of study and the thesis layout are discussed.

1.1. General introduction

Non-Motorised Transport (NMT) encompasses human-powered modes of mobility such as walking, cycling, rickshaws, skating, shopping trolleys, and manual wheelchairs (Das, 2016; Zhou *et al.*, 2020; Fahim *et al.*, 2022; Okoro and Lawani, 2022; Omollo, 2022), as well as other modes not reliant on battery or fuel combustion technologies (Fahim *et al.*, 2022). Animal-drawn carts are commonly considered part of NMT, especially in small- and medium-sized towns which exhibit rural characteristics (Fahim *et al.*, 2022). Nevertheless, non-motorised transportation within urban areas primarily consists of walking and cycling (Das, 2016). In urban areas, walking and cycling are the most dominant modes of transport, accounting for up to 40-60 % of trips in cities across Japan, Germany, and the Netherlands, and nearly two-thirds in major African cities such as Kinshasa in the Democratic Republic of Congo and Dar es Salaam in Tanzania (Okoro and Lawani, 2022).

NMT is a viable and sustainable mode of transportation for both developing and developed countries. It is critical for sustainable urban development due to its affordability, health benefits, and minimal environmental impacts. It reduces traffic congestion, enhances energy efficiency, and improves access to essential services (Zhou *et al.*, 2020; Omollo, 2022). However, despite the widespread reliance on NMT in many urban areas across Africa and its well-associated benefits, these travel modes continue to face substantial challenges, which are discussed in the subsequent subsections. In response the challenges associated with NMT emphasise the need for the provision of NMT facilities by reporting that improving these facilities is anticipated to decrease fatalities and injuries while increasing the number of NMT trips.

1.2. Background of study

Various challenges diminish the attractiveness of using Non-Motorised Transport (NMT) options in developing countries, with inadequate NMT infrastructure being a primary issue which renders NMT trips inefficient and poses safety risks (Das, 2016; Fahim *et al.*, 2022). Walking, cycling, and public transport are the only viable mobility options for many people in developing countries; however, with deteriorating or insufficient facilities, these low-carbon modes are becoming increasingly unsafe (Basil and Nyachieo, 2023). According to the global status report on road safety by the World Health Organization (2018), about 1.3 million people die annually from road traffic crashes. Basil and Nyachieo (2023) note that previous and current reports, along with various studies, reveal that vulnerable road users, including as pedestrians and cyclists, account for up to 46 % of global traffic fatalities due to Road Traffic Deaths (RTDs). The authors further report that sustainable active transport often lacks adequate budgeting with most resources being allocated towards motorised transport instead of NMT. Consequently, the limited prioritisation in active travel modes has contributed to high injury and fatality rates, particularly among pedestrians. The authors further report that the growing demand for mobility, due to rapid urbanisation, will largely be addressed by NMT which is the most affordable option for many people.

In small- and medium-sized towns, infrastructure for pedestrians and cyclists is often lacking or entirely absent, with many roads failing to provide convenient pedestrian facilities. Where footpaths do exist, they are frequently obstructed by private developers or misused for incompatible purposes such as street vending, waste disposal, and vehicle parking, creating serious accessibility issues and land-use conflicts (Omollo, 2022). This is also a common feature of Namibian small- and medium-sized towns including Tsumeb and Walvis Bay. Although paved roads have been shown to reduce pedestrian fatalities, many roads in small and medium-sized towns only provide gravel shoulders, offering minimal protection (Mitullah and Opiyo, 2016). Furthermore, many urban areas worldwide – particularly small and medium-sized towns – tend to prioritize motorisation in their transport planning, often neglecting non-motorised travel modes (Alando, 2017). This insufficient planning and provision have forced NMT users to share road spaces with motorised vehicles, increasing the risks of accidents and compromising the safety of pedestrians and cyclists (Mitullah and Opiyo, 2016; Muigai *et al*., 2021). A paradigm shift is, thus, needed to provide safer environments for NMT users to reduce the number of crashes involving cyclists and pedestrians and to encourage more walkability in our cities and towns (Muigai *et al*., 2021).

Pedestrians and cyclists remain among the most vulnerable road users, largely due to the persistent lack of dedicated NMT facilities, such as sidewalks and bike lanes (Muigai *et al*., 2021). This vulnerability is intensified in small- and medium-sized African towns, including Tsumeb and Walvis Bay in Namibia, where weak traffic management policies and limited institutional support for NMT is evident. Government investments and planning efforts often fail to prioritise or incentivise NMT, reflecting a broader neglect in policy and funding frameworks (Mokitimi and Vanderschuren, 2017). One approach to addressing the challenges faced by NMT users is to establish an NMT infrastructure system that ensures safe, convenient, and comfortable pathways (Fahim *et al.*, 2022). As the quality and quantity of NMT facilities improve, the levels of service for NMT users will also enhance, simultaneously reducing safety concerns associated with NMT (Zhou *et al.*, 2020). Despite the critical roles that NMT plays in urban mobility, small and medium-sized towns in Namibia still exhibit significant gaps in NMT infrastructure and planning – reflecting the persistent challenges highlighted above. Limited studies addressing the unique challenges of small- and medium-sized towns constrains the development of successful policies. This study seeks to address these gaps by reviewing the existing conditions of NMT in selected small and medium-sized towns in Namibia, evaluating policy frameworks, and proposing strategies to improve NMT infrastructure and user safety.

1.3. Problem statement

Urban areas across Africa continue to face critical shortcomings in Non-Motorised Transport (NMT) infrastructure and policy integration. Although NMT remains a dominant and cost-effective mode of travel, it is frequently excluded from urban development and planning frameworks (Mitullah and Opiyo, 2016). This neglect is reflected in the absence of essential infrastructure – such as overpasses and shoulders – in many construction and road upgrading projects increasing crash risks, travel times, and in some cases, rendering NMT routes unusable (Mitullah and Opiyo, 2016). Fahim *et al*. (2022) highlights that despite the role of NMT in improving urban mobility and socioeconomic conditions, it is often marginalised in the development of city and municipal street networks. The result is a growing reliance on motorised transport, accompanied by worsening air pollution, traffic congestion, and urban noise.

Transportation in many urban areas worldwide, particularly small- and medium-sized towns, including Tsumeb and Walvis Bay in Namibia, tend to prioritise motorisation, often at the expense of non-motorised travel modes. This imbalance is evident in land use and transportation policies, skewed road development, and biased traffic rules, all favouring motorised transport (Alando, 2017). Consequently, NMT users face significant disadvantages due to this biased planning, intensified by the lower social status assigned to non-motorised modes in urban areas, further marginalising NMT users (Alando, 2017). This marginalisation of NMT stems from a secondary consideration given to these modes of transport by policy makers and bureaucrats, leading to a lack of relevant policies, planning, and infrastructure provision in most urban areas (Mitullah and Opiyo, 2016). However, rebalancing these priorities could alleviate several urban challenges, such as poor air quality, congestion, and noise, by promoting cleaner and more inclusive transport systems. Fahim *et al*. (2022) argue that integrating continuous and accessible walkway networks into urban circulation systems can improve mobility and support more equitable city planning. Achieving this shift requires a fundamental transformation in transportation planning paradigms towards greater inclusivity and sustainability (Alando, 2017).

The setbacks in NMT infrastructure and policy are intensified by alarming road safety statistics in Namibia. According to the World Health Organization (2018), Namibia has an annual road traffic death rate of 30.4 per 100,000 persons due to crashes (see Table 1.1); making it one of the most dangerous countries in Sub-

Saharan Africa (SSA) in terms of traffic safety. The death rate in Namibia exceeds both the African and global averages. Studies by the World Health Organization (2018) reveal that the average road traffic death rate in Africa is 26.6 per 100,000 population, while the global average is 18.2 per 100,000 population. Furthermore, the variation in death rates across different regions and countries is related to the types of road users most affected. Globally, pedestrians and cyclists account for 26 % of all fatalities, while Africa has the highest proportion of pedestrian and cyclist deaths, at 44 % of total fatalities (World Health Organization, 2018). According to the 2016 Road Crash and Claim Report from the Motor Vehicle Accident (MVA) Fund in Namibia, pedestrian crashes are among the most common types, representing 23 % of all traffic deaths (MWT and GIZ GmbH, 2017). The NMT death rates in Namibia are roughly in line with the global average and about half of the rates in Africa. Jones et al. (2020) notes that this situation is further intensified by a concerning trend of increasing road deaths over the past five years, with Namibia being one of the 17 nations in SSA experiencing such an upward trajectory – as shown in Table 1.1. An overview of road safety across SSA based on the latest WHO data is provided in Table 1.1, highlighting that Namibia has a higher road death rate per 100,000 population than all but eight of the listed countries, which are shaded in grey, and shows an increasing trend in road deaths over a five-year period.

Table 1.1: Overview of road safety in SSA, adopted from (Jones *et al*., 2020)

Country	Road deaths per 100 000 pop.	% road deaths in cars and light duty vehicles (drivers/passengers)	Direction of 5-year trend in road deaths
Angola	23.6	27/33	Decreasing
Benin	27.5	8/9	Flat
Botswana	23.8	23/40	Increasing
Burkina Faso	30.5	No Data	Decreasing
Burundi	34.7	No Data	Decreasing
Cameroon	30.1	No Data	Increasing
Central African Republic	33.6	No Data	No Data
Chad	27.6	No Data	Flat
Comoros	26.5	13/52	Increasing
Congo	27.4	No Data	No Data
Côte d'Ivoire	23.6	4/7	Increasing
DRC	33.7	1/35	Increasing
Equatorial Guinea	24.6	No Data	No Data
Eritrea	25.3	10/26	Decreasing
Eswatini	26.9	24/30	Decreasing
Ethiopia	26.7	No Data	Increasing
Gabon	23.2	No Data	Decreasing
Gambia	29.7	No Data	Increasing
Ghana	24.9	5/7	Decreasing
Guinea	28.2	No Data	Increasing
Guinea-Bissau	31.1	No Data	Increasing
Kenya	27.8	12/25	Decreasing
Lesotho	28.9	No Data	Increasing
Liberia	35.9	No Data	No Data
Madagascar	28.6	No Data	Increasing
Malawi	31.0	6/25	Flat
Mali	23.1	16/12	Decreasing
Mauritania	24.7	No Data	Decreasing
Mauritius	13.7	9/8	Flat
Mozambique	30.1	No Data	Decreasing
Namibia	*30.4*	*No Data*	*Increasing*
Niger	26.2	No Data	Increasing
Nigeria	21.4	No Data	Decreasing
Rwanda	29.7	No Data	No Data
Sao Tome and Principe	27.5	No Data	Decreasing
Seychelles	15.9	20/27	Increasing
Senegal	23.4	No Data	Decreasing
Sierra Leone	No Data	No Data	No Data
Somalia	27.1	No Data	Increasing
South Africa	25.9	21/24	Decreasing
South Sudan	29.9	No Data	Decreasing
Sudan	25.7	No Data	Decreasing
Togo	29.2	No Data	Decreasing
Uganda	29.0	5/17	Increasing
Tanzania	29.2	8/30	Decreasing
Zambia	No Data	No Data	No Data
Zimbabwe	34.7	12/14	Increasing

Beyond the human tragedy associated with these fatalities and injuries, crashes also impose an economic burden on Namibia, leading to loss of productivity and elevated insurance costs (Jones *et al*., 2020). These distressing statistics underscore the urgent need for effective policies and infrastructure improvements to enhance road safety, particularly for NMT users in small and medium-sized towns in Namibia, who are vulnerable to the risks posed by motorised vehicles.

1.4. Research objectives

The primary objective of this study was to investigate the current state of NMT provision, challenges, and opportunities in the towns of Tsumeb and Walvis Bay.

The specific objectives of this study were:

i. To evaluate the extent of NMT networks in the selected towns.
ii. To examine NMT infrastructure conditions in the selected towns.
iii. To evaluate NMT user safety and perceptions in the selected towns.
iv. To evaluate NMT planning (policies, frameworks, and strategies).
v. To evaluate the capacity for the provision of NMT infrastructure and planning (human resource and financial).
vi. To develop phased strategies for NMT in the selected towns.

1.5. Key research questions

The study aims to address the following key questions:

i. How extensive is the current NMT network in the Namibian small- and medium-sized towns that were selected? Are there any developments in towns that already have NMT strategies?

ii. What is the current state of NMT infrastructure in the selected towns of Namibia? How do existing NMT facilities within the selected towns adhere to safety and planning guidelines or standards?

iii. What is the current safety status and user perception of the existing NMT facilities in the selected towns of Namibia? If safety levels are found to be inadequate, what potential consequences can be identified in the study area resulting from insufficient NMT infrastructure and facilities?

iv. Are there existing policies and interventions regarding NMT access and mobility in the selected towns? If so, to what extent have they influenced the establishment of safe and accessible NMT facilities in these areas since their inception?

v. How well-equipped are Namibian small- and medium-sized towns in providing NMT infrastructure, considering the required expertise and financial resources?

vi. Are there strategies in place to address challenges related to NMT in Namibian small- and medium-sized towns?

1.6. Research significance

This study will:

i. Encourage inclusiveness in urban environments by providing strategies for designing NMT infrastructure effectively, which supports the Sustainable Development Goal (SDG) 10 (related to reduced inequalities – "Reduce inequality within and among countries"), and SDG 9 (related to industry, innovation, and infrastructure – "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation").

ii. Achieve the following African Union (AU) aspirations (Goals): Aspiration 1, "A prosperous Africa based on inclusive growth and sustainable development", by promoting non-motorised transport (NMT) which minimises carbon footprint and promotes environmentally friendly transport options; and Aspiration 2, "An integrated continent, politically united, based on the ideas of Pan-Africanisms and the vision of Africa's Renaissance", with a focus on infrastructure connectivity which includes pedestrian and cyclist networks as part of sustainable urban planning (African Union, 2015).

iii. The study on NMT will benefit the climate actions of Namibia as part of its National Determined Contributions (NDCs) and Long-Term Strategies (LTSs) under the Paris Agreement by promoting reduced carbon emissions, increasing resilience, and creating an integrated, inclusive approach to sustainable development.

In addition to these, the study will contribute to knowledge in the following ways:

i. Generate information on NMT infrastructure gaps in Namibian towns, highlighting areas where improvements are required to enhance safety and usability for pedestrians and cyclists.

ii. Provide insights into the effectiveness of current NMT policies and interventions, evaluating their implementation and impact on enhancing NMT infrastructure and user safety.

iii. Provide insights on the challenges of incorporating NMT into urban planning and development and critically evaluate how existing planning practices impact NMT infrastructure and user experience.

iv. Generate information to guide the development of strategies and interventions that will address the identified infrastructure and policy gaps, aiming to improve the overall quality and safety of NMT facilities in the selected towns.

v. The study will employ an integrated approach, collecting data from NMT users, policy makers, and assessments of NMT infrastructure. Few studies have utilised this method involving data collection from all three perspectives, resulting in a lack of comprehensive insights in most research related to NMT.

1.7. Scope of study

The study was primarily focused on two small- and medium-sized towns in Namibia, which typically have a population representing a quarter of that in the major city (NSA, 2024).

This study was delimited to towns:

i. That are smaller than the capital city (population) with an urban-rural character.
ii. That have a population of 15,000 to 125,000 inhabitants.
iii. That were identified as a significant risk of pedestrian and cyclist injuries based on the frequency of NMT crashes.
iv. With mobility patterns typical of small- and medium-sized towns (at least 70 % of trips by NMT).

1.8. Thesis layout

This thesis consists of six chapters, a reference list and an appendix. Below is an overview of the content covered in each chapter:

i. Chapter 1 provides a general introduction and background of the study. The problem statement, research objectives, key research questions, research significance, as well as the scope of study are discussed in this chapter.

ii. Chapter 2 provides a comprehensive review of existing literature relevant to the study and the research questions, establishing a theoretical foundation to support the objectives of the study. It covers the state of Non-Motorised Transport (NMT) in Africa and Namibia, including the NMT policy environment in Namibia, NMT infrastructure and design, as well as safety and risk factors. The chapter also examines benefits of NMT, mode choice and behaviour, and includes case studies of NMT policies and interventions from both global and African perspectives. The chapter ends with a review of gaps in knowledge related to NMT as well as key conclusions from literature studies.

iii. Chapter 3 presents an overview of the study design and explains the rationale behind the adopted methodology. It details the sampling technique; research instruments used for data collection and the procedures for selecting the study towns are discussed. The chapter also discusses data analysis methods and addresses ethical considerations.

iv. Chapter 4 provides information pertaining to the study towns and the locations where NMT infrastructure was assessed in each selected town.

v. Chapter 5 presents the findings of the study and an analysis and discussion of results in comparison to similar studies are discussed.

vi. Chapter 6 presents the conclusions drawn from the study and provides suggestions (recommendations) for future research.

vii. The final section of this thesis consists of a list of references reviewed throughout the study. The appendix contains the infrastructure assessment and stakeholder engagement tools, as well as collected (raw) data.

CHAPTER 2: LITERATURE REVIEW

This chapter provides a critical review of existing literature relevant to the study and its research questions. The state of NMT in Africa and Namibia, infrastructure and design of NMT facilities, safety and risk factors, benefits of NMT, mode choice and behaviour are discussed. Case studies on the effectiveness and challenges of NMT policies and interventions from both global and African perspectives are discussed in this chapter.

2.1. Introduction

The sustainability of transportation systems has been a global concern for decades (Okoro and Lawani, 2022). Promoting active travel is considered a key element in moving towards sustainable urban mobility (Lartey and Glaser, 2024). The purpose of the literature review is to evaluate existing research on Non-Motorised Transport (NMT) from global, African, and Namibian perspectives. It also seeks to identify gaps in the current literature that the study aims to address, thereby providing a foundation for the study and highlighting its contribution to filling these gaps.

2.2. Current state of NMT in Africa

Urban towns across Africa consistently report that Non-Motorised Transport (NMT), especially walking, is the predominant mode of transport. However, a critical synthesis of multiple studies reveals that this dominance is frequently influenced by need rather than choice, exposing systemic disparities and underinvestment in alternative transportation systems. Although global walking rates are on the decline, walking continues to be the most common transportation mode in Africa, either in combination with other modes of transport, such as public transport, or as the primary mode of travel (Benton *et al.*, 2023). Vanderschuren *et al*. (2022) report that pedestrians account for 33 % to 90 % of all trips in urban areas across Africa. Cinderby *et al*. (2024) further report that in African cities, walking makes up more than 75 % of daily trips for the poor, with individuals walking an average of 55 minutes a day. However, the infrastructure supporting these active travel demands is inadequate, contributing to pedestrians making up 33 % of all African road fatalities (Cinderby *et al.*, 2024). In a study conducted by Lartey and Glaser (2024), the authors argue that urban planning networks in the African region, particularly small- and medium-sized towns, prioritise constructing highways and promoting car-centric cities, neglecting the integration of other transportation modes. The authors further highlight that limited access to motorised transportation and financial constraints in Africa have been popularised.

Research indicates that walking conditions in African cities are often dangerous and unreliable, largely due to urban designs that favour automobiles (Oviedo *et al.*, 2021). This reflects a broader trend of marginalisation of vulnerable transport users in planning processes, which mobility justice theory refers to as systemic transport inequality. A study by UNEP and UNHSP (2022) found that 95 % of roads in Africa assessed using the International Road Assessment Program (iRAP) 5-star rating do not meet acceptable standards for pedestrian service, while 93 % fall short of acceptable standards for cyclists. According to Lartey and Glaser (2024), most roads are substandard, lacking safe crossings, bike lanes and experience high vehicle speeds. Mitullah and Opiyo (2016) further report that infrastructure for cyclists and pedestrians is usually lacking in rural areas of Africa. A similar conclusion was made in a study by UNEP and UNHSP (2022), reporting that most roads in Africa are rated 1-star, indicating a lack of cycle paths, unsafe crossings, and high vehicle speeds. Additionally, planning and policies in South African and Zambian cities have long neglected the needs of vulnerable NMT groups, resulting in a lack of investment and inadequate infrastructure (Cooke *et al.*, 2022). According to Cooke *et al.* (2022), the NMT environment in Cape Town has been criticised for its low service quality, particularly in lower-income neighbourhoods, due to inadequate infrastructure planning, lack of integrated design strategies, and challenges with public space operation. The authors also note that in Lusaka, despite the socio-economic importance of NMT in linking formal and informal settlements, many streets lack basic infrastructure such as paved walkways, cycle paths, and bus shelters, making walking unsafe and unattractive for communities. The authors further report that multiple United Nations (UN) agencies and external partners are collaborating to support these countries and other Sub-Saharan African countries in redesigning their transport infrastructure systems to be more inclusive of vulnerable NMT users. Existing literature indicates that improving NMT infrastructure is essential for promoting the health benefits of NMT modes such as walking (Oviedo *et al.*, 2021). The literature also emphasises the urgent need to incorporate NMT into urban planning in urban areas across Africa. It is, therefore, crucial to determine the travel needs of the most vulnerable groups – including children, women, the elderly, and those with disabilities – and to pay attention to their everyday experiences when utilising NMT to improve their transportation experiences (Vanderschuren *et al.*, 2022). When considering how to improve these modes of transportation, for instance, security for NMT users is crucial, particularly for the most vulnerable (Vanderschuren *et al.*, 2022).

2.3. Current state of NMT in Namibia

Over the past decade, there has been minimal focus on developing interconnected pedestrian and cyclist facilities as alternatives to car or bus transportation in Namibian towns, including the capital city, Windhoek. This pattern is paralleled in other African contexts and is indicative of a continuing urban planning paradigm that prioritises car-centric models above non-motorised transport (NMT). As a result, towns across Namibia, including Tsumeb and Walvis Bay, currently have a significant lack of walkways and cycling routes (ITS *et al.*, 2013). Research on the status of NMT infrastructure in Namibian towns is scarce, suggesting a critical gap in the literature and establishing the need for locally grounded studies that go beyond descriptive accounts to assess the socio-spatial consequences of NMT under-provision. Information pertaining to NMT infrastructure and the policy environment in Namibian towns, as well as the City of Windhoek, is presented in the subsequent subsections.

2.3.1. NMT infrastructure in Namibia

Despite the lack of NMT infrastructure in Namibian towns, notable exceptions include areas in the capital city such as the Hosea Kutako Drive, Mandume Ndemufayo Avenue, various blocks in the Inner City, and Independence Road which have some existing infrastructure for NMT users (MWT *et al*., 2013). Figure 2.1 illustrates the extent of the existing fragmented NMT network in the City of Windhoek. From Figure 2.1, it is evident that the limited routes available do not adequately offer safe and interconnected NMT infrastructure, despite the road reserve being sufficient to accommodate such facilities (MWT *et al*., 2013). The MWT *et al*. (2013) suggest that the lack of continuous paved walkways and cycling paths forces pedestrians and cyclists to share the roads with vehicles. The issue of shared road spaces observed in the city of Windhoek reflects a broader global challenge, as noted in the study by Alando (2017). The MWT *et al*. (2013) further report that exposure to vehicle drivers, who may overlook or even endanger them, results in numerous fatal accidents and serious injuries. Moreover, MWT *et al*. (2013) note that NMT users in Windhoek often rely on the extensive riverbed network for walking and cycling, as an alternative to using roads. The authors argue that these riverbed paths are unpaved and pose crime risks. The authors, however, note that plans exist to enhance the connectivity of these riverbed paths and integrate them with formal walkways, as well as with key origins and destinations. Lastly, it is highlighted that the existing plans aim to develop the riverbed network into a central component of the NMT network and create appealing urban spaces in Windhoek.

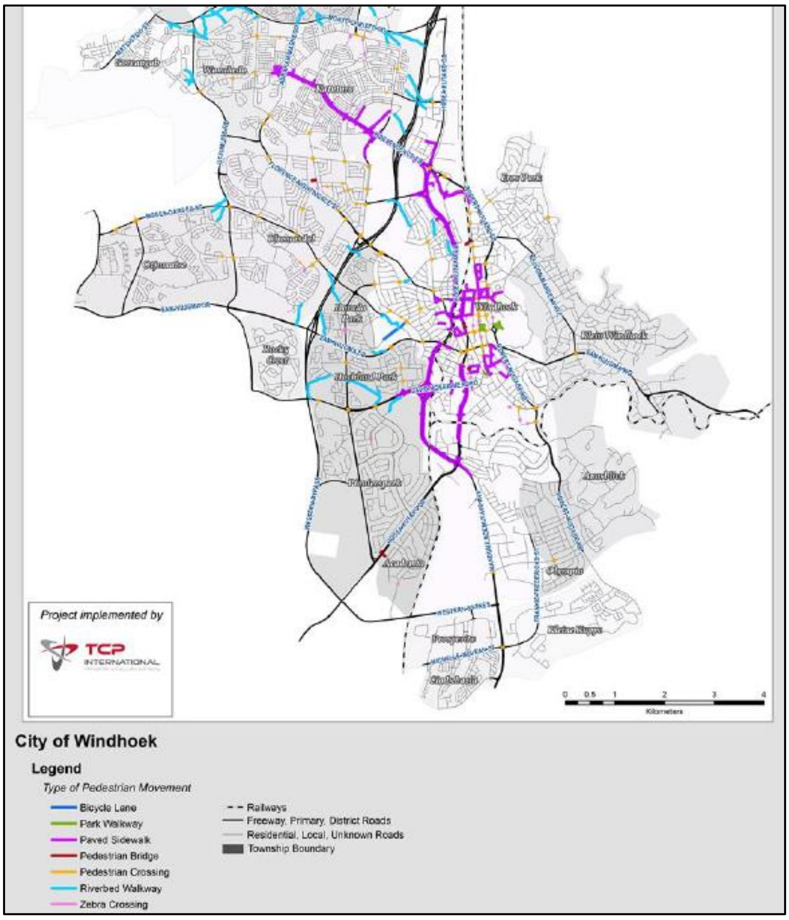


Figure 2.1: Existing NMT network in Windhoek, adopted from (MWT *et al*., 2013)

According to the MWT *et al*. (2013), unlike pedestrians, who lack representation despite their significant modal share in the transportation system in Windhoek, the leisure and sport cyclist community is well organised:

i. Major cyclist events are often held and sponsored by leading Namibian private companies and banks.
ii. Numerous private and non-governmental initiatives aim to promote cycling for recreational use, commuting, and even freight transportation.

The City of Windhoek has an extensive road network of 969 km. According to ITS and BP consulting engineers (2018), while many higher-order roads are paved, the lower-order roads in northwestern residential areas are primarily gravel. The authors report that gravel sidewalks are common throughout the city, significantly outnumbering paved sections. The authors further report that pedestrian facilities are limited, with only 6 % of the road network featuring paved sidewalks. Most roads, according to the authors, have some form of gravel sidewalk or shoulder, but these are often poorly maintained and not continuous. This lack of continuity is evident at intersections, where barriers exist due to the absence of dropped kerbs and pedestrian crossing lines at left turn slip lanes (ITS and BP consulting engineers, 2018). The existing operation of the road presents many challenges for pedestrians and cyclists.

According to ITS and BP consulting engineers (2018), dual-carriageway roads are extremely wide with at least two lanes per direction, which makes it difficult for NMT users to cross along these paths. The authors report that shoulder widths are typically narrow, or non-existent, and there are also some gravel shoulders. Furthermore, the authors note that left-turn slip lanes are a typical feature at most signalised intersections, making NMT crossings unsafe due to conflicts with left-turning vehicles (see Figure 2.2). Thus, accessibility to various employment, educational, healthcare, and recreational opportunities via NMT is considered a crucial aspect addressed in the formulation of future NMT routes MWT *et al*. (2013).

Figure 2.2: Pedestrian attempting to cross a double-left turn slip lane, adopted from (ITS and BP consulting engineers, 2018)

While higher-order roads are intended to facilitate mobility, ITS and BP consulting engineers (2018) note that lower-order streets tend to prioritise vehicular needs as well. NMT considerations are generally lacking across the entire street network, with a significant issue being the common practice of using sidewalks for parking – as seen in Figure 2.3.

Figure 2.3: Vehicles on sidewalks, adopted from (ITS and BP consulting engineers, 2018)

The road networks indicate that pedestrian needs are not prioritised in design and planning, resulting in an inhospitable environment. According to ITS and BP consulting engineers (2018), the inadequate connectivity and varying quality of NMT create considerable infrastructure gaps across Windhoek. The authors recommend the following strategies to make the roads in the city of Windhoek safer and more appealing for NMT users:

i. Enhance road signs and markings in pedestrian hazard zones.
ii. Establish an NMT network for pedestrians and cyclists.
iii. Clear obstructions from sidewalks.
iv. Install bicycle parking facilities.
v. Transform streets and public spaces into multifunctional urban areas.
vi. Upgrade infrastructure in informal settlements.
vii. Prioritise universal accessibility in key areas.
viii. Ensure ongoing maintenance of NMT infrastructure.

2.3.2. NMT policy environment in Namibia

The subsequent subsections present information pertaining to the policy environment of non-motorised transport (NMT) in Namibian towns, including the City of Windhoek.

2.3.2.1. Sustainable urban transport masterplan for the City of Windhoek

On July 18, 2012, the City of Windhoek (CoW), in collaboration with the Ministry of Works and Transport (MWT) and other stakeholders, initiated the development of a Sustainable Urban Transport Master Plan (SUTMP) for the city (MWT *et al*., 2013). The master plan is designed to ensure an efficient, affordable, equitable, safe and convenient public and non-motorised transport (NMT) system for residents of the city and its surroundings (MWT *et al*., 2013). According to MWT *et al*. (2013), the following factors were considered when developing a suggested NMT network in Windhoek:

i. Likely origins and destinations for pedestrians and cyclists based on current and proposed land uses.
ii. Analysis of aerial maps to identify naturalised walking paths, such as faded patches of grass or worn pavement, and available open spaces.
iii. Modal splits, along with economic and demographic statistics.
iv. Existing gaps in the current NMT infrastructure.
v. Available crash information.
vi. Characteristics of sites and road users.

According to MWT *et al*. (2013), the levels of NMT facilities to be provided were influenced by the following factors:

i. Road classification, including traffic volume and speed, directly affected the potential severity of collisions between vehicles and NMT users, as well as the comfort of NMT infrastructure usage.
ii. Higher traffic volumes and speeds required more space between pedestrians and cyclists.
iii. NMT route classification further determined the path hierarchy and its importance in the overall network, with different priorities assigned for principal or link networks.
iv. The expected type, age, and vulnerability of NMT users, such as facilities around primary schools or tertiary institutions, also play a crucial role.

The successful implementation of NMT networks requires consideration of user preferences and attitude changes towards NMT, as reiterated in soft systems theory and behavioural transport frameworks, which stress the interplay of infrastructure and perception in influencing mobility decisions (Van Rooyen and Labuschagne, 2016; Timmons *et al.*, 2024). While the benefits of NMT are well-recognised, MWT *et al*. (2013) highlight that the increase in car dependency remains a challenge. The authors distinguish factors affecting NMT usage into hard measures (infrastructure) and soft measures (information, communication, and marketing). The authors also note that soft measures are often seen as more influential in developed countries, whereas in developing countries, hard measures may be lacking or absent and require implementation. This implies a contrast in implementation dynamics that need contextual adaptation in Sub-Saharan African towns where infrastructural shortfalls persist. Addressing both hard and soft measures simultaneously is essential to changing the cultural attitude that NMT is only for the poor and promoting a more positive perception of NMT (MWT *et al*., 2013).

2.3.2.2. City of Windhoek non-motorised transport strategy

About 20 % of households in Windhoek can afford to own a vehicle. As a result, roads alone are insufficient to provide social sustainability and worsen already existing financial inequalities (ITS and BP consulting engineers, 2018). Low-income households in Windhoek spend up to 25 % of their income on transportation. Hence, the City of Windhoek recognises the need for a new approach that provides sustainable transportation options for all citizens, particularly the poor, children, disabled, and elderly (ITS and BP consulting engineers, 2018).

Planning for the transportation and mobility needs of the society is a top priority for the Namibian government. To that end, the City of Windhoek (CoW), in collaboration with the Ministry of Works and Transport (MWT), the Ministry of Urban and Rural Development (MURD), with support from the Deutsche Gesellchaft für Internationale Zusammenarbeit GmbH (GIZ) developed the Sustainable Urban Transport Master Plan (SUTMP) for the CoW (ITS and BP consulting engineers, 2018). The SUTMP is a comprehensive, long-term strategy plan that gives particular emphasis on the function of NMT and public transportation in the proposed integrated transportation system of 2032. The geographic focus is not limited to the CoW municipal area; it also includes ensuring strong connections to the north and south, respectively, with Okahandja and Rehoboth, and to the east with the Hosea Kutako International Airport, as these connections are important commuting routes (ITS and BP consulting engineers, 2018).

According to ITS and BP consulting engineers (2018), the NMT strategy has the following objectives:

i. Establish a transportation system and road environment that is safe and conducive to cyclists and pedestrians.
ii. Enhance the environment and pedestrian networks in Windhoek.
iii. Select and implement a Windhoek cycle network.
iv. Promote more cycling in Windhoek.

Current road usage prioritises vehicles over pedestrians and other NMT users in the urban street network (ITS and BP consulting engineers, 2018). The SUTMP proposes the following strategies to address these challenges:

i. Establish priority for NMT users at key intersections with high pedestrian traffic.
ii. Increase pedestrian safety on sites where people cross the street.
iii. Gradually restrict on-street parking in high pedestrian movement areas while widening sidewalks.

2.3.2.3. Master plan for sustainable transport for the four northern central regions

The Ministry of Works and Transport (MWT) and the Ministry of Urban and Rural Development (MURD) in Namibia collaborated with the relevant Regional Councils (RCs) and Local Authorities (LAs) to implement a sustainable transport project in the four northern central regions (see Figure 2.4), namely Omusati, Ohangwena, Oshana, and Oshikoto region (MWT and GIZ GmbH, 2017). According to the MWT and GIZ GmbH (2017), the four regions hold significant potential for socioeconomic development, which can be further advanced by improving accessibility, mobility, and connectivity – the central objective of the Sustainable Transport Master Plan.

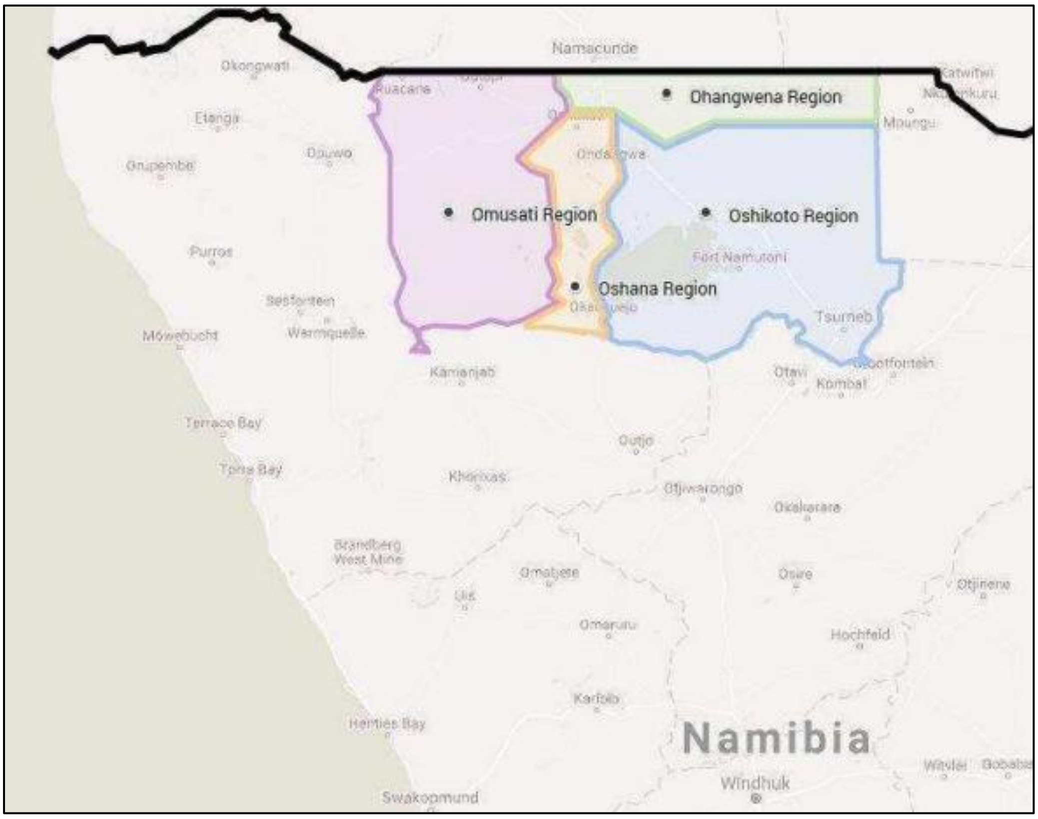


Figure 2.4: The four northern central regions of Namibia, adopted from (MWT and GIZ GmbH, 2017)

An overview of the key issues related to non-motorised transport (NMT) that were identified and addressed in the Master Plan are presented in Table 2.1.

Table 2.1: Regional characteristics and transport issues by area or topic, adapted from (MWT and GIZ GmbH, 2017)

Regional characteristics	Area/topic	NMT issues
Rapid population growth in main settlement	Urban areas	• Insufficient promotion of the role of NMT in facilitating urban mobility • Lack of integrated planning for urban development and transport • Lack of systematic application of best practice solutions in urban transport infrastructure and traffic management
Unplanned urban development in the vicinity of cities and along main transport corridors	Peri-urban areas and inter-city transport	• Insufficient promotion of the role of NMT in facilitating urban mobility

Increasing gap between living standards in remote rural areas and urban areas	Remote areas	• Insufficient promotion of the role of NMT in facilitating urban mobility
Crucial role of transport infrastructure in Namibia's economic development and its role as a regional logistic hub	Travel and transport to and from the regions	• Capacity constraints and safety and environmental problems along main road axes
Awareness of the increasing importance of transport safety, equity and sustainability issues	Cross-cutting issues (road safety, social, environmental)	• Lack of systematic approach in tackling severe road safety issues • Lack of considerations for the transport needs of lower income groups and of people with disabilities and/or special needs
Limited planning and implementation capacity of concerned entities in a decentralised context	Capacity building and training	• Institutional capacity constraints in transport planning and management

According to the MWT and GIZ GmbH (2017), NMT, particularly walking and cycling, has largely been overlooked in the four regions. The authors note that sidewalks are scarce and are typically only found near shopping centres, forcing pedestrians to walk on sandy areas along the road reserves. The authors also note that cycling is extremely limited because utilising the road is too risky, and cycling on sand is inconvenient. The authors, however, report that some residents in remote areas, however, use bicycles for short-distance trips. Lastly, the authors state that there is currently no public organisation that systematically addresses NMT policies.

The development of the Master Plan prioritised cross-cutting issues such as road safety and the environment. Namibia faces severe road safety challenges. According to the 2016 Road Crash and Claim Report from Motor Vehicle Accident (MVA) fund in Namibia, the most common crash types were rollovers (29 %), collisions (27 %), and pedestrian crashes (23 %) (MWT and GIZ GmbH, 2017). The MWT and GIZ GmbH (2017) report that Khomas and Oshana regions are exceptions in this context, as pedestrian-related crashes are the most significant issue. The authors attribute these accidents to the significant importance of pedestrian traffic in these regions. The Namibia National Road Safety Council (NRSC) and the traffic police in these four regions attribute road safety issues to dangerous driving and speeding (MWT and GIZ GmbH, 2017).

The primary focus of the Master Plan is to enhance public transport services and NMT, while implementing strict regulations on the use of private passenger vehicles over the long term (MWT and GIZ GmbH, 2017). Six areas of intervention related to NMT were identified in the Masterplan and are listed in Table 2.2. The Master Plan for the four regions acts as a strategic framework for executing measures and projects that affect travel behaviour and enhances accessibility, mobility and connectivity over the next twenty years. It will also facilitate a transition towards a more sustainable, socially inclusive, and resilient transport system, consistent with the objectives outlined in Table 2.2 (MWT and GIZ GmbH, 2017).

Table 2.2: Project objectives per intervention area, adapted from (MWT and GIZ GmbH, 2017)

Intervention area	**Objectives**
Urban areas	• Reduced transport costs • Higher mobility • Integrated urban planning and traffic management • Higher quality of life for urban residents
Peri-urban areas and inter-city transport	• Higher mobility • Better connectivity within the four regions • Better access to jobs and services • Higher quality of life for residents of peri-urban areas
Remote areas	• Better access to jobs and services • More economic and social opportunities for rural residents • Higher quality of life for residents of rural areas
Cross-cutting issues, i.e. road safety, social, environmental issues	• Safety across all modes of transport, prioritising the safety of vulnerable road users (pedestrians, pupils, and cyclists) • Better access to jobs and services, including for people with disabilities • Reduced vehicle emissions
Capacity building and training	• Sustainable integrated transport/land-use planning capability

2.4. NMT infrastructure and design

A crucial factor in promoting the use of non-motorised transport (NMT) is the need for effective infrastructure, such as bike lanes and pedestrian streets (Pisoni *et al.*, 2022). Effective transportation infrastructure not only facilitates movement but also impacts the rate of growth and level of economic activity within urban areas (Fahim *et al.*, 2022). The subsequent subsections provide information from various guidelines on the design of efficient NMT infrastructure, applicable to the context of small and medium-sized towns.

2.4.1. General design parameters and criteria

Design standards for NMT facilities can contain a broad spectrum of requirements, many of which are considered non-negotiable. Given the relatively slow pace at which NMT users move and navigate around each other, pedestrians tend to use cyclist spaces for walking, and cyclists use pedestrian spaces for cycling when traffic volumes are low (SMEC and UCT, 2014). Table 2.3 provides space requirements often used in the design of NMT facilities.

Table 2.3: Design criteria for NMT infrastructure, adapted from (SMEC and UCT, 2014)

Facility	Parameter	Accepted minimum	Recommended minimum	Optimal
Pedestrian walkway – total separation	Min width	1.2 m	1.5 m	2.0 m subject to capacity requirements
Pedestrian walkway – partial separation	Min width	1.2 m	1.5 m	3.0 m subject to capacity requirements
Bicycle lane – total separation – two ways	Min width	1.5 m (assure adjacent walking space)	1.8 m	2.0 m subject to capacity requirements
Bicycle lane – partial separation – two ways	Min width	1.5 m (check sight distance)	1.8 m	2.5 m subject to capacity requirements
Bicycle lane – marked separation – one way	Min width	1.5 m	1.8 m	1.8 m subject to capacity requirements
Pedestrian walkway	Max gradient	1:15	1:20	1:25
Pedestrian walkway	Min corner splay	2 m	3 m	5 m
Bicycle lane Cross fall/camber	Min radius	3 m	5 m	5 m
	Max gradient	1:50	1:50	
Both	Total separation: Distance from shoulder beak point	120 km/h – 5 m 80 km/h – 2 m 60 km/h – 1 m	120 km/h –7 m 80 km/h–3 m 60 km/h–1m	120 km/h – 9 m 80 km/h – 4 m 60 km/h – 2 m

In general, pedestrian and cyclist facilities ought to be provided in any area where there is a reasonable expectation that they will be utilised by the designated users, even in cases where the number of users is relatively low (SMEC and UCT, 2014).

According to SMEC and UCT (2014), pedestrian walkways and bicycle lanes should be standard features on urban Class 4a, 4b, and 5a streets, which serve as collector and local roadways for accessibility, as detailed in Table 2.4. The authors note that the standards for these facilities should be designed to encourage increased use by pedestrians and cyclists.

Table 2.4: South African road classification, adapted from (SMEC and UCT, 2014)

Class	Function	Description	Rural		Urban	
			Design speed (km/h)	**Typical width (m)**	**Design speed (km/h)**	**Typical width (m)**
1	Mobility	Principal arterial	120	62	120	60
2		Major arterial	120	48	80	40
3		Minor arterial	100 – 120	30	70	30
4	Access/activity	Collector street	80 – 100	25	50 – 60	20 – 25
5		Local street	60 – 80	20	40	14 – 22
6		Walkway/bicycle lane	N/A	N/A	N/A	N/A

According to the SANRAL guidelines for pedestrian and public transport facilities on national roads (SANRAL and ITS, 2017), pedestrian facilities on mobility roads are generally not needed, but if required, should be physically separated to prevent interactions between slow-moving, vulnerable pedestrians and high-speed traffic. The guideline indicates that constructed footpaths should ideally be provided some distance from the road edge, and mid-block crossings are prohibited on mobility roads. Planning for NMT can result in more effective infrastructure that minimises conflicts between pedestrians, cyclists, and vehicular traffic (SANRAL and ITS, 2017). According to SANRAL and ITS (2017), the following additional road safety infrastructure measures have been implemented to support the development of fully integrated pedestrian and public transport facilities:

i. Road signs and markings inform, guide, and regulate road usage.
ii. Median islands serve as a refuge for pedestrians crossing busy streets.
iii. Walls, fences, and barriers define boundaries and offer physical protection.
iv. Lighting systems increase the perceived safety for users, while advancements in technology improve the quality of information available to road authorities, planners, and designers, thereby improving traffic management and control.

2.4.2. Capacity

The subsequent subsections present information on the capacity of pedestrians on walkways and waiting areas at traffic lights.

2.4.2.1. Walkway capacity

Various walkway widths can comfortably accommodate different numbers of pedestrians. The NMT Facility Guideline by SMEC and UCT (2014) defines user comfort in relation to congestion using the Level of Service (LOS) criteria. Table 2.5 summarises the various factors that impact user experience related to LOS.

Table 2.5: Walkway and sidewalk LOS criteria, adapted from (SMEC and UCT, 2014)

LOS	Random situation				Platoon situation	
	Space (m^2/p)	Flow Rate (P/min/m)	Avg speed (m/sec)	V/C Ratio	Space (m^2/p)	Flow Rate (P/min/m)
A	> 6	< 16	1.3	< 0.2	> 49	≤ 1.6
B	> 4 – 6	16 – 23	1.3	0.2 – 0.3	> 9 – 49	> 1.6 – 10
C	> 2 – 4	23 – 32	1.2 – 1.3	0.3 – 0.45	> 4 – 8	> 10 – 20
D	> 1 – 2	32 – 49	1.1 – 1.2	0.45 – 0.65	> 2 – 4	> 20 – 36
E	> 0.7 – 1	49 – 75	0.8 – 1.1	0.65 – 1.0	> 1 – 2	> 36 – 60
F	≤ 0.7	Variable	< 0.8	Variable	≤ 1	> 60

2.4.2.2. Waiting areas

The typical space allocated for pedestrians should also be applied to walkway service areas and waiting zones at traffic lights (SMEC and UCT, 2014). Table 2.6 provides the LOS thresholds applicable for pedestrians in waiting areas.

Table 2.6: LOS criteria for pedestrians and queuing areas, adapted from (SMEC and UCT, 2014)

LOS	Space (m^2/p)
A	> 1.2
B	> 0.9 – 1.2
C	> 0.6 – 0.9
D	> 0.3 – 0.6
E	> 0.2 – 0.3
F	≤ 0.2

Street corners require two types of pedestrian spaces: First, a circulation area for pedestrian crossing the street, and second, holding areas for those waiting to cross (SMEC and UCT, 2014). According to SMEC and UCT (2014), the need to establish holding space requirements, particularly at signalised intersections may lead to issues that require detailed field study and potential corrective actions due to the methodology employed to calculate these areas. The authors note that possible measures include widening the sidewalks, adding a splay at the corner, imposing vehicle turn restrictions, and adjusting signal timing.

2.4.3. Width of sidewalks and cycle ways

The requirements for the provision of walkways and sidewalks along the national road network ought to be evaluated, with particular attention to addressing these needs on freeway sections (SANRAL and ITS, 2017). According to SANRAL and ITS (2017), sidewalks are generally constructed along sections of the national routes that link rural areas to the main commercial centres of the town, provided the distance is considered reasonable for walking. The authors further report that using road markings can help highlight and reinforce the exclusive use of these facilities.

The accepted minimum width for sidewalks ranges from 1.5 – 1.8 m (SMEC and UCT, 2014; SANRAL and ITS, 2017). Optimally, widths of 2 – 3 m should be used, based on capacity and requirements, as specified in the NMT Facility Guidelines by (SANRAL and ITS, 2017; SMEC and UCT 2014). While there is consistency on minimum widths, variations in recommended ideal dimensions reflect a lack of standardisation between authorities, which may pose a barrier in design consistency. The NMT Facility Guideline, however, suggests that an additional 0.6 – 1 m is required on sidewalks adjacent to kerbs, and the minimum width for cycleways should be increased by 0.3 m. Additionally, the "effective width" of a sidewalk must be considered, as obstructions can reduce the actual usable space for pedestrians and cyclists (SANRAL and ITS, 2017).

The design width of bicycle lanes on urban roads is determined by a variety of factors, including traffic design speed, bicycle and other mode volume, vertical slope, and bicycle lane arrangements (ATI *et al.*, 2023). According to ATI *et al.* (2023), a one-way bicycle lane has a minimum width of 1.5 m. The authors, however, note that this only applies to conventional bicycles. This narrow scope limits the applicability of their recommendations to more diverse or emergent bicycle models utilised for urban commuting. The recommended width for one-directional cycleways according to SANRAL and ITS (2017) ranges between 1.5 – 1.8 m. The Technical Recommendations for Highway (TRH) 26 South African Road Classification and Access Management Manual, however, recommends one-way cycle lanes of 1.8 m wide (1.2 m minimum) to be provided on mobility roads when needed, either by widening the carriageway or by integrating them alongside existing pedestrian footways (SANRAL, 2012). Furthermore, the TRH 26 guideline recommends a width of 2.5 – 3.5 m on an offroad two-way cycle lane. On rural roads, pedestrians and cyclists typically use the road shoulder. Sidewalks and bicycle lanes can, however, be added on rural roads with high volumes of pedestrians and cyclists (SANRAL, 2012). Cyclists generally travel faster than pedestrians, with speeds ranging from 15 to 30 km/h compared to 5 to 8 km/h typical for pedestrians (SANRAL and ITS, 2017). The SANRAL guidelines for pedestrian and public transport facilities on national roads outline the following specific considerations for higher design speed:

i. The cycle path should be designed wider to accommodate the higher speeds of cyclists and to minimise conflicts between pedestrians and oncoming cyclists.
ii. All kerbs and entry way into a road must have a gradient that allows bicycles to operate at their intended speed.
iii. Maintaining route continuity is crucial; hence, dustbins, road signs, streetlight poles, and trees should be kept clear of the cycle path. These obstacles can pose danger or force cyclists to dismount, thereby reducing their mobility. For instance, if a 2 m wide cycle path is chosen as the design width, this unobstructed width should be maintained consistently along the entire route.

The emphasis on obstruction-free design from the SANRAL guideline considerations reflects an increasing recognition of the value of continuous, safe paths in encouraging mode changes to NMT. Table 2.7 outlines the required widths for cycle paths as specified in the Department of Transport (DoT) NMT Facility Guideline.

Table 2.7: Cycle Lane widths, adapted from (SANRAL and ITS, 2017)

Classification	**Lane width (m)**
Two-way exclusive path	2.5 – 3.0
Two-way path shared with pedestrians	3.0 – 4.0
One-way exclusive path or lane	1.5 – 2.0
One-way path shared with pedestrians	2.0 – 3.0
Shared roadway/cycle lane for ADT of 1 – 1000 1000 – 3000 3000 – 6000 > 6000	Roadway lane width = 4.0 4.3 4.0 – 4.5 4.3 – 4.8
Note: If ADT exceeds 6000 and trucks exceed 10 %, add 0.5 m If road speed is 100 km/h or greater, add 0.5 m	

2.4.4. Separation

The SANRAL Guidelines for Pedestrian and Public Transport Facilities on National Roads by SANRAL and ITS (2017) defines the different road classes as follows:

i. **Class 1 Principal Arterials (Freeways): Urban**
Mobility roads, typically designed for speeds of 120 km/h, connect urban districts and accommodate traffic in metropolitan areas and large cities. These roads usually extend for 20 km or more.

ii. **Class 1 Principal Arterials (Non-Freeways): Rural**
Mobility roads, designed for speeds of 120 km/h, are characterised by high volumes of traffic between towns, cities, or villages and typically extend to 50 km or more.

iii. **Class 2 Major Arterials: Urban**
Mobility roads, designed for speeds of 80 km/h, serve traffic within metropolitan areas by providing general connectivity throughout the city or town, and typically extend for 10 km or more.

iv. **Class 2 Major Arterials: Rural**
Mobility roads, designed for speeds of 100 – 120 km/h, handle inter-regional traffic in smaller cities and typically extend for 25 km or more.

v. **Class 3 Minor Arterials: Urban**
Mobility roads, designed for speeds of 70 – 80 km/h, cater to traffic in most urban areas and small towns, and typically stretch for 2 km or more.

vi. **Class 3 Minor Arterials: Rural**
Mobility roads, designed for speeds of 100 km/h, accommodate inter-district traffic between small towns, villages, and larger rural settlements, and typically range from 10 – 100 km in length.

The NMT Facility Guideline recommends a complete separation between automobiles and bicycles on class 1 and 2 roads (SMEC and UCT, 2014). The SANRAL Guidelines for Pedestrian and Public Transport Facilities on National Roads recommends that grade-separated facilities are needed for crossing roads on freeways (SANRAL and ITS, 2017). The SANRAL guideline also discourages pedestrians from walking along the verges of freeways. However, when this is unavoidable, the guideline emphasises the need for a physical barrier separating the pedestrian walkway from the travel lane. Furthermore, the SANRAL guideline recommends a 3 m footway from the travelled way in level terrain. The guideline also specifies that pedestrians should use at-grade crossing facilities when crossing class 2 and 3 roads. Pedestrian pathways and cycling paths ought to be positioned with enough space between pedestrians and the travelled way (SANRAL and ITS, 2017).

2.4.5. Traffic calming

ATI *et al*. (2023) define traffic calming as physical or other measures designed to regulate traffic speed and flow, and to ensure the safety of more vulnerable participants, such as cyclists and pedestrians. The authors note that these measures, which are typically implemented in residential areas, aim to decrease or ban the speed of motorised vehicles. This reflects a shift in urban planning philosophy that prioritises vulnerable road users in mixed traffic conditions. The authors also highlight that roundabouts, reduced street widths, chicanes, textured road surfaces, plants, speed bumps, fences, bollards, and surveillance to conduct traffic control are all common measures. Traffic calming is frequently required to protect residential areas and other sensitive land uses from the detrimental effects of traffic. Large volumes of traffic and high speeds can have a negative impact on communities, reducing their safety and quality of life (SANRAL, 2012). The application of traffic calming measures on highways, mobility spines and access roads is summarised in Table 2.8.

Table 2.8: Types, applications, and impacts of traffic calming, adapted from (SMEC and UCT, 2014)

Type	**Application**			**Impact**	
	Highway	**Mobility spine**	**Access road**	**Impact on traffic volumes**	**Impact on vehicle speed reduction**
Grade separation	✓	✓	-	Possible	Yes
Speed hump	-	-	✓	Possible	Yes
Raised crosswalk	-	With caution	✓	Possible	Yes
Raised intersection	-	With caution	✓	Possible	Yes
Rumple strips	✓	✓	✓	No	Yes
Traffic (mini) circle	-	-	✓	Possible	Yes
Bicycle lanes	-	✓	✓	Possible	Possible
Speed limits	✓	✓	✓	Yes	Yes
Median barriers	✓	✓	-	Yes	Yes

2.4.6. Technology and lighting

Improvements in road safety can be achieved by integrating modern information and communication technology through Intelligent Transport Solutions (ITS) (SMEC and UCT, 2014). The subsequent subsections outline available ITS solutions that focus on roadside systems designed to detect, manage, and control traffic situations. However, the extent to which these technologies are effectively implemented in small and medium-sized towns remains under-explored.

2.4.6.1. Surveillance cameras

Closed-Circuit Television (CCTV) surveillance on national roads would facilitate quicker emergency responses, strengthen law enforcement and crime prevention, and enhance public perception on road safety (SMEC and UCT, 2014). Solar-powered cameras and wireless communication are additional options for this technological application (SMEC and UCT, 2014). Nonetheless, the operational stability of these devices in small and medium-sized towns is dependent on strong maintenance and energy infrastructure.

2.4.6.2. Lighting

Lighting systems improve visibility on roads, at intersections at night, and in low-light settings. ATI *et al*. (2023) note that lighting system improves the visibility of road users, allowing them to join traffic more safely. The authors also note that in addition to safety considerations, the good lighting system strives to improve security and the urban landscape. Well-lit walkways and bicycle lanes are essential for ensuring both the safety and visual comfort of pedestrians and cyclists (SMEC and UCT, 2014). The NMT facility guideline by SMEC and UCT (2014) recommends that the area adjacent to walkways and bicycle lanes passing through parks ought to be illuminated to at least one-third of the luminance level recommended for the pathways. This reflects an emerging understanding that sufficient public lighting serves as a dual purpose – both practical and psychological – by cultivating a sense of security while reducing crime risks. The guideline notes that minimising shadows in peripheral areas reduces the chances of potential criminals finding hiding spaces. The guideline indicates that in certain cases, “spill” light from adjacent roadways or streets may be adequate for illuminating walkways and bicycle lanes. Furthermore, the guideline highlights that roadway lighting adjustments or additions will be required if the spill light is unable to provide the suggested average-maintained illuminance levels to enable the visual identification of pedestrians, cyclists, or objects. This identification process largely depends on adequate vertical illumination to clearly define faces and objects (SMEC and UCT, 2014). The SANRAL guidelines for pedestrian and public transport facilities on national roads recommend the usage of solar-powered road studs along pedestrian walkways to enhance visibility and improve the perception of safety. Solar-powered studs ought to be installed along both edges of the walkway, particularly in areas with high pedestrian and cyclist activity at night (SANRAL and ITS, 2017).

2.4.7. Drainage designs

Incorporating non-motorised transport (NMT) facilities into roadways often complicate drainage designs and demands careful consideration to ensure effective drainage at all points. SMEC and UCT (2014) note that any ponding water on the road is likely to spray onto NMT users, discouraging them from using NMT. The authors also note that proper management of road run-off is crucial and must be developed to ensure that sidewalks are always usable and do not get flooded or clogged with soil and debris during the rainy season.

According to SMEC and UCT (2014), several options exist to address drainage issues, and the following aspects are crucial for designing effective drainage systems on and alongside NMT facilities:

i. When the sidewalk is adjacent to the roadway, vertical kerbs help channel stormwater to the nearest drain.
ii. In the absence of subsoil drainage system, mitre drains will help channel stormwater to designated locations along the roadway and cross the walkway.
iii. Paved walkways must have a maximum cross 2 % (1:50) to ensure effective drainage and accommodate persons with disabilities.
iv. A crossfall of 4 % (1:25) must be maintained, where gravel road shoulders are used by learners and cyclists to ensure proper drainage along the entire shoulder.

This technical guideline is well-founded, albeit it implies a degree of infrastructure and maintenance resources that may not be available in all developing contexts.

2.4.8. Road signs and markings

Road signs and marking for pedestrian facilities must be provided to guide and alert all road users about the presence of pedestrian activities and to manage pedestrian behaviour (SANRAL and ITS, 2017). SANRAL guidelines for pedestrian and public transport facilities on national roads highlight that road markings and signage are typically installed at pedestrian crossings and along footpaths to serve as warning signs for motorists. The guideline also recommends the use of high visibility signs to alert motorists about the presence of pedestrians. The use of these visual signs reflects a proactive attitude to pedestrian safety, but their effectiveness is dependent on driver compliance and adequate sign maintenance. Table 2.9 outlines the distance at which a warning sign should be placed away from a hazard on roads with various designated speeds.

Table 2.9: Warning sign location, adapted from (SANRAL and ITS, 2017)

Operating speed (km/h)	Location distance from hazard (m)
120	330
100	240
80	160

2.4.9. Universal access

Universal access is defined as a strategy aimed at creating an environment that best accommodates the needs of all possible road users (SANRAL and ITS, 2017; ITS and BP consulting engineers, 2018). The broad definition of universal access reflects a rising acknowledgement of intersectional mobility demands, albeit implementation varies across states. SANRAL and ITS (2017) note that the concept focuses on inclusive design to ensure participation and access for everyone, particularly for individuals with specific needs, including the following groups:

i. Disabled individuals: this group includes those with physical, sensory, or mental impairments, whether temporary or permanent. This group also includes very young children, typically defined as those aged 0 to 14, making this definition broader than many others.
ii. The elderly: individuals over 55 years of age typically fall under this category.
iii. Pregnant women: typically referred to women in their last three months of pregnancy.

2.4.9.1. Ramps and dropped kerbs

The SANRAL Guidelines for Pedestrian and Public Transport Facilities on National Roads by SANRAL and ITS (2017) recommends the construction of dropped kerbs at all pedestrian crossing points in urban areas and places where kerbed sidewalks are present. The guideline recommends that dropped kerbs be designed according to the following specifications:

i. The dropped kerb should be level with the channel.
ii. The difference between the ram gradient and the channel gradient should be no more than 11 %.
iii. A 300 mm flat precast channel should be introduced.

These design standards reflect best practices in universal design; however, more research is needed to determine their applicability in small and medium-sized towns. Figure 2.5 is an illustration of a dropped kerb designed in accordance with the parameters outlined above.

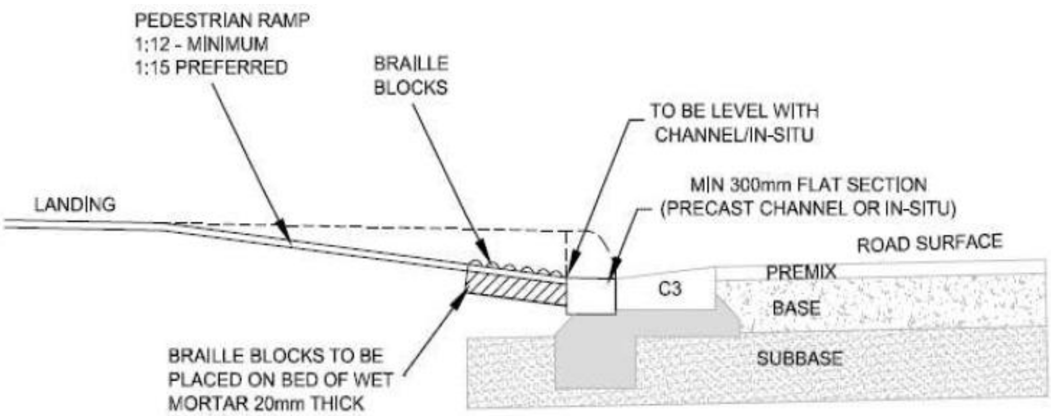


Figure 2.5: Pedestrian ramp details, adopted from (SANRAL and ITS, 2017)

According to the NMT facility guideline drafted by SMEC and UCT (2014), a dropped kerb should be at least 1200 mm wide, with an ideal slope of 1:20 and a maximum slope no steeper than 1:12. The latter slope should only be used in exceptional circumstances when space constraints prevent the use of a less steep slope.

2.4.9.2. Pedestrian pushbuttons

A push button that can be used by both pedestrians and cyclists should be designed when necessary. The buttons should be appropriately designed so that bicycles can activate them without having to dismount and continue their journey (ATI *et al.*, 2023). According to the SANRAL Guidelines for Pedestrian and Public Transport Facilities on National Roads by SANRAL and ITS (2017), audible and vibro-tactile pedestrian push buttons should be installed at signalised pedestrian crossings alongside visual pedestrian signals, as shown Figure 2.6). The guideline further recommends the pedestrian pushbutton be positioned 1 m above the ground to ensure accessibility for individuals using wheelchairs.

Figure 2.6: Pedestrian and cyclist audible and vibro-tactile traffic signal, adopted from (SANRAL and ITS, 2017)

2.4.9.3. Level of pedestrian crossings

SANRAL Guidelines for Pedestrian and Public Transport Facilities on National Roads by SANRAL and ITS (2017), report the existence of multiple variations for pedestrian crossing level that can be explored based on the local context to enhance universal accessibility at pedestrian crossings. The following options can be considered:

i. Kerbed pedestrian sidewalks with ramps and dropped kerbs at crossing points.
ii. Pedestrian sidewalks that are level with the roadway at crossing points.
iii. Kerbed central median with ramps and dropped kerbs at median crossing.
iv. Kerbed central median with a level pedestrian crossing spanning across it.

Figure 2.7 illustrates a level median crossing that satisfies the above considerations.

Figure 2.7: Level median crossing, adopted from (SANRAL and ITS, 2017)

2.4.9.4. Alignment of pedestrian crossings

Pedestrian crossings should be aligned at a 90-degree angle to both the sidewalk and the kerb edge to support blind or visually impaired people, while also ensuring the shortest possible crossing distance.

2.5. Safety and risk factors

Improving infrastructure and public surveillance to enhance the safety of non-motorised transport (NMT) users is essential for reducing crime perceptions and facilitating access for vulnerable users, including children, women, and the elderly. According to a study by Oviedo *et al*. (2021) that built on information about crosswalk usage and conditions, including pedestrian perceptions in New Juaben, Ghana, pedestrian behaviour is central to safety in terms of quantity and severity of collisions. Walking spaces, fatigue, and walking time were identified as significant factors which influenced pedestrian injuries and deaths. The authors report that studies in Ethiopia reveal that the absence of NMT facilities such as crossings, street lightings, and sidewalks, as well as the presence of street vendors on NMT pathways play vital roles in decreasing road safety. The authors also note that in Ghana, the absence of designated pedestrian areas, intense competition for road space from various users, and walking at night have been identified as significant risk factors for pedestrians. According to Das (2016), central business districts (CBDs) in South African cities are now largely inaccessible due to poor infrastructure maintenance, crime, safety concerns, and limited NMT options, such as walking and cycling. Oviedo *et al*. (2021) reports that perceived safety, relies on pathways that enable multidirectional continuous movement, while highlighting the critical role of public surveillance in pedestrian spaces. Crossings also play an important role in improving walking conditions. In a study on rural and peri-urban communities, Oviedo *et al*. (2021) found that high traffic levels limit access to local facilities for children, women, and elderly due to their barrier effect. According to Benton *et al*. (2023), the catalogue of design safety measures from the World Road Association, also referred to as the Permanent International Association of Road Congresses (PIARC) estimates that investment in pedestrian facilities could reduce crashes by as much as 90 %.

2.6. Benefits of NMT

Non-motorised transport has numerous benefits compared to motorised transport. According to Oviedo *et al*. (2021), walking as a mode of NMT has gained significant focus in transportation planning research and practice over the past 20 years. The authors report that walking is acknowledged for its health and environmental benefits. The health and environmental benefits related to NMT are discussed in the subsequent sections.

2.6.1. Health benefits

As per a World Health Organization (WHO) report (2011), physical inactivity was identified a major factor leading to fatalities. According to Mansoor *et al*. (2022), Chronic diseases such as diabetes, cancer, and cardiovascular diseases often result from a lack of physical activity, which is reported to be the second highest behavioural risk factor for diseases after smoking. The authors note that approximately 60 % of adults worldwide are inactive, which leads to obesity and other diseases. The regular use of non-motorised transport (NMT) is one strategy that can be adopted to increase physical activity. NMT also plays a critical role in combating obesity, as evidenced by studies conducted by Mansoor *et al*., (2022) in Australia, Europe, and North America, which report an adverse correlation between NMT usage and obesity levels. Retaining the value of this high modal share requires shifting urban planning, investment, and infrastructure development to prioritise the needs of pedestrians and cyclists, in order to deliver the multiple benefits associated with NMT (UNEP and UNHSP, 2022).

Several studies have been conducted globally to investigate the potential benefits of NMT in addressing health concerns. In Australia, an additional 5 % of people engaging in 30 minutes of daily physical activity could potentially save about 600 lives annually (Mansoor *et al.*, 2022). Similar benefits for NMT users have been observed by Mansoor *et al*. (2022) in China, the Scandinavian countries, and Great Britain. Women in China who used NMT had a mortality rate that was 20-50 % lower than those who did not. In Scandinavia, workers who ride bicycles to work have a mortality rate that is 22 % lower than that of those who do not. Additionally, children from Britain who took NMT to school were reported to be healthier than children who took motorised transport.

2.6.2. Environmental sustainability

Non-Motorised Transport (NMT) produces zero emissions, reduces noise and air pollution, as well as the carbon footprint associated with motorised transport. According to Pisoni *et al.* (2022), NMT plays a significant role in CO_2 mitigation. The authors estimate that life cycle CO_2 emissions can be reduced by 14 % for each additional cycling trip and by 62 % for every car trip avoided. On average, up to one billion people walk or cycle for transport for about 56 minutes each day, contributing the least to noise and air pollution and do not rely on fossil fuels (UNEP and UNHSP, 2022). Despite the apparent environmental benefits, NMT adoption remains low, particularly in developing countries, raising concerns about policy commitment and investment prioritisation. Air pollution and greenhouse gas emissions are largely caused by road transportation, with the United States transportation industry alone accounting for a sizeable amount of these emissions (Mansoor *et al.*, 2022). Transportation emissions are rising rapidly, especially in developing countries, despite the involvement of various energy sectors. Hence, the transportation industry will be critical in addressing air pollution and climate change, in the future, with NMT emerging as a viable solution (Mansoor *et al.*, 2022).

2.7. Mode choice and behaviour

In the domain of urban mobility, understanding the factors that influence the mode choice and behaviour of individuals towards NMT usage serves as a crucial focal point for research. As cities struggle with issues such as traffic congestion, pollution, and sustainability, promoting NMT modes as viable alternatives to motorised transportation have attracted growing interest. This review section seeks to explore the wide range of studies investigating the factors, preferences, and limitations influencing individuals as they decide to adopt or reject the usage of NMT. However, a significant gap exists in the integration of these characteristics into effective policy frameworks, limiting the scalability of successful interventions across varied socio-spatial context. Some of the factors that influence mode choice are:

i. Geography and weather
ii. socio-economic factors
iii. Urban form
iv. The built environment

2.7.1. Geography and weather

Geography and weather conditions significantly affect the use of non-motorised transport (NMT), while having minimal impact on motorised transport (Mansoor *et al.*, 2022). The weather, topography, and climate all have an impact on the frequency of NMT usage such as cycling. Bad weather is a major factor when it comes to cycling. However, the impact of bad weather tends to worsen in areas without resilient NMT infrastructure, revealing a compounded barrier. According to a study conducted by Mansoor *et al*. (2022), cyclists are more likely to shift to alternative forms of transportation when there is adverse weather. The authors also report that hot weather was the primary cause of discomfort while walking, in the arid region of Abu Dhabi.

Moreover, the topography plays a role in bicycle usage – slopes exceeding 5 % are not conducive to cycling. A significant incline seems to discourage the use of NMT, while moderate slopes are regarded as safer by cyclists (Mansoor *et al.*, 2022). According to Mansoor *et al*. (2022), traveling uphill reduces bicycle usage, whereas downhill sections offset the extra effort needed on upward slopes. Furthermore, experienced and inexperienced cyclists exhibit different preferences regarding geography and weather. Mansoor *et al*. (2022) notes that inexperienced cyclists favour flat terrain, whereas experienced cyclists favour mountainous landscapes. The authors also note that the appeal of the surroundings positively influences the usage of bicycles. In addition to geographical factors, cycling is affected by local climate conditions. A study by Mansoor *et al*. (2022), suggests that cyclists travel more in summers compared to winters. The authors observed this trend in Australia, where in summer and autumn seasons, approximately 20 % of all travellers opt for cycling, a figure that decreases to 10 % in winter and spring. This seasonal variation in travel behaviour stresses the need for adaptive NMT strategies aligned to regional climate variances. The authors note that the distance travelled by bicycle also declines in winter, with variations across various regions.

2.7.2. Socio-economic factors

Socio-economic factors such as household and personal circumstances strongly influence travel behaviour. According to Mansoor *et al*. (2022), numerous studies have reported a significant correlation between mode choice and socio-economic factors such as household income, age, gender, and household size. Mansoor *et al*. (2022) report that people with higher incomes tend to cycle more. However, Okoyo (2019) argues that individuals with higher incomes tend to use cars more frequently due to their increased spending capacity for transportation. The argument by Okoyo (2019) is supported by findings from a study conducted by Benton *et al*. (2023) reporting that individuals from low-income households often walk out of necessity, primarily to avoid the high costs of public transport, which can consume between 30 % to 49 % of their household income. A similar conclusion was made in earlier research by Rith *et al*. (2019) suggesting that the use of NMT decreases with an increase in household income. As income levels rise, the tendency for individuals to "buy their way out of walking and cycling" could intensify already strained safety conditions, air quality, and traffic congestion (UNEP and UNHSP, 2022). Furthermore, the utilisation of a transport mode is greatly influenced by age. A study by Okoyo (2019) suggests that young people are favourably associated with increased bicycle usage. The author further reports that age affects transportation mode choice, with older people exhibiting a greater tendency to use motorised transport modes (MTM) compared to younger people, who are inclined to use NMT modes. Nonetheless, while individual research reveals these relationships, there is a lack of synthesis regarding how these variables interact across different urban contexts.

Mansoor *et al*. (2022) highlighted the relationship between gender and cycling, indicating that men engage in cycling more frequently than woman. Rith *et al*. (2019), on the other hand, report that women in Manila and Philippines are more likely to use NMT modes compared to men to commute daily from home to work. Moreover, it appears that the impact of gender on bicycle usage differs by country; in countries where cycling is less common, men tend to be the predominant users of bicycles. On the other hand, women are also more inclined to cycle in countries like the Netherlands and Belgium, where bicycles have a larger mode share. In children, the influence of gender on cycling is inconclusive. Scheiner, *et al*. (2019) argue that primary school girls are being escorted more frequently and do not favour cycling as a mode of transport, particularly on morning trips, whereas boys, on the other hand, prefer riding bicycles to go to school. Having a young family and a high social status decreases the likelihood of using NMT modes such as cycling (Mansoor *et al.*, 2022). Gendered cycling, however, remain under-theorised, with social norms and cultural expectations impacting mobility behaviour that is not fully reflected in existing work.

2.7.3. Urban form

Urban form refers to physical characteristics such as density, shape, and size of settlement (Mansoor *et al.*, 2022). Urban form can be assessed at several scales, from the regional to the street level; at larger and smaller scales, the entire region and a single block can be taken into consideration respectively. According to Mansoor *et al*. (2022), choosing to commute by bicycle is heavily influenced by the trip distance. The authors found that the mode share of bicycles generally decreases as the travel distance increases. The authors also suggest that a greater trip distance discourages riding because it requires more physical effort, and people who ride bicycles typically reside rather near their workplaces. A similar conclusion was made in a study by Pisoni *et al*. (2022), who found that as trip distance increases, the likelihood of an individual choosing an active travel mode of transport decreases. Furthermore, Benton *et al*. (2023) report that travel distance between informal settlements and centres of social and economic activities was an identified challenge related to walking in Africa. The authors further report that low-income residents dedicate more of their time and money to travel, often in difficult conditions, to access essential services such as healthcare, education, and employment opportunities. However, discussions about urban design are frequently limited to its physical elements, while sociopolitical structures influencing access to infrastructure receive little attention. Moreover, a study by Gutiérrez *et al*. (2020) note that, in addition to sociodemographic factors, the willingness to use bicycles declines as trip distance increases.

2.7.4. The built environment

The impact of the built environment (BE) on NMT remains unclear despite extensive research. A review by Okoyo (2019) on the influence of urban form as a built environment factor highlights insufficient evidence linking urban form to transportation modes, indicating a need for further research. Studies conducted in developed countries indicate that BE strongly influences the decision to take an NMT trip (Mansoor *et al.*, 2022). According to Oviedo *et al*. (2021), walking as a mode of urban mobility is influenced not only by individual physical and behavioural attributes but also by the actual and perceived conditions of the built environment. According to Mansoor *et al*. (2022), the usage of NMT is highly influenced by the provision of adequate infrastructure, such as sufficient sidewalk width, availability of rest places, good sidewalk condition, infrastructure aesthetics, and clean infrastructure. The authors further report that countries with strong bicycle infrastructure tend to have a high percentage of cycling and improved bicycle safety. Additionally, the authors note that the preference of active mode choice is also affected by the types of roads available to these users. A study by Mansoor *et al*. (2022) in Rajshahi, Bangladesh, found that NMT users prefer local roads over main roads for safety reasons. Despite these findings, the literature lacks a strong conceptual framework for comparing BE impacts in Global North and South context, limiting generalisability. Furthermore, Khan *et al*. (2014), used data from the 2006 household travel survey from several Washington State counties to create several models to examine the impact of the built environment on NMT. The study concluded that improved street connection, a higher density of bus stops, and non-motorised access encouraged the use of NMT. A similar conclusion was made in a study by Mansoor *et al*. (2022). Khan *et al*. (2014) further report that the likelihood of using NMT for short-distance trips is higher than for long-distance trips. Nonetheless, there is limited discussion on how political will and institutional ability influence the actual implementation of BE reforms that are conducive to NMT.

2.7.5. Attitudes and perceptions

Okoyo (2019) defines attitude and perception factors as mental or psychological attributes that influence mode choice by individuals, including considerations such as trip safety, transportation costs, and comfort, when deciding on a mode of travel. Okoyo (2019) reports that factors such as cost, travel time, required effort, and trip safety are highly significant to bicycle users. The author further reports that people often do not select the mode that will provide them with the highest level of satisfaction when presented with multiple options, possibly due to socioeconomic status. Lastly, the author highlights that time and comfort variables influenced the mode choice to the extent that a person would pay more if these two requirements were satisfied. Furthermore, a study by Pisoni *et al*. (2022) examined the perception of cycling in Warsaw. The authors found that while many people recognise the clear benefits of cycling, it is primarily viewed as a leisure activity, which hinders its adoption as a regular mode of transport. The authors also identified safety concerns related to driver behaviour as a key barrier for NMT. Additionally, the study found that less frequent cyclists – those who use bikes primarily for leisure – face a higher risk of accidents, as infrequent use is associated with a greater likelihood of crashes. Oviedo *et al*. (2021) report that empirical research on NMT modes, like walking in SSA urban areas, is evolving and highlights areas that warrant further investigation. The findings by Oviedo *et al*. (2021) indicate a direct correlation between neighbourhood walking conditions and income level pointing to the need for further studies that take into consideration how people perceive pedestrian infrastructure, and the inequalities associated with it.

2.8. Case studies of NMT policies and interventions: Global perspective

In recent years, growing attention in research has been directed toward environmental sustainability and human health (Zhou *et al.*, 2020). In this context, Zhou *et al*. (2020) note that sustainable and environmentally friendly mobility is critical for reducing urbanisation pressure and improving urban quality of life. The authors also note that advanced transportation infrastructure and policies are needed to encourage sustainable travel and reduce traffic congestion. This section discusses the effectiveness and challenges of non-motorised transport policies and interventions in small- and medium-sized towns from a global perspective, aimed at promoting sustainable modes of travel. These case studies as well as those discussed in Section 2.9 provide useful comparative insights on the experiences and actions with the observed conditions in Namibian small and medium-sized towns. The case studies also help to contextualise the local findings and assess the extent to which lessons from elsewhere may, or may not, be applicable to the Namibian context. According to Mainet and Racaud (2015), small- and medium-sized towns are municipalities that serve as important relay and redistribution centres between urban and rural areas. The authors report that the intermediation role of these small- and medium-sized towns is twofold: externally, they act as gateways to larger markets and networks, while internally, they serve nearby areas with vital functions such as service centres and influence over the surrounding regions, emphasising the importance of proximity. The authors further report that these small- and medium sized towns facilitate the transition between major cities or the capital and smaller towns and rural areas, effectively connecting all levels of the urban hierarchy. Mainet and Racaud (2015) also note that medium-sized towns serve as vital gateways to rural areas, playing a key role in the distribution of products, which are often manufactured or imported from other regions or countries. Two global case studies related to NMT policies and interventions in small- and medium-sized towns are discussed in the subsequent subsections. The two selected case studies are Pabna Municipality in Bangladesh and Ang Mo Kio (AMK) Town in Singapore.

2.8.1. Pabna Municipality, Bangladesh

The subsequent subsections provide information regarding the challenges and effectiveness of non-motorised transport (NMT) infrastructure and policy interventions in Pabna Municipality, a medium sized town in Pabna District, Bangladesh.

2.8.1.1. Introduction

The case study by Fahim *et al.* (2022) explored user' perceptions regarding non-motorised transport (NMT) infrastructure and services in Pabna Municipality, Bangladesh. The case seems to reveal gaps between policy intervention and user experience. According to Fahim *et al*. (2022), NMT modes including cycling, walking, and rickshaws were identified as crucial modes of transportation, especially for short distance trips. The authors, however, report that inadequate infrastructure provision and planning in many developing countries, including Bangladesh, have increased the risks of using NMT modes and made NMT less appealing. The authors further report that the local government in Bangladesh have paid little attention to improving NMT services, leading to inefficiency and safety concerns for users. Moreover, the rapid increase in motorised vehicles reported in Bangladesh, contribute to poor air quality and traffic congestion, stressing the urgent need of NMT development. The reported increase in motorised vehicles was noted to cause noise pollution, further discouraging the use of NMT modes. Despite the benefits associated with NMT, such as reduced traffic and air pollution, Fahim *et al*. (2022) report that NMT in Bangladesh has largely been overlooked in urban planning. This suggests that the limited implementation of integrated urban transport planning may have constrained their potential. Furthermore, the case study by Fahim *et al*. (2022) focused on understanding NMT users' perceptions, satisfaction with existing NMT facilities, and travel behaviour in Pabna Municipality as a medium-sized town with growing urban challenges.

2.8.1.2. Study area and research design

Pabna Municipality, located in the northwestern part of Bangladesh – see Figure 2.8 – is a growing town with a population of approximately 144,442 inhabitants (Fahim *et al.*, 2022). The primary travel modes include cycling, motorised vehicles, and rickshaws. According to Fahim *et al*. (2022), the municipality lacks well-connected road networks and NMT infrastructure, such as bicycle lanes and footpaths, despite being a significant transit centre. The study used a cross-sectional survey method, with 120 respondents selected through purposive sampling. Data was collected through questionnaires and oral interviews, focusing on travel patterns, socio economic factors, and user satisfaction with NMT facilities. Statistical analyses, including Pearson Correlation Matrix and Principal Component Analysis (PCA), were employed to understand the relationship between different NMT service factors and user satisfaction.

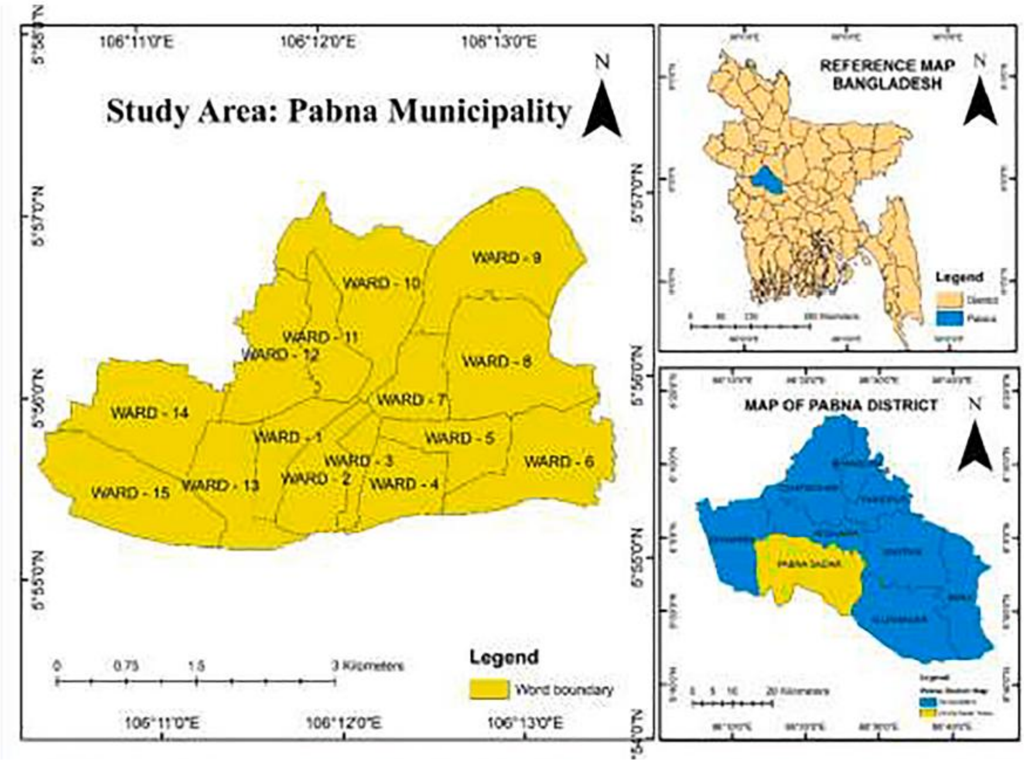


Figure 2.8: Study area (Pabna Municipality), adopted from (Fahim *et al*., 2022)

2.8.1.3. Research findings

The following key findings were derived from the study by Fahim *et al*. (2022):

i. Most users were dissatisfied with the road infrastructure, including road width and the lack of pedestrian and cycle lanes. Access to public transport and main roads were also inadequate.

ii. Noise and dust conditions were major concerns for users, significantly affecting their choice of NMT modes.

iii. Social security for NMT users was moderate, but street lighting was found to be adequate. The absence of traffic signals and road signage contributed to safety concerns.

iv. A strong positive correlation was noted between noise and dust conditions and a negative correlation between access to public transport and efficient speed. These factors highlighted the interconnected challenges faced by NMT users in Pabna.

v. PCA revealed that road conditions, (width and signage), dust, noise, and access to public transport were the most significant factors influencing NMT user satisfaction. Inadequate road width and lack of smooth rides led to lower NMT usage.

2.8.1.4. conclusions and recommendations

The study by Fahim *et al*. (2022) highlighted the need for improved NMT infrastructure in Pabna Municipality. Key challenges that were identified included insufficient pedestrians and cycling lanes, poor road conditions, and safety concerns due to lack of traffic lights and road signage. Addressing these issues through targeted interventions, such as reducing environmental pollutants and improving road networks, was anticipated to increase NMT usage, leading to more sustainable urban transportation.

Based on the case study of Pabna Municipality, Fahim *et al*. (2022) made the following recommendations:

i. Local governments should prioritise the construction of dedicated lanes for pedestrians and cyclists.
ii. Efforts to reduce noise and dust pollution should be integrated into urban planning.
iii. Incorporating NMT into broader transportation policies at the municipal level is needed to create a more balanced and sustainable transport system.

2.8.2. Ang Mo Kio (AMK) Town, Singapore

The subsequent subsections provide information regarding the effects of upgraded cycling infrastructure on non-motorised transport (NMT) in Ang Mo Kio, a medium sized town located in the North-East region of Singapore.

2.8.2.1. Introduction

Non-Motorised Transport (NMT), also referred to as active mobility, which includes cycling, walking, and the use of personal mobility devices (PMDs), is gaining popularity as a sustainable and eco-friendly mode of urban transportation (Zhou *et al.*, 2020). This case study evaluated the effects of upgraded cycling infrastructure on NMT in Ang Mo Kio (AMK), a residential township in Singapore. A focus on how infrastructure upgrades influence modal shift behaviour and user satisfaction was highlighted in the case study. The study was conducted as part of a National Cycling Plan in Singapore to promote a car-reduced society. According to Zhou *et al*. (2020), Singapore faces challenges related to traffic congestion and environmental sustainability, due to the growing urban population and the resulting increase in private vehicles. The authors report that the lack of dedicated NMT infrastructure has led to traffic inefficiencies, limited adoption of walking and cycling, and safety concerns.

The case study conducted by Zhou *et al*. (2020) aimed to achieve the following objectives:

i. Assess the impact of newly implemented cycling paths on active mobility.

ii. Evaluate user perceptions of safety and convenience post-implementation.
iii. Analyse changes in traffic patterns among pedestrians and cyclists in the township.

2.8.2.2. Methodology

The study by Zhou *et al*. (2020) adopted the following methodology:

i. NMT volume counts were conducted in 2015, 2018, and 2018 to track fluctuations in cyclist and pedestrian activity levels. Furthermore, perception surveys were conducted at key locations in the township, including mass rapid transit (MRT) stations and road crossings, before and after the infrastructure upgrade, to gather views regarding convenience, safety, and satisfaction with the cycling infrastructure.

ii. The authors employed paired two-tailed tests to determine significant differences in NMT usage before and after the cycling network upgrade. Additionally, Geographic Information System (GIS) mapping was applied to visualise changes in pedestrian and cyclist distribution across Ang Mo Kio town.

2.8.2.3. Interventions

Infrastructure upgrades were launched by the Land Transport Authority (LTA) of Singapore in 2017. The key intervention was the construction of a 4 km cycling network in Ang Mo Kio, connecting major transport nodes, including mass rapid transit (MRT) stations and bus interchanges, to public amenities such as schools and shops. Footpaths previously shared between pedestrians and cyclists were replaced with distinct lanes to ensure the safety of NMT users. This serves as a test case for scalable NMT interventions in similar urban contexts.

2.8.2.4. Results and challenges

The following results were drawn from the study by Zhou *et al*. (2020):

i. Pedestrian and cyclist counts increased by 31 % and 28 % respectively, from 2015 to 2017. An increase in pedestrian counts by 286 % was noted on upgraded cycling paths, with a 65 % increase in cyclist counts along these paths. The authors suggested that cycling network also promote walking after reporting a continued increase in pedestrian flow by 49 % from 2017 to 2018.

ii. In 2017, 56 % of pedestrians and 70 % of cyclists reported to have felt safe sharing footpaths, with an increase from 33 % and 59 % in 2016 respectively.

iii. A notable shift towards walking and cycling as preferred modes of transport was observed as a result of improved cycling network. The upgrades not only encouraged more cycling activities but also fostered greater community engagement in active mobility.

The study by Zhou *et al*. (2020) identified the following challenges:

i. Pedestrians expressed concerns about sharing footpaths with cyclists and personal mobility device (PMD) users. This highlights design oversights in multimodal infrastructure planning. The increasing usage of PMDs, particularly for food delivery, posed safety challenges due to speed differentials.
ii. Safety perceptions decreased in 2018 despite the initial success, highlighting the need for continuous infrastructure upgrades and user education on shared path etiquette.

2.8.2.5. Conclusions

The findings by Zhou *et al*. (2020) indicate that interventions in Ang Mo Kio successfully increased NMT, with a reported positive outcome for both pedestrians and cyclists. Zhou *et al*. (2020) concluded that the before-and-after study revealed that enhanced NMT infrastructure leads to greater community satisfaction and higher usage. The authors also concluded that despite the positive outcomes from the study, ongoing adjustments are required to address emerging challenges, including the need for continued cycling network expansion to meet growing demands and the rise of personal mobility devices (PMDs).

2.9. Case Studies of NMT Policies and Interventions: African Perspective

Well-designed pedestrian spaces enhance the appeal, safety, and convenience of living environments. Additionally, inclusive street design boosts the local economy and provides access to chances for productive work (Mokitimi and Vanderschuren, 2017). The subsequent subsections discuss two case studies related to NMT policies and interventions in a medium-sized and small town in Sub-Saharan Africa (SSA). The case studies offer insights for the development and implementation of NMT facilities. The two selected cases are Kisii Town in Kenya and Thaba Nchu in South Africa.

2.9.1. Kisii Town, Kenya

The following subsections present information regarding non-motorised transport (NMT) infrastructure and policy interventions in Kisii Town, a medium sized town in South-Western Kenya.

2.9.1.1. Introduction

Kisii Town faces challenges related to non-motorised transport (NMT) infrastructure, particularly in maintaining and providing pedestrian pathways. Despite a heavy reliance on walking among the majority of the population in Kisii, the town lacks sufficient NMT pathways, resulting in safety risks and conflicts between motorised transport (MT) and NMT users (Omollo, 2022), which reflects a mismatch between infrastructure demand and planning priorities. The case study by Omollo (2022) examined the compliance of residential developments with the planning standards requiring two-meter-wide pedestrian pathways, as mandated in the Physical Planning Handbook in Kenya. According to Omollo (2022), NMT infrastructure provision in Kisii Town is inadequate despite the critical need for pedestrian infrastructure. The author reports that road reserves are often encroached by residential buildings, creating safety concerns and reducing available spaces for the construction of NMT pathways. The author notes that County Government of Kisii (CGOK) has faced challenges in enforcing development controls and ensuring adherence to standards governing pedestrian areas.

2.9.1.2. Methodology

The study by Omollo (2022) utilised a correlational research design, focusing on seven residential neighbourhoods in Kisii Town. Data was collected through structured observation checklists, satellite imagery, and field measurements. Compliance with footpath standards were analysed using one-sample t-test and Pearson's bivariate correlation, while road reserves and encroachments were mapped using GIS technology. The analyses revealed critical infrastructure deficits that impede sustainable mobility goals.

2.9.1.3. Research findings

The following findings were drawn from the study by Omollo (2022):

i. Most residential developments in Kisii Town did not comply with the 2 m standard for footpaths, exposing the systemic neglect in urban design regulations The average shortfall was 0.3 m, undermining pedestrian safety and accessibility.

ii. Many structures encroached into road reserves, further limiting pedestrian spaces. A significant positive correlation between footpath compliance and road reserve width was identified – where road reserves were encroached, footpaths were either narrowed or eliminated entirely.

iii. Road maintenance and construction tenders barely provided pedestrian pathways, contributing to further neglect of NMT infrastructure provision. The inability to enforce regulations by the County Government has intensified the issue.

iv. Encroachment on NMT pathways in areas with high traffic such as Daraja Mbili and Nyanchwa – home o schools, markets, and hospitals – expose NMT users to dangers, including accidents due to lack of safe walking spaces.

2.9.1.4. Conclusion and recommendations

Non-compliance of infrastructure with non-motorised transport (NMT) planning standards in Kisii Town hinders pedestrian safety and urban mobility. The need of the predominantly walking population in Kisii Town can be provided for by enforcing gaps and integrating the provision of NMT pathways and into infrastructure projects (Omollo, 2022).

The following recommendations were made by Omollo (2022), after conducting his study in Kisii Town:

i. The CGOK must prioritise the enforcement of planning rules to ensure NMT pathways and road reserves are well maintained. Regular inspections and audits of construction operations ought to be conducted.

ii. Pedestrian pathways should be a basic component of all road construction and maintenance projects. This would ensure that future projects will include appropriate infrastructure for NMT users.

iii. The study recommends investigating compliance with other road reserve aspects, such as stormwater drains, to guarantee holistic infrastructure planning.

2.9.2. Thaba Nchu, South Africa

The subsequent subsections present information regarding non-motorised transport (NMT) infrastructure and policy initiatives in Thaba Nchu, as a small town in the Free State province of South Africa.

2.9.2.1. Background and challenges

Thaba Nchu, located 67 km east of Bloemfontein, has a more rural atmosphere compared to medium-sized towns and serves as a centre for surrounding villages and communities, with commercial and residential infrastructure. While it has amenities such as schools, stores, and clinics, it lacks the extensive facilities and population that define medium-sized towns in South Africa. According to Mokitimi and Vanderschuren (2017), the town is distinguished by a development pattern of 37 villages surrounding the peri-urban centre, with some villages as far as 35 km away, which presents unique logistical challenges for cohesive NMT infrastructure implementation. The authors report that several important pedestrian paths in Thaba Nchu lack NMT infrastructure. Mokitimi and Vanderschuren (2017) note that two issues related to NMT infrastructure conditions were identified in the area and are outlined below:

i. As one of the primary routes for mobility into Thaba Nchu, Brand Street is close to two important educational institutions. There were no NMT facilities or traffic calming measures on the street for school children crossing it before road interventions. The fast speeds at which cars travelled without stopping made it extremely dangerous for children to cross, demonstrating the urgent need for traffic-calming measures in NMT planning.

ii. Situated in Thabu Nchu 16, on the southern side of the N8, is the second concern that was identified. The region lacked a direct route to Brand Street for access to the N8, and all other internal roads were made of gravel without any NMT facilities.

2.9.2.2. Interventions

The road has been paved and now features raised pedestrian crossings, sidewalks on both sides, adequate pedestrian signage, a bus stop, and a pedestrian crossing near the school. Improved access points to the main school along the corridor have been created, and walkways have been installed, as shown in Figures 2.9 and 2.10. Block paving was used in Thaba Nchu extension 16 to build the access roads and walkways for pedestrians. An entrance into the community has been built from Brand Street, as seen in Figure 2.11, demonstrating the transformative potential of targeted infrastructure upgrades for NMT accessibility.

(a) Brand Street-2010

(b) Brand Street-2014

Figure 2.9: Upgrade of NMT facilities on Brand Street, adopted from (Mokitimi and Vanderschuren, 2017)

(a) Entrance of school-2010

(b) New entrance at school-2014

Figure 2.10: Upgrade of pedestrian crossing at a school in Thaba Nchu, adopted from (Mokitimi and Vanderschuren, 2017)

(a) Part of the route before Intervention

(b) Same route after intervention

Figure 2.11: Upgrade of pedestrian access roads and walkways, adopted from (Mokitimi and Vanderschuren, 2017)

2.10. Research gaps and future directions

The reviewed literature on non-motorised transport (NMT) identified significant research gaps that limit the complete integration and efficiency of NMT systems, particularly in African contexts. Key gaps include a lack of empirical studies in small- and medium-sized towns, inadequate infrastructure for vulnerable road users, and limited investigation into socio-economic barriers towards NMT adoption. Table 2.11 presents the key findings and identified gaps from the reviewed literature. Future directions and recommendations by the authors to address the identified gaps are discussed.

Table 2.10: Key findings and identified gaps from reviewed literature

Literature reviewed (Authors)	Key findings	Identified gaps
Vanderschuren *et al*. (2022)	High rate of walking trips in urban areas across Africa; Numerous pedestrian fatalities as a result of inadequate infrastructure.	Need for safer, pedestrian-friendly urban planning in African cities.
UNEP and UNHSP (2022)	Most African roads lack essential NMT specifications for pedestrians and cyclists, resulting in poor safety outcomes	Inadequate funding for NMT infrastructure in African countries; need for international support.
MWT *et al*. (2013)	Windhoek lacks interconnected NMT routes; the lack of continuous and paved NMT pathways puts users at risk.	Limited studies on NMT infrastructure in smaller Namibian towns outside Windhoek.
Cooke *et al*. (2022)	Inadequate NMT facilities in cities like Cape Town impact accessibility and safety for vulnerable road users.	Need for an integrated urban NMT policy to meet the demands of lower-income neighbourhoods.
Fahim *et al*. (2022)	high noise and dust discourage NMT users, and the lack of NMT infrastructure in Bangladesh contributes to low satisfaction and utilisation.	Need for better urban planning and pollution prevention strategies to increase the appeal of NMT.
Mansoor *et al*. (2022)	The choice of NMT is heavily influenced by socio-economic variables; low-income users rely on walking, often in hazardous conditions.	Additional research on NMT barriers related to socio-economic and demographic factors is required.
Oviedo *et al*. (2021)	The lack of designated NMT routes and street illumination in Ghana and Ethiopia compromises pedestrian safety.	Need for further studies into how NMT users in other SSA countries view NMT infrastructure and safety.
Zhou *et al*. (2020)	The successful implementation of NMT infrastructure in Singapore and promoted active travel improved safety.	The potential impact of NMT infrastructure investments, similar to the case in Singapore, have not been thoroughly studied in SSA.

The development of context-sensitive NMT policies and infrastructure to improve safety, inclusivity, and accessibility in small- and medium-sized towns across Africa is a key area for future research. Vanderschuren *et al*. (2022) and UNEP and UNHSP (2022) recommend prioritising safe urban designs that specifically serves vulnerable road users, such as pedestrians and cyclists, by integrating dedicated pathways and crossings to reduce road fatalities. Additionally, Cooke *et al*. (2022) and Oviedo *et al*. (2021) recommend investigating the unique NMT requirements of marginalised and lower-income neighbourhoods, suggesting that urban planners take socio-economic factors into consideration when developing NMT systems to increase equitable access to transportation. Building on successful models, such as infrastructure improvements in Singapore, Zhou *et al*. (2020) provide SSA countries with insights into developing NMT solutions that are both practically feasible and culturally relevant. Furthermore, Fahim *et al*. (2022) and MWT *et al*. (2013) recommend additional empirical studies in under-investigated regions, particularly small towns, to address specific infrastructural and user satisfaction gaps. These recommendations point to a more comprehensive, multi-faceted approach of NMT planning that considers regional, social, economic variations in various urban and rural contexts.

2.11. Key conclusions from literature studies

This chapter addressed the body of research on the role and effects of non-motorised transport (NMT) on urban mobility and sustainability, with a focus on NMT infrastructure design, safety, and socio-economic factors. The following key conclusions were drawn regarding the benefits and challenges of NMT systems in developing urban areas:

i. NMT, particularly walking, remains the primary transportation mode in urban areas across Africa, especially among low-income populations. Pedestrians account for a large proportion of daily trips, with over 75 % of trips made on foot among poorer communities.

ii. Despite the high demand for NMT, African towns and cities, including those in Namibia, suffer from inadequate infrastructure such as insufficient sidewalks, cycle paths, and safe crossings. For instance, in Namibia, only 6 % of roads in Windhoek feature paved sidewalks.

iii. Due to the lack of dedicated NMT infrastructure, pedestrians and cyclists are at high risks of accidents. In Africa, over 33 % of road fatalities involve pedestrians. Urban areas in Namibia show similar challenges, with lack of lighting on NMT pathways, traffic volumes, and speeds often making NMT travel unsafe.

iv. Intelligent transport solutions (ITS) such as CCTV surveillance and solar-powered road studs can improve safety and accessibility for NMT users, particularly in areas prone to high vehicular speeds and low lighting.

v. Policies often prioritise motorised vehicles, sidelining NMT. For instance, transportation policies in Windhoek have historically overlooked NMT, limiting the development of comprehensive infrastructure for pedestrians and cyclists.

vi. Increased motorisation contributes to noise and air pollution, which are deterrents for NMT users. Additionally, socio-economic factors such as income and access to affordable transport options heavily influence NMT adoption.

vii. NMT provides affordable mobility for low-income groups, reducing household expenditure on transport. In African towns and cities, however, the lack of NMT infrastructure can intensify social inequalities, limiting access to essential services for disadvantaged populations.

viii. NMT offers significant health benefits through increased physical activity and reduced pollution. Regular use of NMT could help address rising health issues related to physical activity, including cardiovascular diseases and obesity.

ix. As an emission-free mode of transport, NMT contributes to lower carbon footprints and less air pollution. Expanding NMT can support urban areas in reducing overall transportation emissions.

x. Case studies from countries like Singapore demonstrate how integrated cycling and pedestrian networks, supported by strong policies, can enhance NMT adoption. These case studies provide models for African towns and cities, including those in Namibia, to integrate NMT into urban planning, aiming for safer and more efficient pathways.

A summary of the key empirical studies on NMT policies and infrastructure usage, their primary variables, and the modelling techniques used are presented in Table 2.12.

Table 2.11: Summary of key empirical studies on NMT: primary variables and modelling techniques

Authors	Focus	Variables	Modelling techniques
Lartey and Glaser (2024)	NMT demand and infrastructure in African cities	Urban design factors, motorisation rate, pedestrian and cyclist safety, public health benefits	Descriptive analysis, case study review
Oviedo *et al*. (2021)	Pedestrian safety and risk factors	Pedestrian behaviour, traffic levels, crosswalk conditions, demographics	Observational analysis, risk assessment
MWT *et al* (2013)	NMT infrastructure in Windhoek, Namibia	Road network type, pedestrian and cyclist facilities, accident rates, infrastructure gaps	GIS mapping, spatial analysis
Mansoor *et al*. (2022)	Socio-economic influence on NMT adoption	Household income, vehicle ownership, age, gender, geography, weather	Correlation analysis
Fahim *et al*. (2022)	NMT infrastructure user satisfaction in Bangladesh	Road conditions, access to public transport, safety features, environmental factors	Pearson Correlation Matrix, PCA
ITS and BP consulting engineers (2018)	NMT policy impact in Namibia	Traffic volume, vehicle speed, pedestrian accessibility, policy adherence	Policy impact assessment, descriptive statistics
Pisoni *et al*. (2022)	Environmental benefits of cycling	Emission reduction rates, frequency of NMT use, CO_2 levels	Life Cycle Assessment, CO_2 modelling
Khan *et al*. (2014)	Built environment impact on NMT in Washington	Street connectivity, bus stop density, access to NMT routes, socio-economic factors	Regression models

CHAPTER 3: RESEARCH METHODOLOGY

This chapter discusses the methodology that was adopted to investigate the current state of NMT provision, challenges, and opportunities in the towns of Tsumeb and Walvis Bay. Information pertaining to the study methodology is outlined in the subsequent subsections.

3.1. Introduction

The methodology outlines the approach used to achieve the study objectives in two main ways: first, by identifying relevant stakeholders and adopting a sampling method to estimate participant numbers for the study; and second, by gathering quantitative and qualitative data on user perceptions and experiences regarding NMT in the selected towns, as well as information on NMT infrastructure conditions and planning procedures. This section also describes the instruments, procedures, and software packages utilised for collecting and analysing data. The chapter is structured as follows:

i. Research design
ii. Study population
iii. Study setting
iv. Sampling approach
v. Research instruments
vi. Research procedures
vii. Data collection
viii. Data analysis
ix. Research ethics

3.2. Research design

A mixed methods approach was adopted for the study to ensure that the complexity of NMT planning, and provision were fully investigated. The method involved the collection of both quantitative and qualitative data. The integration of qualitative and quantitative data was opted to enhance the relevance and validity of the study. In-depth interviews with NMT users and Focus Group Discussions (FGDs) with policy makers were conducted as part of the qualitative aspect to explore their perspectives, experiences, and insights on NMT in the selected towns. Furthermore, quantitative data was gathered through surveys (closed-ended questionnaires) that were distributed to NMT policy makers in the selected towns and assessments of NMT infrastructure were conducted during field visits.

3.3. Study population

The target population for this study comprised of residents and commuters from the selected small- and medium-sized towns who use NMT modes, as well as NMT policy makers. A total of 70 participants from Tsumeb and 98 participants from Walvis Bay were recruited through stratified random sampling. The selection criteria that were used to identify stakeholders for the study are detailed in Table 3.1.

Table 3.1: Criteria for stakeholder engagement

Inclusion criteria	
Residency and commuting patterns	Participants had to be either regular commuters or present inhabitants of the selected towns. This guaranteed that participants were actively engaged with the urban transportation infrastructure under study.
NMT usage	Participants who used NMT for at least some of their daily travel or commuting activities were eligible to participate in the study. The eligible participants included cyclists, pedestrians, people with disabilities (PWDs) and users of other human-powered modes of transportation.
Age and demographic criteria	Participants from diverse age groups, socio-economic backgrounds, and demographic profiles were included in the study to capture a broad spectrum of experiences and perspectives related to NMT usage within the selected towns.
Exclusion criteria	
Non-residents	Participants who lived outside the selected towns were excluded from the study to maintain the geographic focus and relevance of the study.
Motorised transport users	Participants who solely depend on motorised means of transportation (such as private cars or motorbikes) for their daily commuting needs were excluded from the study, as the focus was on NMT users.

3.4. Study setting

The study assessed NMT infrastructure at identified locations (key NMT traffic generators and attractors) recognised as critical hubs for NMT activities within the selected towns. These locations featured built environment components, including pathways for pedestrians and cyclists, that promote the use of NMT modes such as walking and cycling. The study opted to assess the NMT infrastructure at these locations due to their status as prominent land uses, particularly for NMT users, and their potential to provide a wide range of data relevant to the study.

3.5. Sampling approach

The study adopted a stratified random sampling technique, grouping the population into subgroups (strata) based on shared attributes, such as NMT infrastructure usage and their involvement in the planning and provision of NMT infrastructure in the selected study areas. Potential stakeholders for each stratum were identified, and the sample size was subsequently calculated using the stratified random sampling formula. The researcher selected random participants from each stratum to form the sample, which was subsequently combined to create a complete stratified random sample. Adopting this method ensures that the sample accurately represents the population and minimises sampling errors, thereby improving result accuracy. The procedures on how stratified random sampling was conducted in the study are outlined in Figure 3.1.

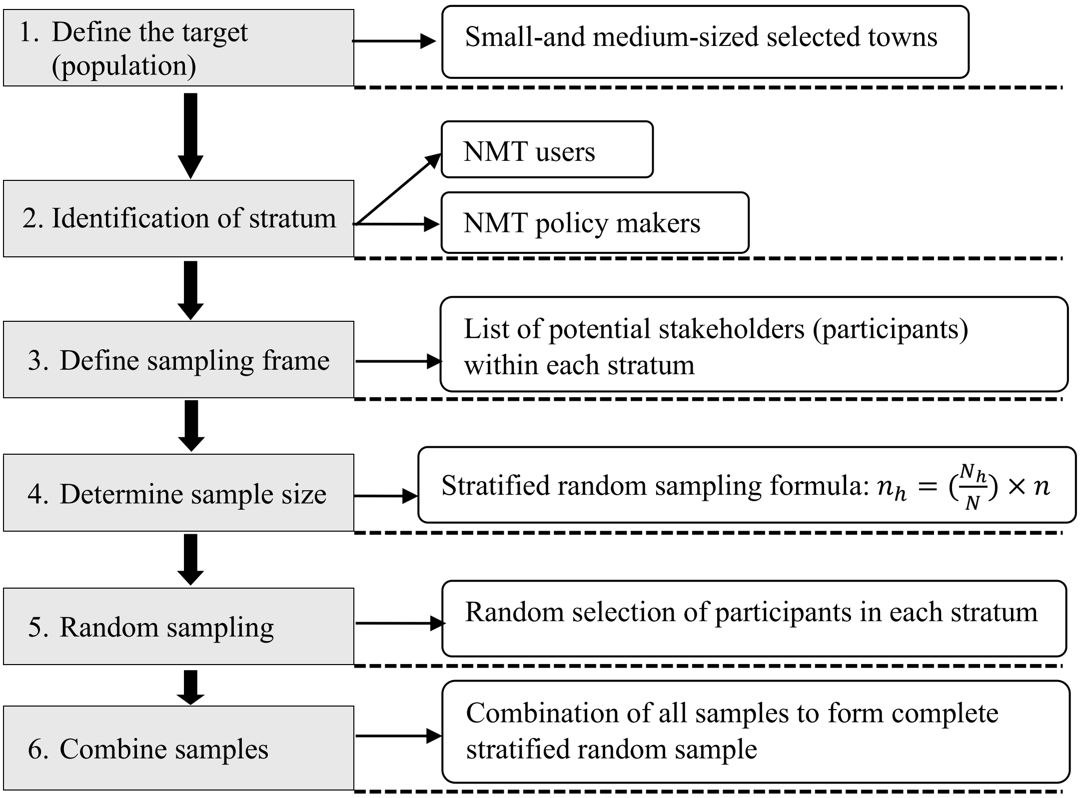


Figure 3.1: Stepwise process of stratified random sampling

In this approach, the sample size for each stratum is directly proportional to the population of that stratum, ensuring consistent sampling fractions across all strata. Equation 3.1 outlines the formula for stratified random sampling.

$$n_h = (\frac{N_h}{N}) \times n \quad (3.1)$$

Where; n_h = Sample size for h^{th} stratum

N_h = Population size for h^{th} stratum

N = Size of the entire population

n = Size of the entire sample

Stratified random sampling provides several advantages compared to other methods. Among the key advantages are the following:

i. Ensures that every segment of the population is sufficiently included in the sample, which is especially beneficial when the population displays notable diversity or variation across various characteristics.
ii. Provides a fair representation of the entire population by ensuring that each subgroup has an equal chance of being included in the sample.
iii. Better precision when compared to alternative probability sampling techniques.
iv. It is convenient to train a team to stratify a sample because of the precision inherent in this sampling technique.
v. Due to its statistical accuracy, smaller sample sizes can yield valuable results.

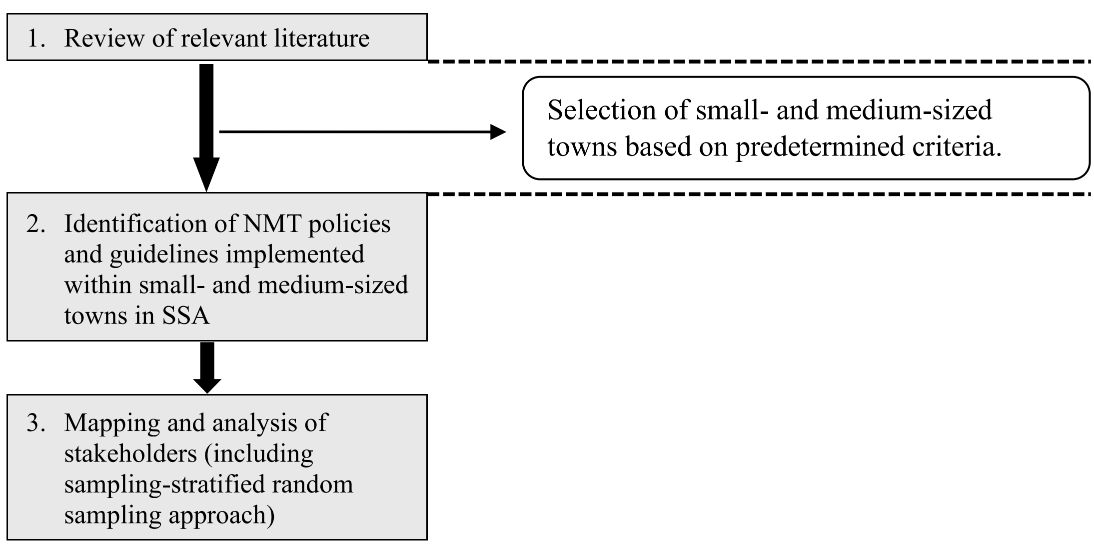
3.6. Research instruments

The following tools were used in this study:

i. Surveys: to gather data on travel behaviour, preferences and challenges. This involved the use of questionnaires and interviews.
ii. Tablets: to administer surveys and questionnaires among NMT stakeholders.
iii. Geographical Information System (GIS): for geospatial analysis and mapping.
iv. Smartphones: to take photographs of the NMT infrastructure as part of observational studies.

3.7. Research procedures

This section outlines the procedures that were undertaken throughout the study to achieve the objectives outlined in Chapter 1. The research procedures are illustrated in Figure 3.2. Further details on the study procedures are presented in the subsequent subsections.



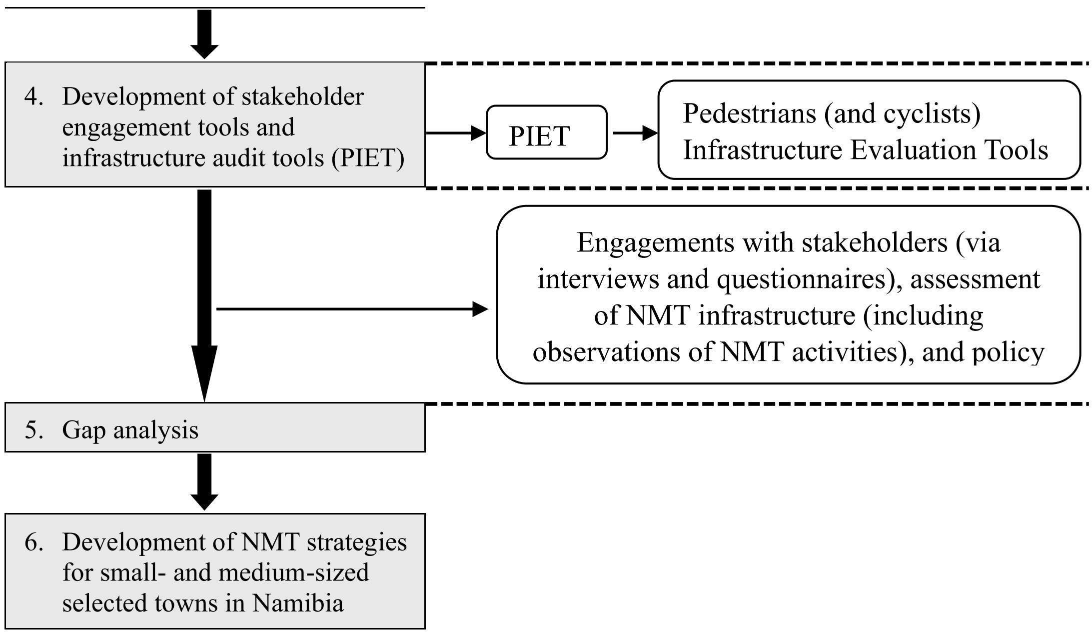


Figure 3.2: Research approach

3.7.1. Selection of study towns

The study selected two small- and medium-sized towns to achieve the objectives outlined in Chapter 1. To be selected, the small- and medium-sized towns had to meet the following criteria:

i. To have a quarter (¼) of the population of the capital (major) city.
ii. To have a population of 15,000 to 125,000 inhabitants.
iii. To be identified as a significant risk of pedestrian and cyclist injuries based on NMT crash data sourced from the National Road Safety Council (NRSC).

Data regarding the population meeting the selection criteria was sourced from the Namibia Statistic Agency (NSA) website. Figure 3.3 presents the outcomes for the towns in Namibia that satisfy the criteria mentioned above.

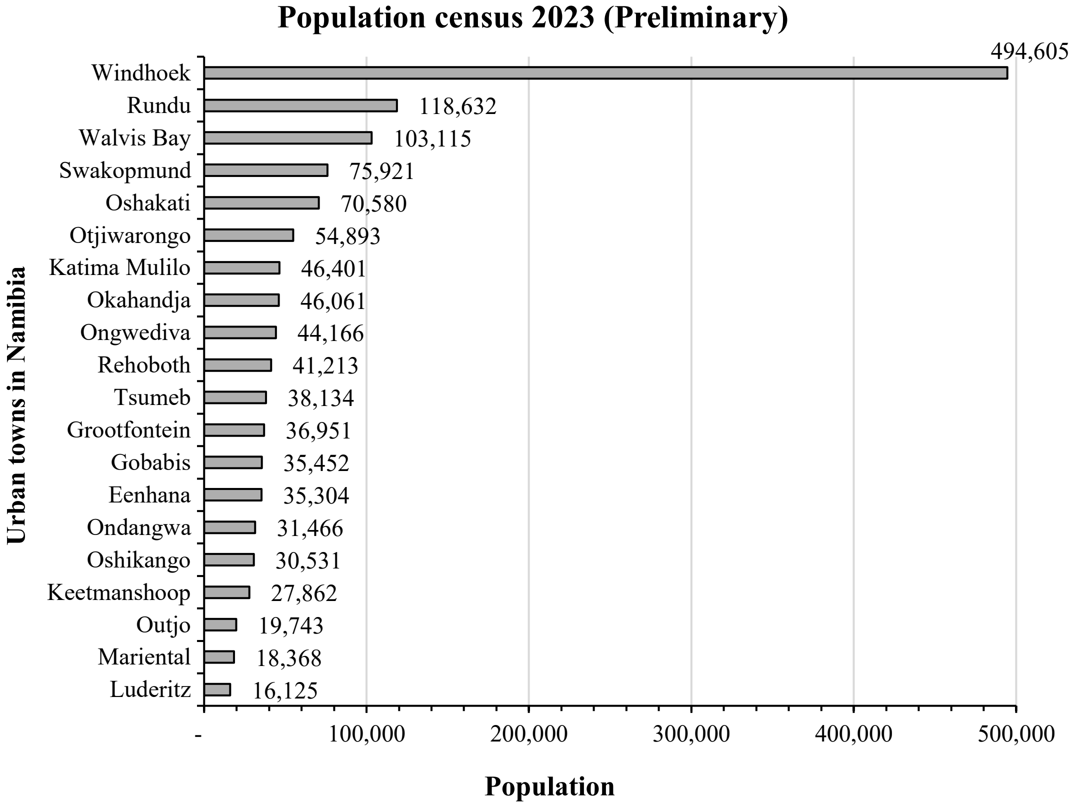


Figure 3.3: Towns with population greater than 15,000, adopted from (NSA, 2024)

The towns presented in Figure 3.3 were further categorised into the Top 10 Namibian towns with the highest occurrence of severe NMT accidents, based on the frequency of NMT crashes, to aid in selecting the two study towns. The study utilised data on the frequency of NMT crashes from 2019 to 2023, obtained from the NRSC, to ensure an all-inclusive selection process of the study towns, as shown in Figure 3.4.

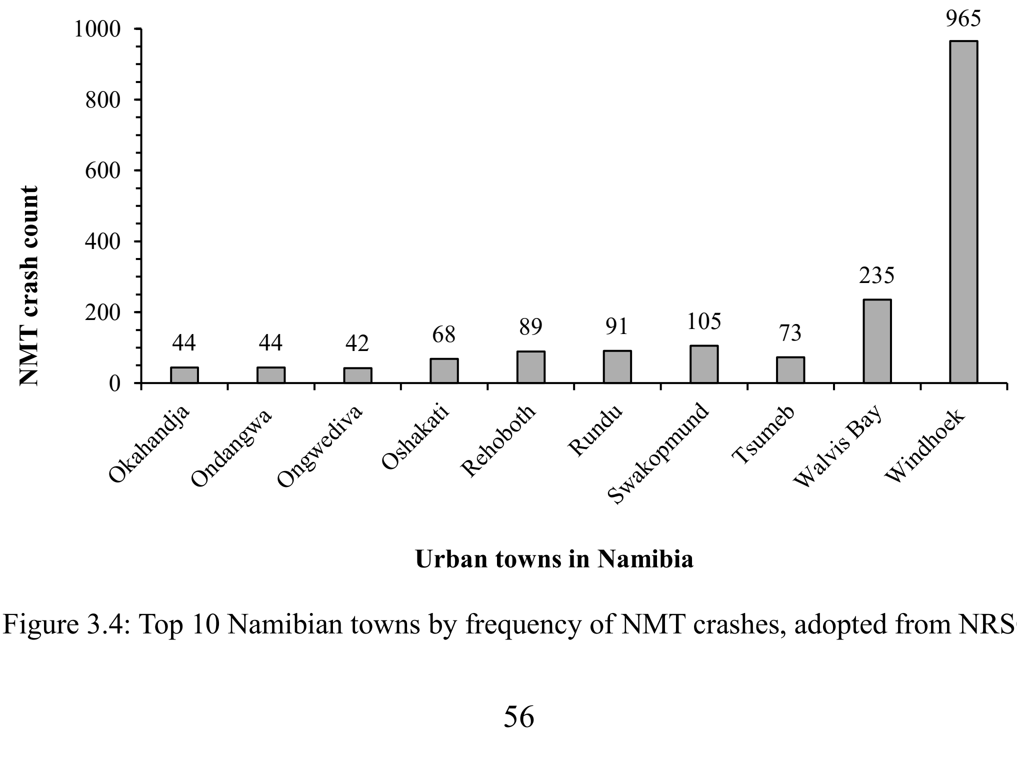


Figure 3.4: Top 10 Namibian towns by frequency of NMT crashes, adopted from NRSC

The data presented in Figure 3.4 indicate that small- and medium-sized towns in the northern and western regions of Namibia, which meet the selection criteria for the study, exhibit the highest occurrence of severe NMT crash statistics. The crash rate per 10,000 population for the towns illustrated in Figure 3.4 was calculated using population census data from Figure 3.3 and NMT crash counts from Figure 3.4, to aid in the selection of the two study towns. The formula for calculating the crash rate per population and the corresponding outcomes are outlined in Equation 3.2 and Table 3.2 respectively.

$$\text{crash rate per population} = \frac{\text{NMT crash count}}{\text{Population}} \times 10,000 \tag{3.2}$$

Table 3.2: Crash rate per population

Town	NMT crash count	Population	Crash rate
Okahandja	44	46,061	9.553
Ondangwa	44	31,466	13.983
Ongwediva	42	44,166	9.510
Oshakati	68	70,580	9.634
Rehoboth	89	41,213	21.595
Rundu	91	118,632	7.671
Swakopmund	105	75,921	13.830
Tsumeb	73	38,134	19.143
Walvis Bay	235	103,115	22.790
Windhoek	965	494,605	19.511

From Table 3.2, it can be observed that three towns (shaded in grey) have the highest crash rate per 10,000 population. Tsumeb and Walvis Bay were selected as the study towns to represent a town in the western and northern regions, respectively, based on the preliminary analysis of the frequency of NMT crashes from Figure 3.4 and the crash rate per 10,000 population presented in Table 3.2. The approach for selection of Tsumeb and Walvis Bay as study towns enhances relevance and generalisability for similar Namibian towns and areas with similar urban characteristics.

3.7.2. Identification of guidelines and reports

The study utilised several chosen guides and reports as a foundation to understand the NMT policy environment in the selected small and medium-sized towns in Namibia. These resources include:

i. The Capacity and Network Development of Non-Motorised Transport in Northern Namibia, part of the Implementation of the Master Plan for Sustainable Transport for Ohangwena, Omusati, Oshana, and Oshikoto Regions in Northern Namibia (Ministry of Works and Transport and GIZ GmbH, 2017).

ii. The 2018 Non-Motorised Transport Strategy for the City of Windhoek (ITS and BP consulting engineers, 2018).
iii. Sustainable Urban Transport Masterplan for Windhoek (MWT, CoW and GIZ, 2013).
iv. SANRAL Guidelines for Pedestrian and Public Transport Facilities on National Roads (SANRAL and ITS, 2017).
v. NMT Facility Design Guidelines 2014: Policy and Legislations, Planning, Design and Operations (SMEC and UCT, 2014).
vi. TRH 26 South African Road Classification and Access Management Manual (SANRAL, 2012).
vii. Technical Guideline for Bicycle Infrastructure Design in Urban Area (ATI *et al.*, 2023).

An in-depth review of the selected guides and reports has been discussed in Chapter 2.

3.7.3. NMT stakeholder mapping and analysis

The potential key stakeholders were identified, mapped, and analysed through interactions with relevant personnel, desktop searches, referrals, and other sources of information. The primary stakeholder and role player groupings for this study included, but were not limited to:

i. Government departments: National and regional
ii. Regional, local authorities and councils:
    - City/Town engineers
    - Town/City planners/spatial planners
iii. Communities in Urban/Peri-Urban areas:
    - Vulnerable Road Users (VRUs), particularly pedestrians and cyclists, within the study areas.

Identified stakeholders were analysed and categorised based on their influence and decision-making authority concerning NMT policies and strategies, as well as their level of interest in the study. The engagement strategy was formulated based on the outcome of the analysis outlined in Figure 3.5.

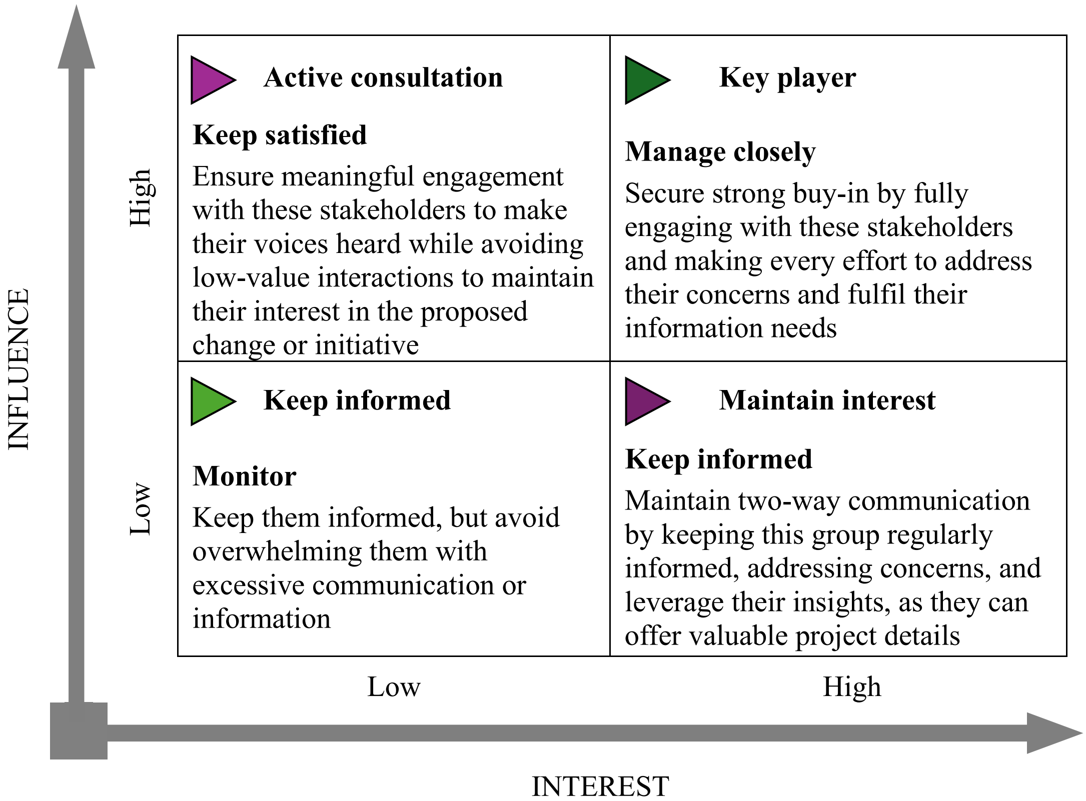


Figure 3.5: Stakeholder influence vs interest matrix

3.7.4. Development of innovative NMT stakeholder engagement tools

The approach for engaging the various identified stakeholders was determined by the results of the stakeholder mapping. The stakeholder engagement tools were designed according to the specific objectives of the engagement, ensuring that they facilitate productive interactions and effective input collection. The study utilised google forms and softcopy questionnaires as survey tools. The digital survey tools (Google Forms) were used to input responses from NMT users during interviews. Separate Google Forms were accessible to policy makers through a link shared via email and remained open for responses indefinitely. The questions that were used to develop the Google Form surveys for NMT user and policy maker engagements are presented in Appendix D.1 and Appendix E.1 respectively.

3.7.5. Development of NMT infrastructure audit tools

The NMT infrastructure audit tools were developed to highlight the general conditions and issues of NMT infrastructure as well as the availability of crosswalks, sidewalks, and bikeways at the study locations in each town – see Section 5.3 and Appendix C.

3.8. Data collection

This study aimed to investigate the current state of NMT provision, challenges, and opportunities in the towns of Tsumeb and Walvis Bay.

The objectives of this study were:

i. To evaluate the extent of NMT networks in the selected towns.
ii. To examine NMT infrastructure conditions in the selected towns.
iii. To evaluate NMT user safety and perceptions in the selected towns.
iv. To evaluate NMT planning (policies, frameworks, and strategies).
v. To evaluate the capacity for the provision of NMT infrastructure and planning (human resource and financial).
vi. To develop phased strategies for NMT in the selected towns.

The data collection process undertaken to achieve the study objectives are outlined in Figure 3.6 and discussed thereafter.

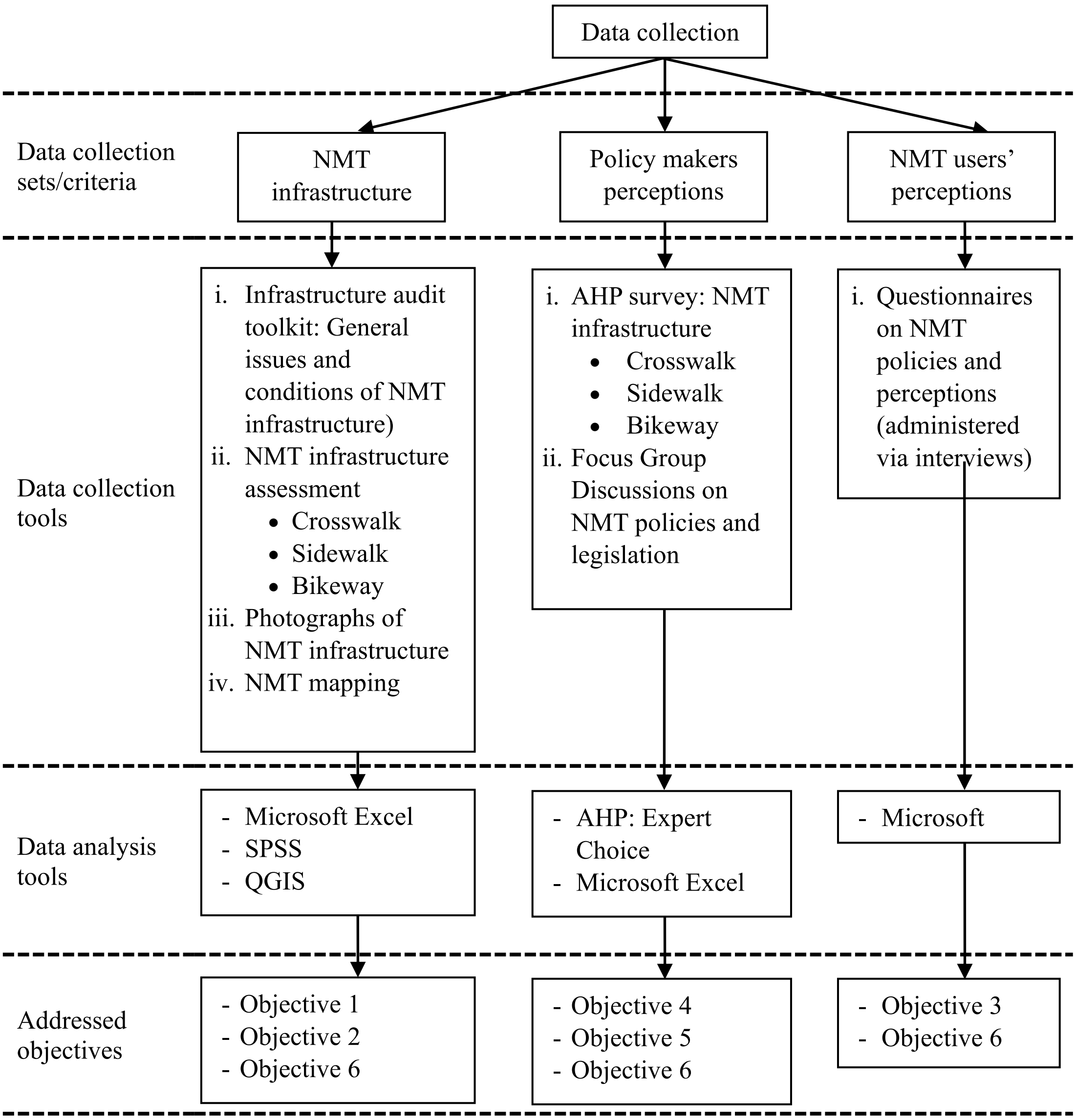


Figure 3.6: Data collection process

Data were collected using a three-pronged approach and an integrated analyses of the collected data was conducted thereafter. The collected data included information regarding NMT infrastructure conditions, and the perceptions of both policy makers and non-motorised transport (NMT) users. Firstly, NMT infrastructure assessments of the general issues and conditions of NMT infrastructure, as well as assessments of specific NMT elements including crosswalks, sidewalks, and bikeways, were conducted using the developed infrastructure audit toolkits discussed in Section 5.3 and presented in Appendix C. Photographs of existing NMT infrastructure were also captured as part of observational studies accompanied by NMT infrastructure mapping to identify areas with existing infrastructure across the selected study towns. Secondly, perceptions of policy makers were gathered through questionnaires – AHP survey (see Appendix E.1) focused on NMT infrastructure – and focus group discussions (FGDs) on NMT policies and legislation implemented in the selected towns as well as the capacity for the provision of NMT infrastructure and planning. FGDs were conducted with policymakers from regional and local governments, including town/city engineers and spatial/town planners. These participants were selected primarily for their roles in municipal NMT infrastructure design and development. The FGDs explored existing policy frameworks, planning tools, and institutional capacity linked to NMT. Key themes that emerged included: Outdated and fragmented infrastructure, policy and planning gaps, financial and human resource constraints, lack of community involvement, and disconnection from broader transport network. The questions that formed the basis of the FGDs are discussed in Appendix E.2. Lastly, perceptions of NMT users regarding safety and infrastructure provision was gathered through interviews. Data was analysed using tools such as Microsoft Excel, SPSS, AHP: Expert Choice, and QGIS, with each set of collected data linked to specific study objectives, as shown in Figure 3.6. The data analyses procedures are detailed in the subsequent section.

3.9. Data analysis

Data in this study were analysed using Graphical Information System (GIS), Microsoft Excel, IBM SPSS 25 software, and Analytical Hierarchy Process (AHP). The programs were used to perform univariate and bivariate analyses. Information on how data analyses were undertaken are presented in the following sections.

3.9.1. Graphical Information System (GIS)

GIS was used in the study to visualise and analyse geographic data. QGIS, an open-source GIS software was employed to map and evaluate the NMT network, particularly the extent of NMT infrastructure availability in the selected study areas. The software was used to analyse land uses and zoning; thereafter, areas with high coverage, connectivity, and good quality of infrastructure available to NMT users, such as pedestrians and cyclists, were identified. Moreover, the software was used to identify locations within the study towns with potential for high NMT movements, through an analysis of land zones and land uses. NMT volume counts during peak hours were conducted at the identified locations to assess the usage of NMT in the study areas.

3.9.2. Microsoft Excel

Microsoft Excel was used for data entry to input interview responses from NMT users. These responses were coded accordingly to clean and condense the data, as well as omit possible outliers. Data was imported to IBM SPSS 25 software for further analysis. Thereafter, graphs of frequency (in percentage) of responses were plotted in Microsoft Excel for interpretation.

3.9.3. Statistical Packages for the Social Sciences (SPSS)

Interview responses from non-motorised transport (NMT) users were analysed using IBM SPSS 25 software. Frequency analysis (statistical tool) was utilised in SPSS to identify patterns, trends, and common themes from interview responses (qualitative data). Moreover, frequency analysis was employed to quantify interview responses – insights – from NMT users, making it easier to compare and interpret results systematically.

3.9.4. Analytical Hierarchy Process (AHP) – statistical method

The Analytical Hierarchy Process (AHP), developed by Saaty in 1990, is a Multi-Criteria Decision Analysis (MCDA) tool designed to evaluate complex, hard-to-quantify decision-making processes (Bivina and Parida, 2020). The process entails pairwise comparisons to assign weights indicating the relative influence of attributes (Patil and Majumdar, 2022). Grounded in rational decision-making theory, AHP incorporates subjective assessments, typically from experts, to rank criteria by perceived importance and calculate weights based on these rankings (Rajina Rahiman and Naseer, 2022). AHP is particularly useful in situations where qualitative information is difficult to quantify. Its ability to rank, weigh, and prioritise enables analysts to transform abstract concepts into quantitatively measures effectively (Rajina Rahiman and Naseer, 2022). AHP supports group decision-making by organising decision problems hierarchically into goals, criteria, and alternatives, incorporating intangible factors and verifying expert judgements through consistency checks (Patil and Majumdar, 2022). The method aids in understanding phenomena, has a simple mathematical foundation, and applies to both individual and group decisions (Rajina Rahiman and Naseer, 2022).

The approach structures a decision problem as a hierarchical upside-down tree, with the primary objective positioned at the apex. Subordinate objectives, or criteria, aligned with the main objective are placed at the second tier and can be further broken down into third-level objectives, with each set at every tier aligned to meet the objective of the superior level to which they are subordinate. At lower levels, alternatives are enumerated and evaluated pairwise based on their impact on achieving each objective or criterion from the lower tier (Bivina and Parida, 2020; Leal, 2020). Pairwise comparisons are carried out at the fundamental scale shown in Table 3.3 using the Saaty scale approach.

Table 3.3: Foundational Saaty scale, adapted from (Leal, 2020)

Intensity of importance	Description
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance

The AHP is a versatile decision-making tool used across the fields of economics, politics, and engineering (Leal, 2020). According to Rajina Rahiman and Naseer (2022), AHP has been effectively applied in previous research to evaluate the hierarchy of pedestrian needs, assign weights, and establish scores for walkability indices in an Indian city. Rajina Rahiman and Naseer (2022) further report that AHP helps prioritise criteria influencing pedestrians' choices to walk in urban areas of India. The technique also serves as a tool for qualitative evaluation and subjective assessment. A study Bivina and Parida (2020) suggests that AHP is applied in various areas such as selecting traffic tools, prioritising tasks, and evaluating transportation options.

Several methods of Multi-Criteria Decision Analysis (MCDA) include AHP (Analytical Hierarchy Process), TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), ELECTRE (Elimination and Choice Expressing Reality), and PROMETHUS (Preference Ranking Organization Method for Enrichment of Evaluations) (Bivina and Parida, 2020). Among these methods, AHP is recognised for its ability to establish a complete ranking of options, ordered from most preferred to least preferred. It has been widely adopted as the preferred technique for addressing problems with multiple objectives (Bivina and Parida, 2020). The method is noted for its reliability and flexibility in accommodating the perspectives of decision-makers involved in urban planning and transportation investments (Bivina and Parida, 2020).

The Analytic Hierarchy Process (AHP) tool was used in the study for decision-making purposes. By structuring decision problems hierarchically and drawing out pairwise comparisons, AHP aided in formulating recommendations that will enable stakeholders to make informed decisions to promote the accessibility, safety, and sustainability of NMT systems.

The following procedures were followed for the AHP (Bivina and Parida, 2020):

i. The ranking problem was developed by means of a hierarchical framework with goal, criteria, and alternatives.

ii. Pairwise comparisons were formed separately for each criterion and its alternatives. The following equations present the decision matrix with values of alternatives (a_{ij}) and criteria weights (w_j).

$$[C_1 \quad C_2 \quad . \quad C_m] \text{ Criteria} \tag{3.3}$$

$$[w_1 \quad w_2 \quad . \quad w_m] \text{ Weights} \tag{3.4}$$

$$\begin{bmatrix} A_1 \\ A_2 \\ . \\ A_n \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} & . & a_{1m} \\ a_{21} & a_{22} & . & a_{2m} \\ . & . & . & . \\ a_{n1} & a_{n2} & . & a_{nm} \end{bmatrix} \text{ Alternatives} \tag{3.5}$$

iii. A scale of numbers was used to compare how important one element was with respect to another element. The comparison of importance between responses was done using the Saaty scale ranging from 1-9, which has been detailed in Table 2.10 – Chapter 2.

iv. Principal eigenvalue and nominalised eigenvector were calculated. The nominalised eigenvector includes weights based on criteria or alternative. For a pairwise matrix

$$\begin{bmatrix} a_{11} & a_{12} & . & a_{1m} \\ a_{21} & a_{22} & . & a_{2m} \\ . & . & . & . \\ a_{n1} & a_{n2} & . & a_{nm} \end{bmatrix} \tag{3.6}$$

The values in each column were summed up

$$a_{ij} = \sum_{i=1}^{n} a_{ij} \tag{3.7}$$

The nominalised pairwise matrix is calculated by dividing each matrix element by its sum of columns

$$X_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \begin{bmatrix} a_{11} & a_{12} & . & a_{1m} \\ a_{21} & a_{22} & . & a_{2m} \\ . & . & . & . \\ a_{n1} & a_{n2} & . & a_{nm} \end{bmatrix} \tag{3.8}$$

The weighted matrix is calculated by summing the nominalised columns of the matrix and dividing by the number of criteria.

$$W_{ij} = \frac{\sum_{j=1}^{n} x_{ij}}{n} \begin{bmatrix} W_1 \\ W_2 \\ W_3 \\ . \\ W_m \end{bmatrix} \tag{3.9}$$

v. This W_{ij} provides weights of parent criteria. The same process was used to calculate the alternative weights. The local weights of the alternative were multiplied by the weights of the parent criteria to determine the global weights of the alternative.

vi. Two indices, consistency ratio (CI) and consistency index (CR), were used to assess the matrix consistency. CR and CI are computed when λ is obtained,

Where – the consistency ratio compares the CI to a random index (RI) value, based on matrix size.

$$\frac{\lambda_{max} - n}{n-1} \tag{3.10}$$

$$CR = \frac{CI}{RI} \tag{3.11}$$

The decision is considered consistent if CR < 0.1

3.10. Research ethics

Addressing ethical concerns is essential to maintaining the validity and integrity of the study. Consequently, ethical clearance was obtained from the School of Engineering and the Built Environment Ethical Clearance Committee at the University of Namibia. The following methods were used to address ethical considerations for the study:

i. The study adhered to rigorous data collection and analysis methods, documented the procedures, and ensured data were recorded accurately and consistently.
ii. Private data regarding the locations and travel habits of participants were safeguarded to protect the privacy of participant data and personal information.
iii. Consent was obtained from participants before involving them in the study and they were made aware of the purpose, methods, risks, and benefits related to the study.

CHAPTER 4: STUDY AREAS

This chapter presents information on the selected study towns. Locations (key NMT generators and attractors) where NMT infrastructure was assessed in each study town are illustrated and discussed in this chapter.

4.1. Introduction

The study selected two small and medium-sized towns in Namibia based on a set of criteria, including having a population equivalent to at least a quarter of that of the major city, exceeding 15,000 inhabitants, and being identified as having a significant risk of pedestrian and cyclist injuries, based on NMT crash data sourced from the National Road Safety Council (NRSC). The selected study towns are Tsumeb and Walvis Bay – see Figure 4.1. This selection is crucial because it ensures that the developed strategies and interventions can have the greatest impact where they are most needed.

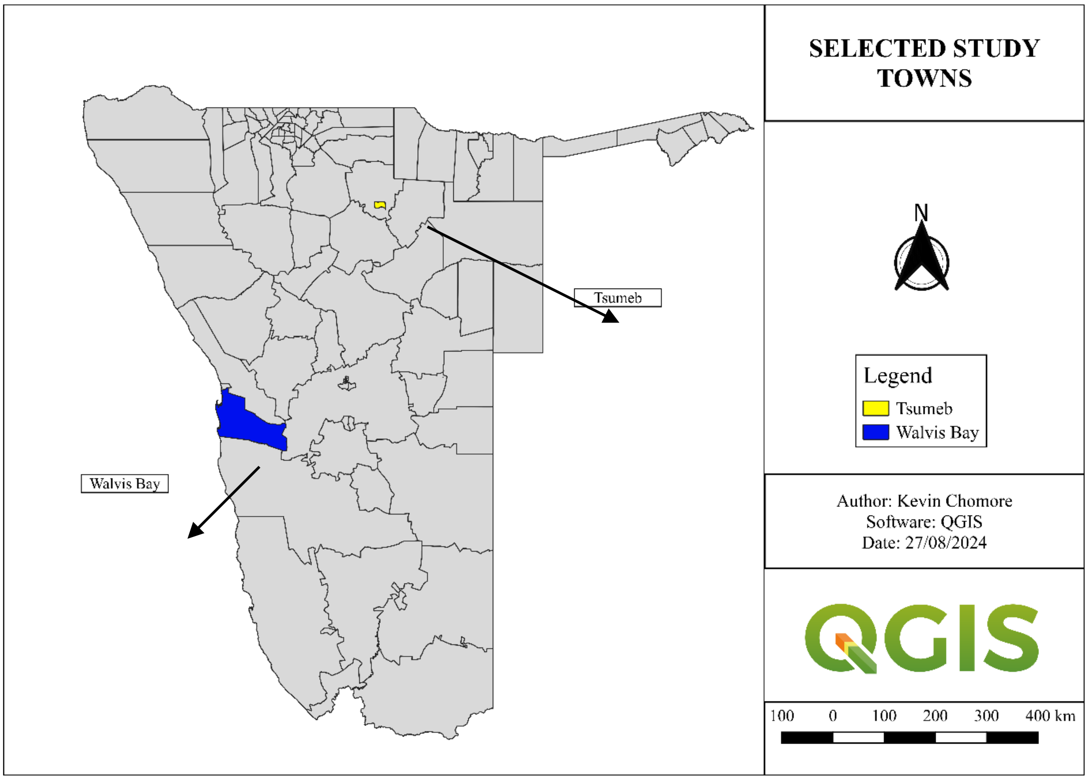


Figure 4.1: Study towns

4.2. Tsumeb

Tsumeb is the largest town in the northern Namibian region of Oshikoto, home to about 38,000 people. The town covers 18 square kilometres. Tsumeb, recognised as the "gateway" to northern Namibia is the nearest town to the Etosha National Park. Three study locations were assessed in Tsumeb to identify challenges related to NMT, as seen in Figure 4.2. The streets, roads, or avenues assessed in each location are detailed in Figure 4.3. The first location was the central business district (CBD), where NMT infrastructure conditions were assessed along Hage Geingob Drive, also known as B1. This road section was selected because it forms part of the main route running through the town and serves as the commercial and economic centre in Tsumeb, where pedestrian and cyclist activity is typically highest due to the concentrated businesses, services and public transport connections. The second location was the informal settlement, where NMT infrastructure was assessed along Leevi Mueshekele Street. This street was selected because it is the main arterial road that serves as the primary route for commuters walking and cycling between the informal settlements and other parts of town. Streets in informal settlements often encounter distinct NMT challenges, such as inadequate infrastructure, and safety concerns, all of which tend to affect mobility for residents. The third location, in high-income areas, encompassed two routes: 1st Avenue and Ilse Schatz Street. These routes were selected because they lead to several schools in the town and pedestrian movements are prominent in these streets.

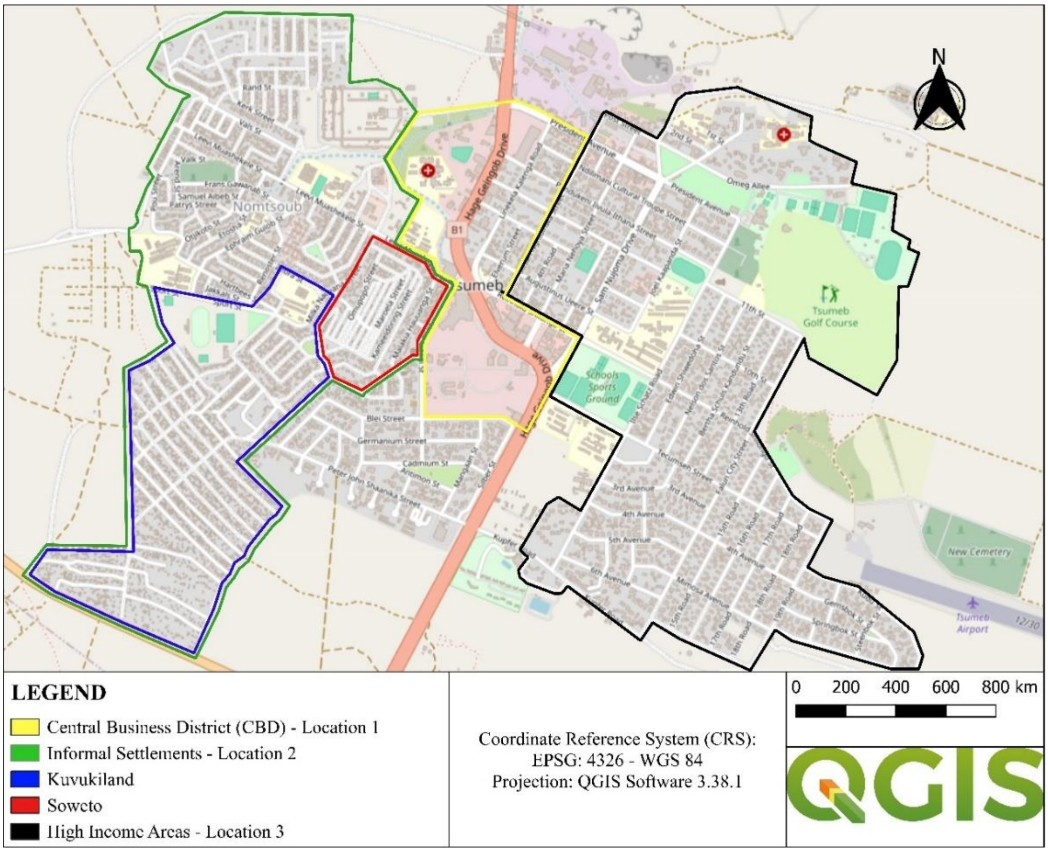


Figure 4.2: Study locations in Tsumeb

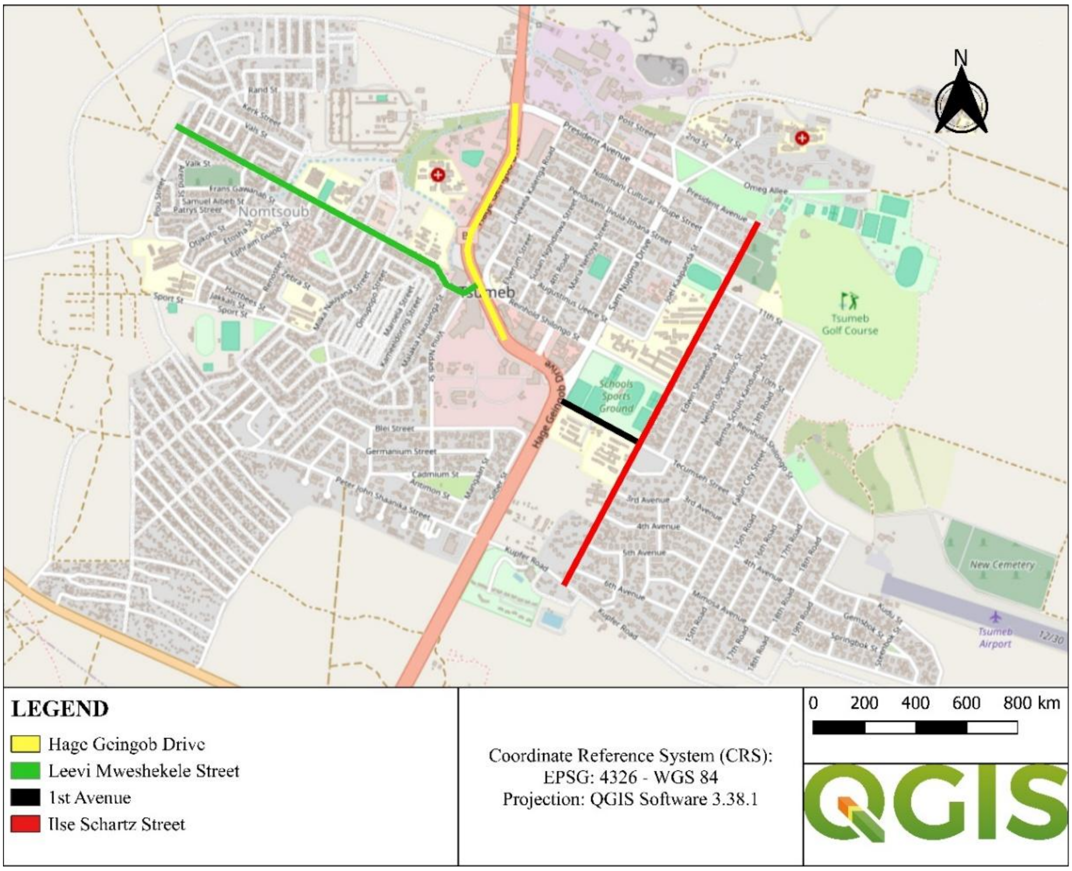


Figure 4.3: Assessed routes (streets) in Tsumeb

4.3. Walvis Bay

Walvis Bay in Namibia, named after the bay on which it is located, is the largest coastal town and the second largest town in the country. The town is located approximately north of the Tropic of Capricorn in the Kuiseb River delta, near the terminus of the TransNamib Railway to Windhoek and on the B2 road. The city covers 29 square kilometres of land. The study assessed three distinct locations in Walvis Bay to identify challenges related to NMT – see Figure 4.4. The first location was the central business district (CBD), which included four routes: 6th street, Sam Nujoma Avenue, Hage Geingob Street, and Theo-Ben Gurirab Street. The CBD was selected due to its high pedestrian and bicycle traffic. The second location was Kuisebmond informal settlement. The NMT infrastructure assessments in Location 2 were conducted on Nathaniel Maxuilili Avenue and Agaat street because these streets are the main arterial roads used by pedestrians and cyclists to travel from the informal settlements to the CBD and town areas. The informal settlement was also included in the study due to its unique NMT challenges, such as safety concerns, inadequate infrastructure, and limited access to basic services, all of which affect mobility for residents. The third location was Naraville, encompassing Sam Nujoma Avenue, Namib Street, and Caesar Martin Street. This location was assessed because it contains three major arterial roads that are commonly used by NMT users traveling to the town centre, establishing it a critical hub for NMT activities.

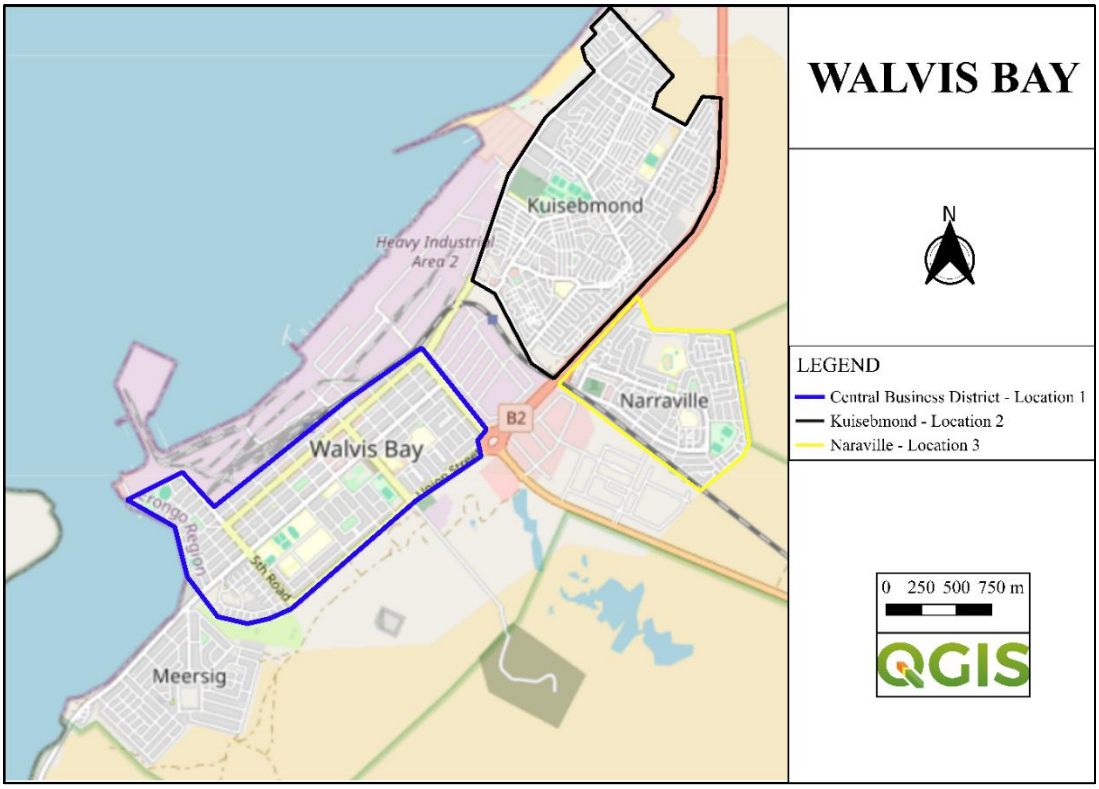


Figure 4.4: Study locations in Walvis Bay

The routes that were assessed at the CBD – Location 1 – are illustrated in Figure 4.5.

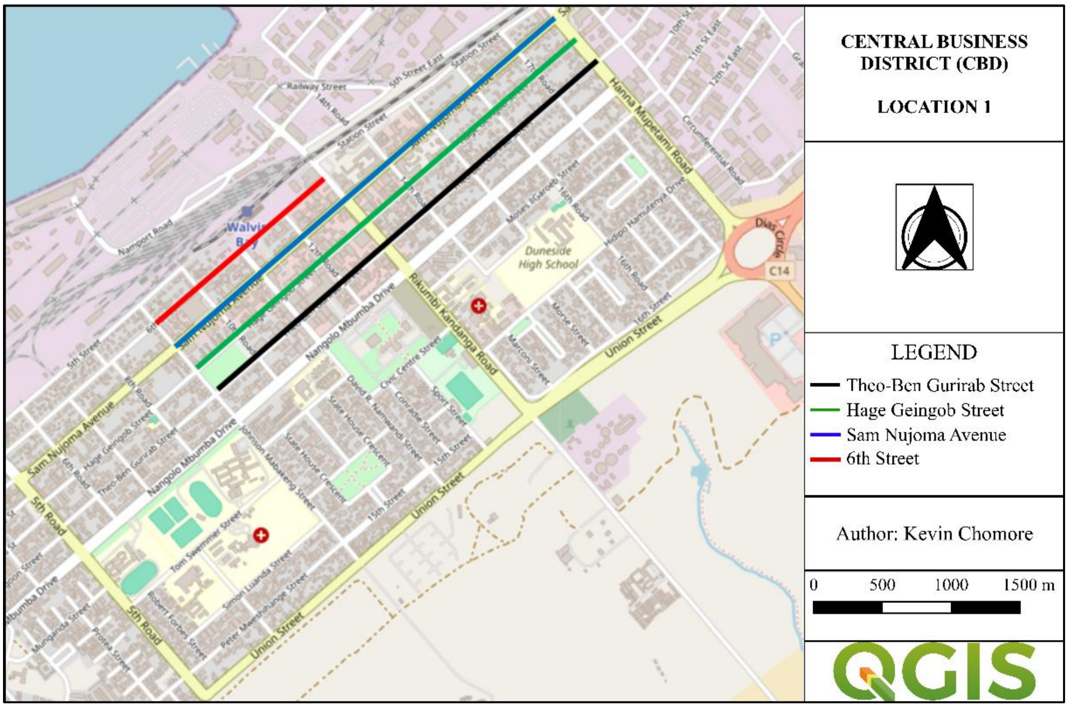


Figure 4.5: Assessed routes (streets) at the CBD – Location 1

The routes that were assessed in Kuisebmond – Location 2 – are illustrated in Figure 4.6.

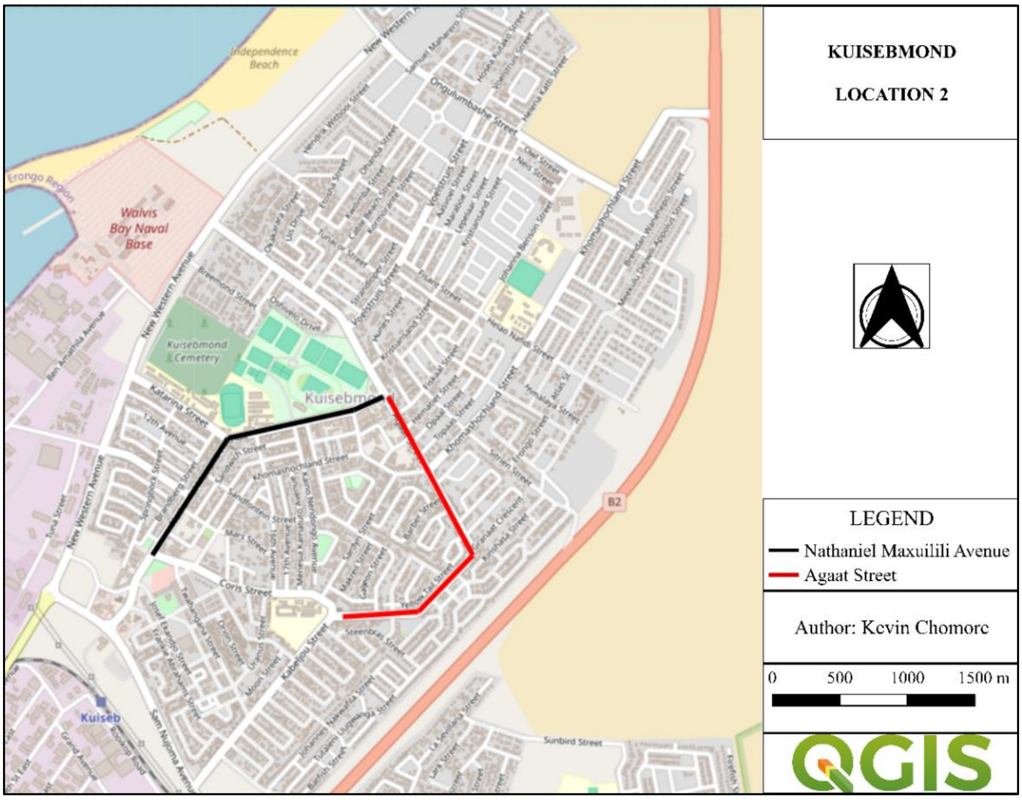


Figure 4.6: Assessed routes (streets) at the informal settlements – Location 2

Figure 4.7 illustrates the main arterial routes that were assessed at Naraville – Location 3.

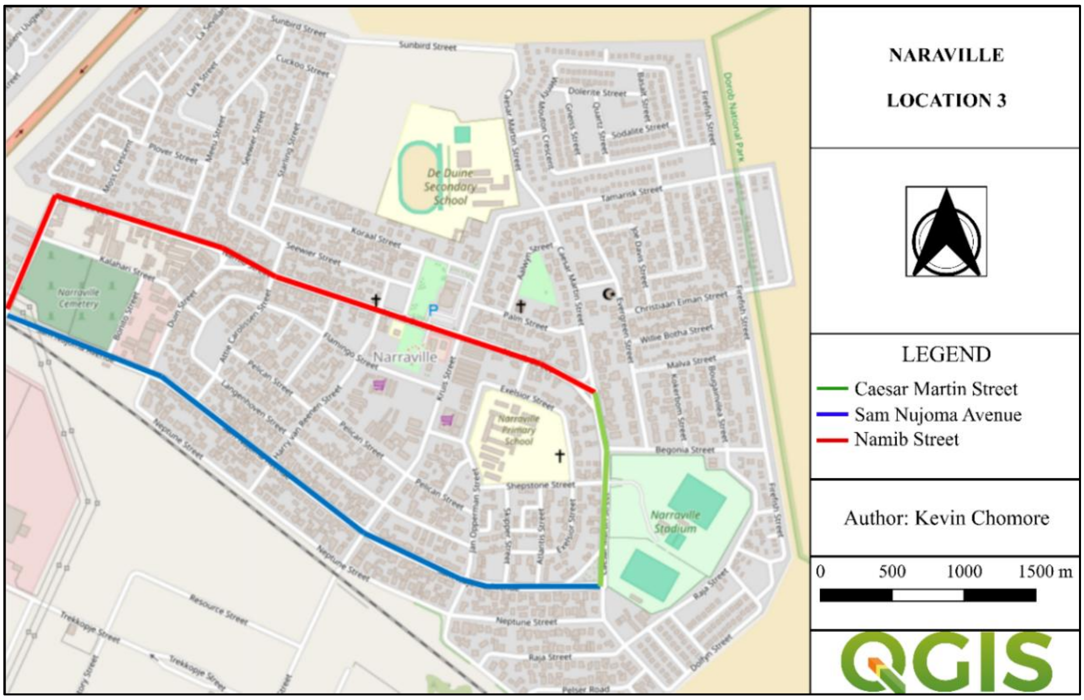


Figure 4.7: Assessed routes (streets) at Naraville – Location 3

CHAPTER 5: RESULTS AND DISCUSSIONS

This chapter presents the findings of the study. The results from the study are presented in various formats, including figures, tables, and graphs, to provide a clear and concise representation of the outcomes. A detailed analysis and discussion of the study findings is presented in this chapter.

5.1. Introduction

Limited studies on non-motorised transport (NMT) have employed an integrated data collection approach, combining input from NMT users, policy makers, and infrastructure assessments. Most studies on NMT focus on one or two of the inputs in their data collection processes, resulting in a lack of comprehensive insights on NMT challenges. Thus, a mixed methods approach was utilised in the study to thoroughly investigate the complexity of NMT planning and provision. The study findings are presented and discussed in the subsequent subsections.

5.2. Evaluation of NMT networks

The extent of non-motorised transport (NMT) networks in the selected study towns was evaluated by mapping the availability of NMT infrastructure and conducting NMT volume counts during peak hours on major arterial roads. These methods were utilised to assess both the coverage and actual usage of NMT infrastructure, providing insights into current demands and network adequacy.

5.2.1. NMT infrastructure overview

Non-Motorised Transport (NMT) infrastructure mapping was conducted in the study towns to evaluate the coverage, connectivity, and quality of facilities for pedestrians and cyclists. Figure 5.1 shows the fragmented nature of the existing NMT network in Tsumeb, with unpaved roads indicating areas with a complete absence of NMT facilities. Observations from the study locations (Figure 4.2, Chapter 4) and the map presented in Figure 5.1 reveal that the complete absence of NMT infrastructure was limited to informal settlements. The town lacks interconnected pedestrian and cyclist facilities as alternatives to vehicle or bus travel, resulting in few walkways or cycling routes (see Figure 5.1), with notable exceptions such as Hage Geingob Drive, Leevi Mueshekele Street, Efraim Guiob Street, Milka Nauyana Street, Ilse Schatz Street, and various routes in high-income areas. While these arterial roads provide some infrastructure for NMT users, they lack safe and interconnected pathways, despite sufficient road reserve to accommodate these facilities. Furthermore, an absence of dedicated cycling lanes was observed, forcing cyclists and pedestrians to share pathways, increasing accident risks, while poor infrastructure designs, such as obstructions (e.g., poles) and poor drainage designs, compelled NMT users to share roads with motorised vehicles, posing safety risks. Poor NMT facilities reflects a systemic disregard for pedestrian and cycling needs, increasing vehicle dependency and excluding those without private transport. Accessibility issues, including the absence of lowered kerbs and gaps between crosswalks and sidewalks, were noted to be major barriers for NMT usage, particularly for people with disabilities. The fragmented and inconsistent NMT infrastructure in Tsumeb is further analysed in Section 5.3.1. The observations on insufficient connectivity discussed in this section are reflected in the challenges identified in the informal settlements and the central business district (CBD) of Tsumeb, such as unpaved sidewalks, poorly designed drainage structures on NMT facilities, and gaps between sidewalks and crosswalks as outlined in sections 5.3.1.1 and 5.3.1.2. These gaps indicate policy neglect, not just technical faults. Fragmented networks deter vulnerable users and diminish NMT use, resulting in inefficient mobility and poor urban cohesiveness. Thus, inclusive planning is urgently required.

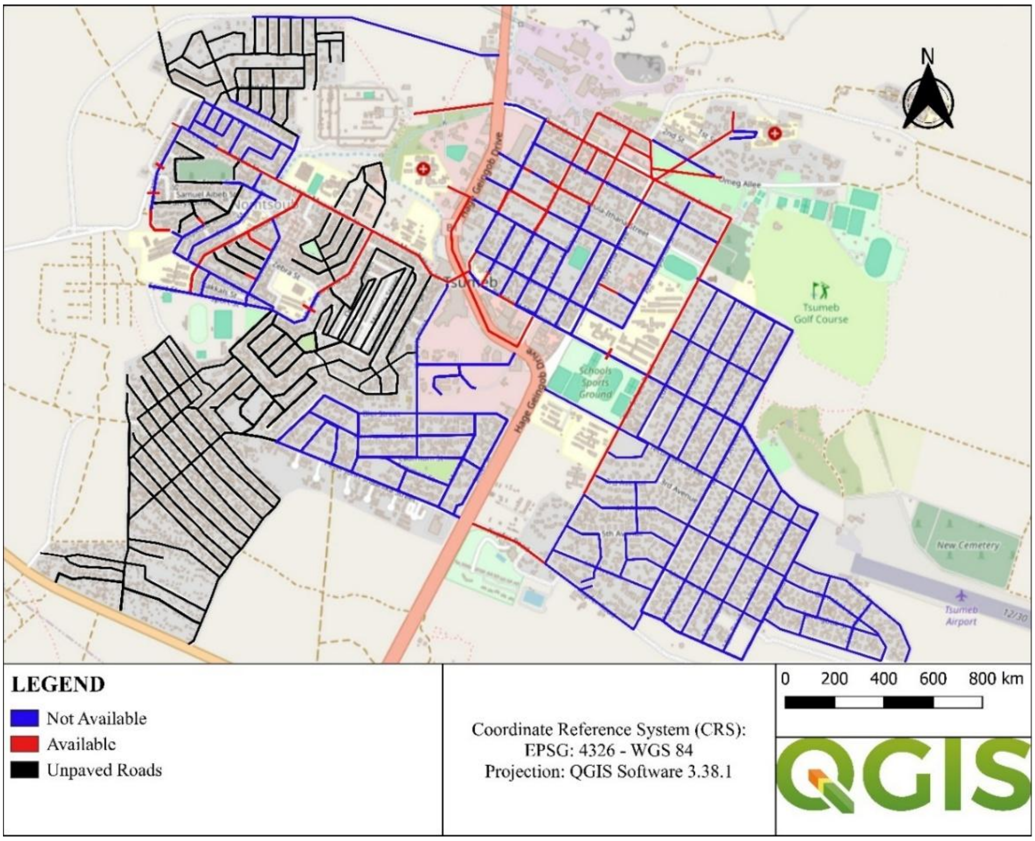


Figure 5.1: Availability of NMT infrastructure in Tsumeb

NMT infrastructure, in the case of Walvis Bay, was present along all streets within the CBD, as illustrated in Figure 5.2. These streets feature crosswalks at every intersection (4-way stop) and sidewalks on both sides of every road, with the exception of Sam Nujoma Avenue, where sidewalks were provided on one side of the street. The infrastructure, however, were poorly maintained and did not adequately accommodate users with disabilities. Moreover, streets in the informal settlement feature NMT facilities along all major arterial routes, including crossing facilities at key intersections and traffic calming measures, such as speed humps, at locations with high potential for NMT activities and fast-moving vehicles. Despite the presence of infrastructure in this location, the condition of these facilities was substandard, forcing NMT users to rely on roads designated for vehicular traffic. Additionally, all major arterial routes in Naraville were equipped with NMT facilities, but accessibility challenges and poor maintenance remain significant issues. Furthermore, NMT infrastructure was entirely absent along the primary routes connecting the three assessed locations, compelling pedestrians and cyclists to rely on informal tracks for travel between these areas. The condition of NMT facilities in these assessed areas of Walvis Bay is discussed in detail in Section 5.3.2.

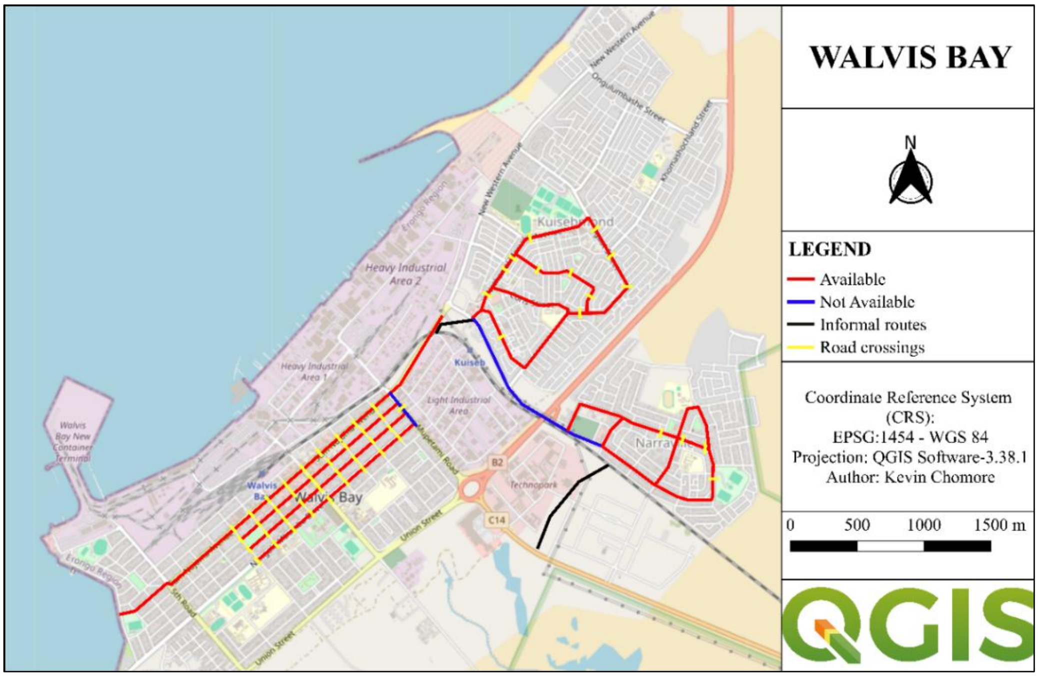


Figure 5.2: Availability of NMT infrastructure in Walvis Bay

5.2.2. Level of NMT activities

Non-Motorised Transport (NMT) volume counts in Tsumeb and Walvis Bay were conducted in areas that have been identified to have high NMT traffic. In Tsumeb, three locations were selected to assess NMT activity levels (see Figure 5.3), with counts conducted during peak hours (AM: 07h00-09h00; PM: 16h00-18h00). The highest NMT activities were observed at **Location 1**, in the northern parts of town within the central business district (CBD), surrounding Hage Geingob Drive (B1 Road). This area includes key structures such as Tsumeb Mall, Engen Le Platz service station, and Tsumeb State Hospital (7th street). During morning peak hours, more than 1,500 pedestrians and cyclists were recorded traveling to and from residential areas, the shopping mall, the service station, and the state hospital. This high NMT usage indicates a great need for NMT facilities in the area. However, without intervention, poor infrastructure endangers safety, discourages use, and threatens long-term sustainability. Fewer than 1,500 NMT users were observed walking and cycling around the same location during evening peak hours, likely due to reduced business hours and a preference for morning shopping and hospital visits. Reduced evening activity suggests safety and lighting concerns, revealing how poor infrastructure impacts not only routes but also travel times, limiting users' flexibility and access to after-hours events. The second highest activities were recorded at **Location 2** in the informal settlement along Leevi Mueshekele Street, a primary route connecting the informal settlements and the CBD. Over 500 pedestrians and cyclists, including school children, were observed using this route during morning peak hours. Evening counts dropped to fewer than 300 NMT users, attributed to school dismissal times being earlier than evening peak hours. **Location 3**, which includes 1st Avenue and Ilse Schatz Street, recorded the lowest NMT activity, with fewer than 500 NMT movements observed along these routes during morning peak hours. Evening counts were not conducted in Location 3, as this area primarily serves schools, and the Department of Transport (DoT) trip generation rate manual (South African Roads Board, 1995), recommends a morning trip generation in areas surrounded by schools. The low NMT activity levels in high-income areas corresponds to the limited infrastructure, such as lack of dedicated cycling lanes and absence of NMT facilities on 1st Avenue, in the high-income zones of Tsumeb, as detailed in Section 5.3.1.3.

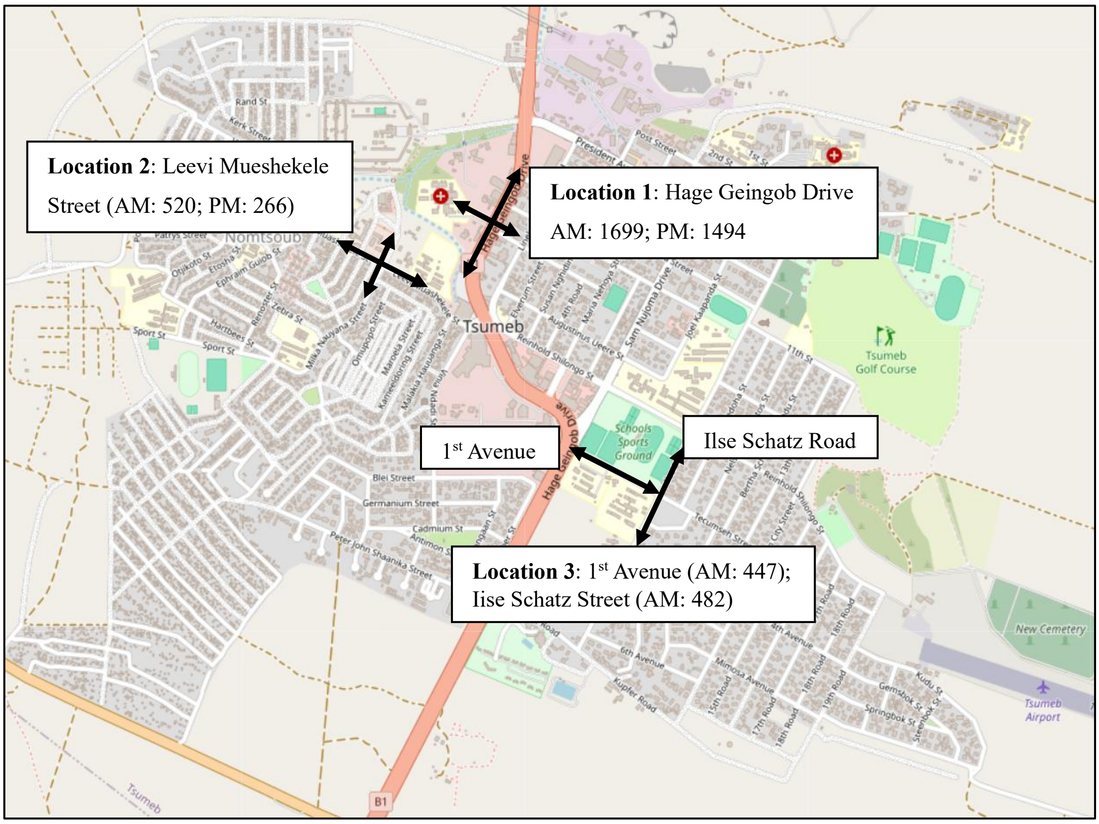


Figure 5.3: Level of pedestrian and cyclist activities in Tsumeb

NMT volume counts in Walvis Bay were conducted at two locations, as shown in Figure 5.4. These locations were identified as key areas for NMT movements; however, only **Location 2** was selected for infrastructure audit because NMT infrastructure in **Location 1** was non-existent. The pedestrian and cyclist count in Walvis Bay were conducted during peak hours (AM: 07h00-09h00; PM: 16h00-

18h00). The highest NMT activities were recorded at **Location 2**, along Nathaniel Maxuilili Avenue in the Kuisebmond informal settlement in northeastern Walvis Bay. At this location, over 2,200 pedestrians were recorded during afternoon peak hours, commuting between residential areas and the Woermann Brock supermarket, primarily for work-related travel. Heavy use despite inadequate facilities reveals user resilience while highlighting planning deficiencies. Neglecting such routes risks increasing inequality, limiting access to jobs. The lowest NMT movements were observed along the route connecting the CBD to the informal settlement (**Location 1**), with fewer than 2,000 pedestrians recorded during morning peak hours. Despite the absence of NMT infrastructure, this route was frequently used, likely due to its convenience in reducing long-distance trips for NMT users.

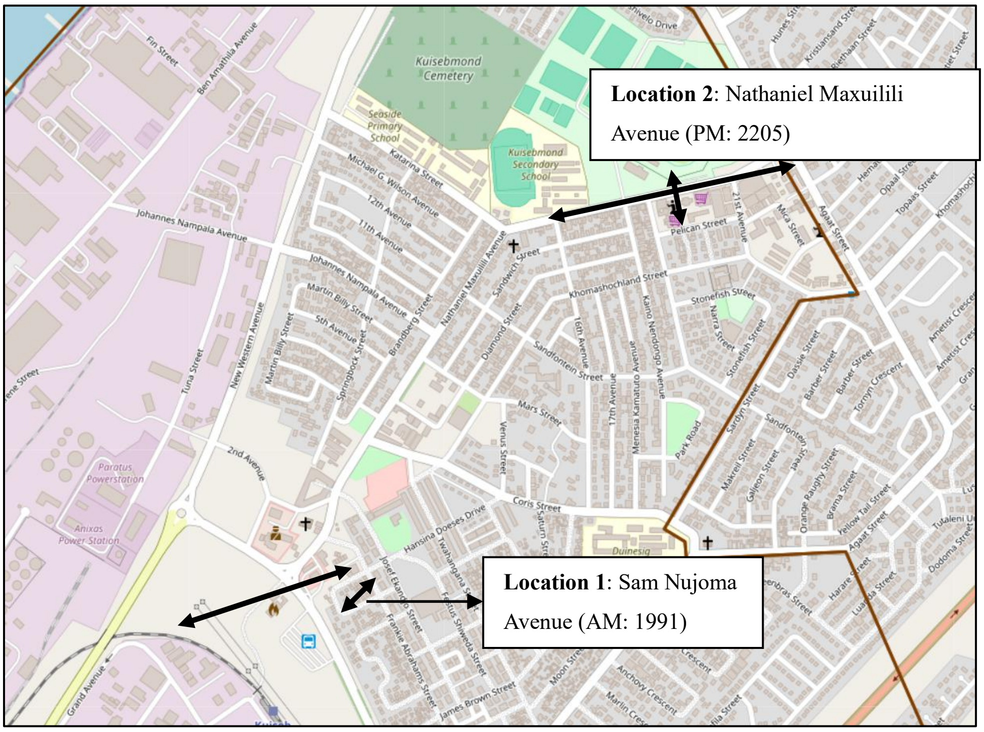


Figure 5.4: Level of pedestrian and cyclist activities in Walvis Bay

5.3. NMT infrastructure audit

The state of non-motorised transport (NMT) infrastructure at the assessed locations in Tsumeb and Walvis Bay are presented in the subsequent subsections.

5.3.1. Tsumeb

The study assessed Non-Motorised Transport (NMT) infrastructure at three distinct locations in Tsumeb: the central business district – **Location 1**, the informal settlement – **Location 2**, and high-income areas in the eastern part of town – **Location 3**. Details regarding these locations, including the assessed routes and the rationale for their selection, have been presented in section 4.2. A variety of NMT issues were identified across these locations, as summarised in Table 5.1, with consistent NMT challenges highlighted in Figures 5.5, 5.6, and 5.7. Consistent issues included the lack of dropped kerbs (on and off ramps), inappropriate vehicle access on pedestrian land use, and road signs obstructing pedestrian movements on sidewalks. The lack of dropped kerbs, particularly at the central median at **Location 1**, forced NMT users, especially cyclists, to share roads with motorised vehicles. The shared road usage between cyclists and motor vehicles was most prevalent in **Location 2**. While sidewalks were raised in all three locations to protect pedestrians from motor vehicles, drivers continued to park their vehicles on these sidewalks, as seen in Figure 5.6. Additional obstructions such as poles, as well as trees and rocks, were observed at Hage Geingob Drive (**Location 1**) and Ilse Schatz Street (**Location 3**). The lack of essential NMT infrastructure, such as lowered kerbs and unobstructed sidewalks, are consistent with the findings by the MWT *et al*. (2013), which reported inadequate sidewalks and cycle paths as major issue in Windhoek.

(a) Location 1 (b) Location 2 (c) Location 3

Figure 5.5: Lack of dropped kerbs

(a) Location 1 (b) Location 2 (c) Location 3

Figure 5.6: Inappropriate vehicle access on land use

(a) Location 1 (b) Location 2 (c) Location 3

Figure 5.7: Obstructions (poles) along sidewalks

Table 5.1: Tsumeb infrastructure assessment results

	Location 1	Location 2	Location 3	
	Hage Geingob Drive (B1)	Leevi Mueshekele Street	1st Avenue	Ilse Schatz Road
CROSSWALK ASSESSMENT (Intersections and mid-sections)				
1. Availability of crosswalk	√	√	X	√
2. Crosswalk along pedestrian desire crossing lines	X	X	X	X
3. Accessibility of crosswalk				
• Minimum width (1.2. m)	√	√	X	√
• Available on/off ramp – dropped kerbs	X	X	X	X
• Audible warning – rumble strips, road humps etc.	X	√	X	√
• Availability of crosswalk button	√	√	X	√
4. Safe and comfortable crosswalk				
• Even crosswalk (no pavement failure or cracks)	√	√	X	√
• No obstacles/ obstructions	√	√	X	√
5. Visible crosswalk marking and road (motorist) warning signage				
• Pavement marking available	√	√	X	√
• Road signage available and visible	√	√	X	√
SIDEWALK ASSESSMENT				
1. Availability of sidewalk	√	√	X	√
2. Sidewalk shared with bicycles	√	√	X	√
3. Accessibility of sidewalk				
• Minimum width (1.2 m)	X	√	X	√
• Available on/off ramp – dropped kerbs	X	X	X	X
• Continuous sidewalk (not fragmented/ no missing links)	X	X	X	X
4. Safe and comfortable sidewalk				
• Paved sidewalk	√	√	X	√
• Even sidewalk	X	X	X	X
• No obstacles/ obstructions (hawkers/ vendors, trees etc.) – available free height and width	X	X	X	X
• Protected from vehicles/ motorised transport – raised kerbs	√	X	X	X
5. Vehicle parking along sidewalk				
• Legally parked vehicles (marking available)	X	X	X	X
• Appropriate vehicle access to land uses.	X	X	X	X
BIKEWAY ASSESSMENT				
1. Availability of bikeway (separate)	X	X	X	X
2. Minimum required width	-	-	-	-
3. Safe and comfortable bikeway	-	-	-	-
• Paved bikeway surface	-	-	-	-
• Undisrupted movement along bikeway (No obstructions)	-	-	-	-
• Protected from vehicles/ motorised transport	-	-	-	-

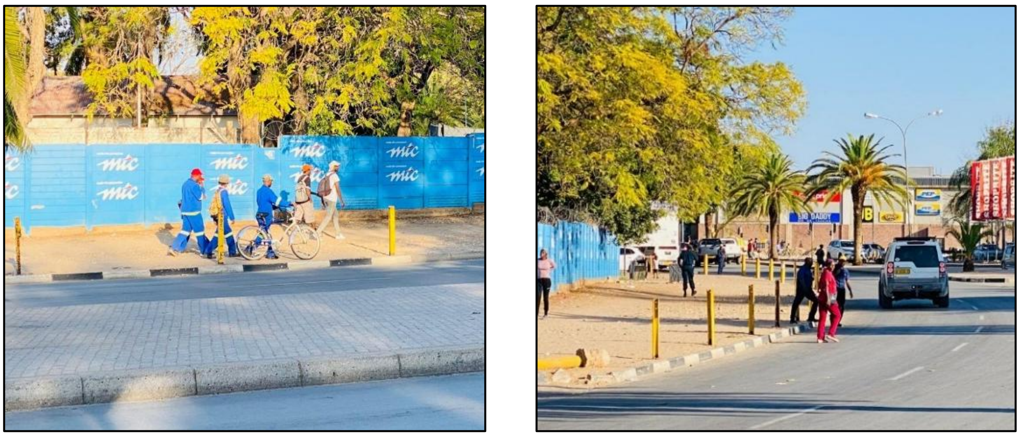
4. Vehicle parking along bikeway	-	-	-	-
• Legally parked vehicles (marking available)	-	-	-	-
• Appropriate vehicle access to land uses	-	-	-	-

5.3.1.1. Central business district

At Hage Geingob Drive (**Location 1**), several NMT infrastructure issues were observed. Crosswalks at intersections had poor visibility, making navigation unsafe for pedestrians and drivers (see Figure 5.8). Additionally, vehicles frequently parked on pedestrian walkways and failed to yield to NMT users, as shown in Figure 5.8, forcing pedestrians to share pathways with cyclists – see Figure 5.9 – which increased accident risks. These poor driver behaviours may be attributed to limited traffic law enforcement, lack of penalties for traffic violations, low road safety awareness, and a cultural bias prioritising motorised vehicles over pedestrians and cyclists. Safety concerns such as poor crosswalk visibility and obstructive parking are consistent with user complaints about accessibility, which is discussed in Section 5.4. These observed safety hazards are consistent with the findings by Oviedo *et al*. (2021), which highlighted high accident risks for NMT users in African cities, particularly in areas where they are forced to interact closely with motor vehicles due to poor NMT infrastructure conditions. This misalignment and disregard for pedestrian movement heightens accident risk and discourages NMT use, diminishing its influence on mobility and equity. The perceived danger, particularly for children, the elderly, and those with disabilities discourages NMT. Furthermore, pedestrian crosswalks were misaligned with desired crossing lines, being situated only at intersections. This was observed to disrupt pedestrian traffic flow, forcing pedestrians to navigate areas of the road with high moving vehicles (see Figure 5.9). The misalignment of crosswalks with desired pedestrian crossing lines may be attributed to poor planning and insufficient traffic studies that do not consider the patterns of NMT traffic through the town in practice. While pushbuttons for crossing signals were installed, they were often non-functional, further complicating safe crossing. Poor maintenance, noted through dysfunctional pushbuttons is consistent with the findings by Fahim *et al*. (2022) in Bangladesh, where deteriorating road conditions were reported as a barrier to NMT usability. This systematic neglect and poor prioritisation of NMT infrastructure in urban management point to a larger governance issue, in which reactive maintenance fails to assure long-term use and inclusion. This issue has also been identified as a challenge related to NMT usage in the study by UNEP and UNHSP (2022).

(a) (b)

Figure 5.8: (a) Poor visibility of road markings at intersections; (b) Drivers ignoring pedestrians waiting to cross the road



(a) (b)

Figure 5.9: (a) Pedestrians sharing the sidewalk with cyclists; (b) Lack of crossing facilities along pedestrian desired crossing lines

Furthermore, the current NMT infrastructure on the right-hand side (RHS) was noted to have poorly maintained and unpaved sidewalks in some sections of the road (see Figure 5.10). On the left-hand side (LHS), pedestrian pathways were obstructed by infrastructure and street vendors, limiting walking space (see Figure 5.11). The lack of adequate maintenance, including poor and unpaved NMT facilities may be attributed to limited government resources or insufficient attention to NMT infrastructure. The poorly maintained NMT infrastructure and obstructions on NMT facilities are consistent with the findings by Fahim *et al*. (2022) and the MWT *et al*. (2013). Moreover, the sidewalk on the LHS was noted to comply with the minimum width requirements, a 1.2 m width in reference to NMT infrastructure design guidelines by SMEC and UCT (2014) and SANRAL (2012), while the sidewalk on the RHS failed to meet the requirements, limiting accessibility. The NMT pathways at Hage Geingob Drive was observed to have uneven sidewalks, with certain sections having sidewalk widths of 2-3 m, an observation that aligns with the width requirements from NMT facilities guidelines by SANRAL and ITS (2017).

(a) (b)

Figure 5.10: (a) Poor NMT infrastructure conditions; (b) Unpaved sidewalks

(a) (b)

Figure 5.11: (a) Sidewalk obstructed by existing infrastructure; (b) Street vendors along sidewalks

5.3.1.2. Informal settlement

Several issues related to NMT infrastructure were observed at Leevi Mueshekele Street in the informal settlement (**Location 2**). Poorly designed drainage structures across sidewalks failed to accommodate NMT users due to the absence of ramps; forcing these users, particularly cyclists and people with disabilities, to utilise roads designated for vehicles (see Figure 5.12), which poses accident risks. The lack of ramps and drainage structures accessible to NMT users may be attributed to designs that primarily focus on vehicle traffic, overlooking the needs of NMT users. The shared road usage between NMT users and vehicles are consistent with user' concerns, as discussed in Section 5.4 and findings by Oviedo *et al*. (2021), which reported higher accident risks for NMT users in areas where they must share spaces closely with motor vehicles due to lack of dedicated pathways. Additionally, cyclists were observed sharing sidewalks with pedestrians, along the left-hand side of the road, creating unsafe conditions for pedestrian traffic (see Figure 5.13). Similar findings by Oviedo *et al*. (2021) and MWT *et al*. (2013) highlighted the dangers of insufficient NMT facilities in urban areas. At crossing points, gaps were observed between crosswalks and sidewalks (see Figure 5.13), leading to additional accessibility challenges. The observed gaps between sidewalks and crosswalks may be attributed to poor planning for pedestrian accessibility. These discontinuities impair pedestrian path reasoning, indicating poor user-centred design. They promote dangerous improvisation, which eventually threatens road safety. Although sidewalks were available at this location, they were often underutilised, as illustrated in Figure 5.14, highlighting a disconnect between infrastructure and user behaviour. The underusage of NMT facilities on this street can be attributed to the construction of these facilities on undesired pathways. Pedestrian signals were noted at midsections along this route; however, there were no crosswalks or pedestrian markings identified in these sections (see Figure 5.14), an observation that is consistent with the findings by MWT *et al*. (2013).

(a) (b)

Figure 5.12: (a) Accessibility issues caused by drainage on the sidewalk; (b) Cyclist using vehicle routed due to poor accessibility on the sidewalk

(a) (b)

Figure 5.13: (a) Pedestrians and cyclists sharing sidewalk; (b) Gap between crosswalk and sidewalk at crossing point

(a) (b)

Figure 5.14: (a) Pedestrians underutilising existing sidewalk; (b) Lack of crosswalk or pedestrian marking at midsection

5.3.1.3. High-income areas

The NMT infrastructure at Ilse Schatz Street and 1st Avenue (**Location 3**) was found to have multiple issues that compromise safety and usability for pedestrians and cyclists. On Ilse Schatz Street, sidewalks were fragmented, poorly maintained, and obstructed by poles and parked vehicles (see Figure 5.15). The fragmented NMT facilities can be attributed to poor planning that prioritises vehicles over NMT users, while sidewalk obstructions suggest a lack of consideration for pedestrian pathways. These issues are consistent with the findings by MWT *et al*. (2013), which reported inadequate, fragmented NMT infrastructure in African cities, particularly in Namibia, and Vanderschuren *et al*. (2022) and ITS and BP consulting engineers (2018), who noted vehicle-centric planning as a barrier for NMT users. Although pedestrian pushbuttons for crossing were available, they were non-functional, leaving users reliant on crossing guard signs, as shown in Figure 5.16. The lack of functional pushbuttons and continuous sidewalks suggest a gap in accessibility planning, especially for people with disabilities. Additionally, road markings at midsections designed to guide NMT users were present but poorly visible, as shown in Figure 5.16. The dysfunction of pushbuttons and faded road markings likely stem from poor maintenance and possible budget constraints, which are consistent with the findings by ITS and BP consulting engineers (2018); however, the findings by ITS and BP consulting engineers (2018) focused more broadly on infrastructural gaps and maintenance. Moreover, pedestrians and cyclists were observed utilising the same space on the sidewalks along this street (see Figure 5.17), which may not only be a result of a lack of dedicated cycling lanes but also a result of patterns where users feel safer sharing pedestrian spaces than navigating near vehicles. The observed shared spaces on sidewalks among pedestrians and cyclists are consistent with the findings by Vanderschuren *et al*. (2022) and Oviedo *et al*. (2021) who noted that shared spaces between NMT users often emerge from infrastructure gaps, resulting in safety risks. A similar observation was highlighted in the findings by

Fahim *et al*. (2022). In contrast, 1st Avenue Road lacked NMT infrastructure entirely, compelling pedestrians to share roads with vehicles, further intensifying safety risks (see Figure 5.17). The absence of dedicated NMT facilities on 1st Avenue indicated that NMT users were not considered in the infrastructure design, possibly due to limited planning focus on NMT, with a focus on motorised traffic, or insufficient funding to provide pedestrian and cycling facilities alongside motorised lanes. This absence is more than just a planning oversight; it is a clear form of exclusion that reinforces car dependency and entrenches disparities in access to public space, impeding long-term urban progress. As observed on 1st Avenue, the complete absence of NMT facilities align with findings by MWT *et al*. (2013) on NMT planning neglect in Namibia and African cities.

(a) (b)

Figure 5.15: (a) Fragmented NMT infrastructure – Ilse Schatz Street; (b) Poor NMT conditions – Ilse Schatz Street

(a) (b)

Figure 5.16: (a) Non-functional pushbuttons – Ilse Schatz Street; (b) Poor visibility of crosswalk marking – Ilse Schatz Street

(a) (b)

Figure 5.17: (a) Pedestrian and cyclist sharing a sidewalk – Ilse Schatz Street; (b) Lack of NMT infrastructure (sidewalks) on 1st Avenue Road

5.3.2. Walvis Bay

The study assessed three locations in Walvis Bay to identify NMT challenges. The first location was the central business district (CBD), which included four streets: 6th Street, Sam Nujoma Avenue, Hage Geingob Street, and Theo-Ben Gurirab Street. The second location was the informal settlement of Kuisebmond, with NMT infrastructure assessments conducted on Nathaniel Maxuilili Avenue and Agaat Street. The third location was Naraville, which covers Sam Nujoma Avenue, Namib Street, and Caesar Martin Street. Detailed maps and the rationale for selecting these areas for NMT assessments have been presented in section 4.3.

5.3.2.1. Central business district

Numerous NMT challenges were identified in the CBD (**Location 1**), as detailed in Table 5.2. A common infrastructure issue observed in **Location 1** was the absence of lowered kerbs at intersections (see Figure 5.18). While some sections of these streets had lowered kerbs, they were insufficient and poorly maintained and bikeway infrastructure at this was non-existent, likely due to inadequate urban planning for NMT users. The absence of lowered kerbs at intersections and the complete lack of bikeways in the CBD suggests that infrastructure planning may prioritise vehicular needs over NMT, resulting in limited support for pedestrian and cycling needs. These findings may also be attributed to the high traffic and commercial activity in the area, which creates spatial constraints and limits the availability of space for dedicated NMT infrastructure. The lack of NMT infrastructure in the CBD is consistent with the findings by UNEP and UNHSP (2022) and Vanderschuren *et al*. (2022) who reported a shortage of adequate pedestrian facilities and safe pathways in African cities. Similar observations have been reported in the findings by Mansoor *et al*. (2022). This absence restricts safe access and economic potential for NMT users. Without pedestrian-friendly design, commercial areas may lose potential foot traffic and financial gains. In contrast to the findings in Walvis Bay, where limited NMT facilities exist due to spatial constraints, the findings by Cooke *et al*. (2022) suggests that a lack of policy prioritisation is a primary cause in the broader African context. Furthermore, while findings in Walvis Bay highlight constraints on NMT infrastructure specific to the CBD, the findings by MWT *et al*. (2013) note that rural and peri-urban areas in Africa often lack any substantial planning or policy support for NMT, unlike urban areas where some degree of infrastructure (minimal) exits.

(a) 6th Street (b) Sam Nujoma Avenue (c) Hage Geingob Street

Figure 5.18: Absence of lowered kerbs at intersections

Table 5.2: Walvis Bay infrastructure assessment results at Location 1

	6th street	Sam Nujoma Avenue	Hage Geingob Street	Theo-Ben Gurirab Street
CROSSWALK ASSESSMENT (Intersections and mid-sections)				
1. Availability of crosswalk	√	√	√	√
2. Crosswalk along pedestrian desire crossing lines	X	X	√	√
3. Accessibility of crosswalk				
• Minimum width (1.2 m)	√	√	√	√
• Available on/off ramp – dropped kerbs	X	√	√	√
• Audible warning – rumble strips, road humps etc.	X	X	√	X
• Availability of crosswalk button	X	X	X	X
4. Safe and comfortable crosswalk				
• Even crosswalk (no pavement failure or cracks)	X	X	X	√
• No obstacles/ obstructions	√	√	√	√
5. Visible crosswalk marking and road (motorist) warning signage				
• Pavement marking available	√	√	√	√
• Road signage available and visible	X	X	√	√
SIDEWALK ASSESSMENT				
1. Availability of sidewalk	√	√	√	√
2. Sidewalk shared with bicycles	√	√	√	√
3. Accessibility of sidewalk				
• Minimum width (1.2 m)	√	√	√	√
• Available on/off ramp – dropped kerbs	X	√	√	√

• Continuous sidewalk (not fragmented/ no missing links)	X	√	X	√
4. Safe and comfortable sidewalk				
• Paved sidewalk	√	√	√	√
• Even sidewalk	X	X	X	X
• No obstacles/ obstructions (hawkers/ vendors, trees etc.) – available free height and width	X	X	X	X
• Protected from vehicles/ motorised transport – raised kerbs	√	√	√	√
5. Vehicle parking along sidewalk				
• Legally parked vehicles (marking available)	√	X	√	√
• Appropriate vehicle access to land uses.	√	√	√	√
BIKEWAY ASSESSMENT				
1. Availability of bikeway (separate)	X	X	X	X
2. Minimum required width	-	-	-	-
3. Safe and comfortable bikeway	-	-	-	-
• Paved bikeway surface	-	-	-	-
• Undisrupted movement along bikeway (No obstructions)	-	-	-	-
• Protected from vehicles/ motorised transport	-	-	-	-
4. Vehicle parking along bikeway	-	-	-	-
• Legally parked vehicles (marking available)	-	-	-	-
• Appropriate vehicle access to land uses	-	-	-	-

At 6th Street, issues related to NMT infrastructure that hinder safe and efficient pedestrian movements were noted. Poor visibility of crosswalks was observed, along with misalignment of crosswalks from pedestrian-desired crossing points, which made safe crossings more difficult (see Figure 5.19), while inconsistent driver behaviour – often neglecting to stop at crosswalks – was observed, as seen in Figure 5.19. Challenges with crosswalk visibility and inconsistent driver behaviour aligns with findings by UNEP and UNHSP (2022) which highlight poor road user compliance and visibility issues as common obstacles for NMT users. Pavement failure was also noted on crosswalks along 6th street. Sidewalks (shared with bicycles) were fragmented and uneven, restricting accessibility and comfort for pedestrians. Similar to the study in Walvis Bay, where fragmented and uneven sidewalks were observed, Vanderschuren *et al*. (2022) noted that uneven surfaces and inadequate width can reduce accessibility and deter pedestrians from using NMT facilities. These sidewalks, however, meet the minimum width of 1.2 m recommended by NMT infrastructure design guidelines by SMEC and UCT (2014) and SANRAL (2012).

(a) (b) (c)

Figure 5.19: (a) Poor crosswalk visibility; (b) Lack of crosswalks on pedestrian-desired crossing lines; (c) Drivers failing to yield at pedestrian crosswalks

Several issues with NMT were identified across Sam Nujoma Avenue. Obstructions along pedestrian pathways including construction debris, infrastructure elements, and poles, were observed, which limited the available walking space (see Figure 5.20). This issue was further compounded by the presence of poles installed directly after crosswalks at intersections, as seen in Figure 5.20, which were noted to obstruct pedestrian movement. The sidewalks, however, have been elevated to protect pedestrians from vehicles that attempt to park on NMT facilities. The NMT infrastructure was poorly maintained, and crosswalks lacked visibility and proper upkeep, particularly at intersections (see Figure 5.21). Crosswalks did not align with pedestrian-desired crossing lines, and there was a notable absence of crosswalk buttons at intersections equipped with pedestrian traffic lights. Poor crosswalk alignment confuses users and promotes dangerous travel behaviour. Infrastructure that prevents natural traffic flow is less likely to be embraced or utilised effectively. Although some sections featured lowered kerbs and continuous sidewalks meeting the minimum width of 1.2 m, their maintenance remains inadequate.

(a) (b)

Figure 5.20: (a) Obstructions on sidewalk; (b) Poles installed after crosswalk

(a) (b)

Figure 5.21: (a) Poor NMT infrastructure conditions; (b) Poor crosswalk visibility

Several issues that hinder the efficiency of NMT infrastructure were also observed across Hage Geingob Street, as seen in Figures 5.22 and 5.23. Sidewalks were often obstructed by dustbins, trees, infrastructure, and sand, limiting the available walking space for pedestrians. Additionally, NMT facilities were poorly maintained, particularly sidewalks. Poor visibility of crosswalks was noted, particularly at intersections, while cyclists were observed sharing the road with vehicles, exposing them to potential hazards. The pathways designated for NMT users were uneven and fragmented; however, these facilities meet the minimum width requirement of 1.2 m. Furthermore, dropped kerbs were noted along NMT facilities, improving accessibility for NMT users. Inconsistent facilities reveal a fragmented approach to inclusive design. Without a planned strategy, pedestrian mobility is interrupted, discouraging vulnerable populations from using it. Standardised designs are thus needed to ensure inclusive safety and comfort.

(a) (b)

Figure 5.22: (a) Obstructions on NMT pathway; (b) Poor NMT infrastructure; (c) Poor crosswalk visibility

(a)

(b)

Figure 5.23: Poor NMT infrastructure along Hage Geingob Street

Poor visibility of road markings and wide intersections were observed at Theo-Ben Gurirab Street, resulting in increased crossing distances and elevating the risks of accidents. Additionally, the surface conditions on the pedestrian pathways were poor, while pedestrian crossings were inadequate, which limited safe passage for pedestrians. Moreover, uneven NMT pathways, particularly sidewalks, were observed compounded by the presence of obstructions along these NMT facilities. Furthermore, positive infrastructure conditions including lowered kerbs, continuous NMT facilities, and protection for NMT users from motorised vehicles – through raised kerbs – were noted. The contrast between positive and adverse outcomes indicates ineffective planning or uneven upgrading. This can misrepresent safety, particularly when safe areas lead to hazards, weakening trust in NMT and promoting car dependence.

5.3.2.2. Kuisebmond

A multitude of NMT issues were identified at **Location 2**, as outlined in Table 5.3. Among these, consistent issues were observed across all the streets assessed at this location. Common issues identified across these streets include the following:

i. Presence of obstructions on pedestrian pathways, which severely limited the available walking space for pedestrians.
ii. NMT users utilising roads designated for vehicles, due to a lack of NMT facilities or limited spaces on existing facilities.
iii. Lack of on and off-ramps (lowered kerbs) on NMT pathways.

Obstructions on NMT facilities ranging from electrical light poles, sewage structures, road signs, dustbins, parked vehicles, sand on sidewalks – Agaat Street – to street vendors operating along pedestrian pathways – Nathaniel Maxuilili Avenue – restricted the flow of pedestrian traffic and created safety hazards for pedestrians (see Figure 5.24). The presence of street vendors on NMT facilities was one of the main concerns among the issues observed across these streets, forcing pedestrians and cyclists to navigate around these barriers, often moving onto the road or squeezing through narrow gaps, compromising safety and comfort. Additionally, the use of roads designated for vehicles by NMT users (see Figure 5.25) occurs primarily due to the absence of dedicated NMT infrastructure or insufficient space on existing facilities. As a result, pedestrians, cyclists, and other NMT users were forced to share roadways with motor vehicles, increasing the risks of accidents. The absence of dedicated NMT facilities and limited spaces on these facilities are consistent with users' concerns about safety risks due to shared roads with motorised vehicles, as discussed in Section 5.4. Furthermore, the absence of lowered kerbs – as seen in Figure 5.26 – limits the accessibility and functionality of NMT infrastructure, creating barriers for NMT users. Infrastructure deficiencies, such as the lack of lowered kerbs and narrow sidewalks in Kuisebmond, are echoed in user perceptions on challenges faced by pedestrians and cyclists in Walvis Bay, as discussed in Section 5.4. Issues such as obstructions on pedestrian pathways, lack of dedicated NMT facilities, and absence of lowered kerbs are consistent with the findings by MWT *et al*. (2013) who reported similar issues – related to inadequate infrastructure and poor maintenance – in Namibian towns. Moreover, barriers including obstructions such as light poles, parked vehicles, and street vendors; reflect findings by Cooke *et al*. (2022), who emphasise that encroachment on pedestrian pathways reduces safety and forces NMT users into motorised traffic lanes, increasing risks of accidents. These barriers reflect both physical constraints and insufficient oversight of public space. Vendor encroachment and unauthorised parking reflect an imbalance between the transportation and informal economy. Solutions require redesign and governance that balances enforcement and livelihoods. Additionally, the lack of space and absence of dedicated NMT facilities are consistent with the findings by Oviedo *et al*. (2021) similarly identifying insufficient and fragmented NMT facilities as factors increasing the risks of accidents for NMT users.

(a) (b)

Figure 5.24: (a) Obstructions on NMT pathways – Agaat Street; (b) Street vendors operating on NMT pathways – Nathaniel Maxuilili Avenue

(a) (b)

Figure 5.25: (a) Disabled person sharing roadway with vehicles – Agaat Street; (b) Pedestrians sharing roadway with vehicles – Nathaniel Maxuilili Avenue

(a) (b)

Figure 5.26: (a) Lack of lowered kerbs – Agaat Street; (b) Lack of lowered kerbs – Nathaniel Maxuilili Avenue

Table 5.3: Walvis Bay infrastructure assessment results at Location 2

	Nathaniel Maxuilili Avenue	Agaat Street
CROSSWALK ASSESSMENT (Intersections and mid-sections)		
1. Availability of crosswalk	√	√
2. Crosswalk along pedestrian desire crossing lines	X	X
3. Accessibility of crosswalk		
• Minimum width (1.2 m)	X	√
• Available on/off ramp – dropped kerbs	X	X
• Audible warning – rumble strips, road humps etc.	X	X
• Availability of crosswalk button	X	X
4. Safe and comfortable crosswalk		
• Even crosswalk (no pavement failure or cracks)	X	X
• No obstacles/ obstructions	√	√
5. Visible crosswalk marking and road (motorist) warning		

signage		
• Pavement marking available	√	√
• Road signage available and visible	X	√
SIDEWALK ASSESSMENT		
1. Availability of sidewalk	√	√
2. Sidewalk shared with bicycles	√	√
3. Accessibility of sidewalk		
• Minimum width (1.2 m)	√	√
• Available on/off ramp – dropped kerbs	X	√
• Continuous sidewalk (not fragmented/ no missing links)	X	X
4. Safe and comfortable sidewalk		
• Paved sidewalk	√	√
• Even sidewalk	X	X
• No obstacles/ obstructions (hawkers/ vendors, trees etc.) – available free height and width	X	X
• Protected from vehicles/ motorised transport – raised kerbs	√	X
5. Vehicle parking along sidewalk		
• Legally parked vehicles (marking available)	X	X
• Appropriate vehicle access to land uses.	X	X
BIKEWAY ASSESSMENT		
1. Availability of bikeway (separate)	X	X
2. Minimum required width	-	-
3. Safe and comfortable bikeway	-	-
• Paved bikeway surface	-	-
• Undisrupted movement along bikeway (No obstructions)	-	-
• Protected from vehicles/ motorised transport	-	-
4. Vehicle parking along bikeway	-	-
• Legally parked vehicles (marking available)	-	-
• Appropriate vehicle access to land uses	-	-

Additional issues related to NMT infrastructure were observed at Agaat Street including poor driver behaviour, with motorists failing to stop at traffic signals to give right of way to pedestrians – see Figure 5.27 – while the visibility of crosswalk markings (at intersections) was insufficient, making it difficult for pedestrians to navigate safely – see Figure 5.27. Pedestrian pushbuttons were observed in some sections of the street but were non-functional, further hindering pedestrian mobility (see Figure 5.28). Challenges, such as poor driver behaviour and inadequate crosswalk marking are consistent with observations by ITS and BP consulting engineers (2018). Similarly, the presence of non-functional pedestrian pushbuttons and misaligned crosswalks reflect a failure in maintenance and upkeep of essential infrastructure to meet user needs. Additionally, crosswalks located in mid-sections of the street were not level with the adjacent sidewalks, as seen in Figure 5.28, creating accessibility challenges. Some sections, however, offer better accessibility, with seamless transition between crosswalks and sidewalks at crossing points, where the crosswalks were level with the sidewalks, enhancing pedestrian comfort. Despite improved accessibility offered in some sections, UNEP and UNHSP (2022) note that isolated improvements are insufficient without a comprehensive and well-connected NMT network. Furthermore, some crosswalks were positioned in front of parking areas, obstructing visibility and hindering the safe use of NMT facilities. These misplacements reveal a misalignment between road safety and on-the-ground execution, stressing a lack of adherence to planning standards. Inadequate placement of critical infrastructure – such as crosswalks – not only restricts access but also poses danger, particularly at intersections with minimal visibility. These oversights weaken pedestrian confidence in NMT and discourage walking. Poorly maintained and fragmented NMT facilities were observed at Nathaniel Maxuilili Avenue (see Figure 5.29) and crosswalks were not along desired crossing paths.

(a)

(b)

Figure 5.27: (a) Drivers ignoring traffic signals at pedestrian crossings; (b) Poor crosswalk visibility

(a)

(b)

Figure 5.28: (a) Non-functional pedestrian pushbuttons; (b) Poorly designed crossing (access) facility

(a) (b)

Figure 5.29: (a) Fragmented NMT facility; (b) Poor NMT infrastructure conditions

5.3.2.3. Naraville

A multitude of NMT issues were identified at **Location 3**, as outlined in Table 5.4. Common NMT issues were observed across all the streets in **Location 3** – see Figures 5.30 and 5.31. NMT facilities were poorly maintained, including the accumulation of sand on Caesar Martin Street and Namib Street, and the presence of potholes along Sam Nujoma Avenue, which poses safety risks to pedestrians and cyclists. Additionally, the visibility of crosswalk markings was inadequate, making it difficult for both drivers and pedestrians to navigate these intersections safely. Poor maintenance of NMT facilities, obstructions, and inadequate crosswalk visibility are consistent with the findings by MWT *et al*. (2013), who reported that poorly maintained NMT infrastructure significantly compromised the safety and usability of NMT pathways, particularly for pedestrians and cyclists. This impacts daily mobility and has broader socio-economic effects; low-income pedestrians are at risk, while unsafe events feed vehicle dependency, congestion, and emissions, impeding long-term urban growth.

Table 5.4: Walvis Bay infrastructure assessment results at Location 3

	Sam Nujoma Avenue	Namib Street	Caesar Martin Street
CROSSWALK ASSESSMENT (Intersections and mid-sections)			
1. Availability of crosswalk	√	√	√
2. Crosswalk along pedestrian desire crossing lines	X	X	X
3. Accessibility of crosswalk			
• Minimum width (1.2 m)	√	√	√
• Available on/off ramp – dropped kerbs	X	X	X
• Audible warning – rumble strips, road humps etc.	X	√	√
• Availability of crosswalk button	√	√	X
4. Safe and comfortable crosswalk			
• Even crosswalk (no pavement failure or cracks)	√	√	X

• No obstacles/ obstructions	√	√	√
5. Visible crosswalk marking and road (motorist) warning signage			
• Pavement marking available	√	√	√
• Road signage available and visible	X	√	X
SIDEWALK ASSESSMENT			
1. Availability of sidewalk	√	√	√
2. Sidewalk shared with bicycles	√	√	√
3. Accessibility of sidewalk			
• Minimum width (1.2 m)	X	√	√
• Available on/off ramp – dropped kerbs	X	X	X
• Continuous sidewalk (not fragmented/ no missing links)	X	X	X
4. Safe and comfortable sidewalk			
• Paved sidewalk	√	√	√
• Even sidewalk	X	X	X
• No obstacles/ obstructions (hawkers/ vendors, trees etc.) – available free height and width	X	X	X
• Protected from vehicles/ motorised transport – raised kerbs	√	X	X
5. Vehicle parking along sidewalk			
• Legally parked vehicles (marking available)	X	X	X
• Appropriate vehicle access to land uses.	X	X	X
BIKEWAY ASSESSMENT			
1. Availability of bikeway (separate)	X	X	X
2. Minimum required width	-	-	-
3. Safe and comfortable bikeway	-	-	-
• Paved bikeway surface	-	-	-
• Undisrupted movement along bikeway (No obstructions)	-	-	-
• Protected from vehicles/ motorised transport	-	-	-
4. Vehicle parking along bikeway	-	-	-
• Legally parked vehicles (marking available)	-	-	-
• Appropriate vehicle access to land uses	-	-	-

(a) Sam Nujoma Avenue (b) Namib Street (c) Caesar Martin Street

Figure 5.30: Poor maintenance of NMT facilities

(a) Sam Nujoma Avenue (b) Namib Street (c) Caesar Martin Street

Figure 5.31: Poor crosswalk visibility

Additional challenges were observed across the streets at **Location 3**. On Sam Nujoma Avenue, pedestrians and cyclists faced accessibility challenges such as gaps between the sidewalk and crosswalk at crossing points (see Figure 5.32), the absence of lowered kerbs (see Figure 5.32), and obstructions, such as poles and vehicles, on NMT pathways. Additionally, there was a lack of proper NMT facilities in some sections, while certain areas had well-paved sidewalks. NMT facilities at Namib Street were limited to fragments (see Figure 5.33), poor crosswalk visibility, and accessibility issues, such as parking entrances that were not level with the sidewalk, as seen in Figure 5.33. Obstructions from signs, electrical poles, vehicles, sand, and dustbins were also observed – see Figure 5.34. Obstructions on NMT pathways further reflect findings by Cooke *et al*. (2022). Similarly, fragmented infrastructure, such as limited crosswalk visibility and unlevel sidewalks at parking entrances, points to systematic design flaws, as noted by ITS and BP consulting engineers (2018). Caesar Martin Street had similar issues with a lack of lowered kerbs, as seen in Figure 5.34, and poor visibility of crosswalks; however, some sections featured good NMT facilities, with certain pathways meeting the minimum width requirement of 1.2 m. Obstructions like poles, however, persist along the NMT pathways. The lack of lowered kerbs at crossing points, as observed on Sam Nujoma Avenue and Caesar Martin Street, mirrors accessibility challenges identified by Oviedo *et al*. (2021). Some sections featuring well-paved sidewalks and pathways meeting minimum width requirements suggests isolated progress, which stands in contrast to the findings by UNEP and UNHSP (2022).

(a) (b)

Figure 5.32: (a) Gaps at crossing point – Sam Nujoma Avenue; (b) Absence of lowered kerbs – Sam Nujoma Avenue

(a) (b)

Figure 5.33: (a) Fragmented NMT facilities – Namib Street; (b) Poor accessibility on NMT facilities – Namib Street

(a) (b)

Figure 5.34: (a) Obstructions on NMT facilities – Namib Street; (b) Absence of lowered kerbs – Caesar Martin Street

5.4. NMT user safety and perceptions

An analysis of results from interviews with Non-Motorised Transport (NMT) users in the selected study towns is presented and discussed.

1. What is your understanding of Non-Motorised Transport (NMT)?

The findings in Figure 5.35 indicate that a significant majority of respondents (67 %) in Tsumeb associate NMT primarily with walking, making it the most recognised form of NMT in the town. The high association of NMT with walking is consistent with the findings by Cinderby *et al*. (2024), who highlight walking as a dominant transport mode in African urban areas, especially in low-income communities where it often accounts for over 75 % of daily trips. This high correlation implies that cycling and other NMT modes may be disregarded in infrastructure development and public education, restricting future multimodal mobility. Only 4 % of the participants associate NMT with cycling, making it the category with the fewest responses, possibly due to the lack of visibility or limited cycling activities in the community. The low visibility of cycling as an NMT mode in Tsumeb aligns with the findings by MWT *et al*. (2013) and ITS and BP consulting engineers (2018), who report inadequate cycling infrastructure in Namibian cities like Windhoek, where only 6 % of roads have paved sidewalks, and dedicated cycling paths are scarce. Additionally, 7 % of respondents mention other modes, such as animal-drawn carts, likely due to limited awareness of NMT in the town. Notably, 21 % of respondents had no understanding of NMT, indicating a gap in NMT awareness and education, as was the case in Walvis Bay. This gap reflects not only a lack of awareness on sustainable transportation, but also a general disregard for NMT in urban planning, undercutting efforts to promote it as a viable alternative. The lack of understanding regarding NMT in Tsumeb are consistent with the findings by MWT *et al*. (2013), which attributes low NMT adoption in Namibian towns to insufficient public awareness and infrastructure. In contrast, Zhou *et al*. (2020) found that dedicated NMT infrastructure in Ang Mo Kio Town improved both safety and public perception of NMT making it a recognised mode of transport.

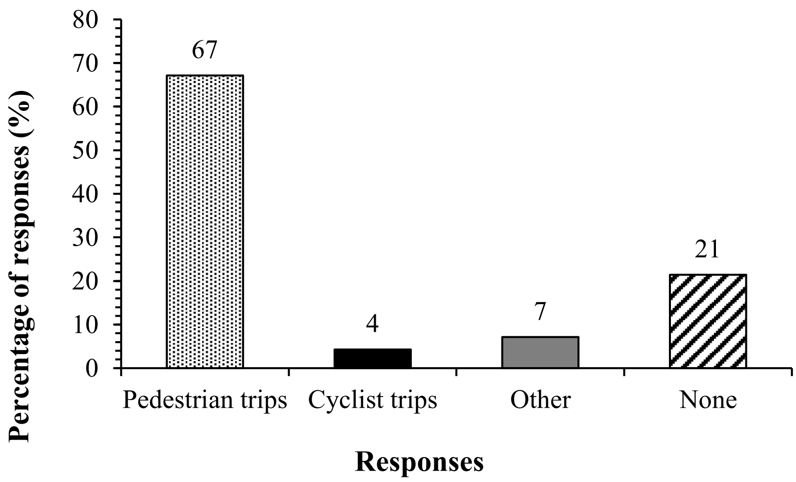


Figure 5.35: Users understanding of NMT in Tsumeb

The findings in Figure 5.36 reveal that nearly equal proportions of respondents in Walvis Bay understand NMT as pedestrian trips, 43 %, and have no understanding of NMT, 44 %. These findings may be attributed to a critical awareness gap in Walvis Bay with almost half of the participants unaware of what constitutes NMT. The NMT awareness gap are consistent with the findings by MWT and GIZ GmbH (2017), which highlights low public awareness and insufficient infrastructure as common challenges in Namibia, where NMT modes are often overlooked. Additionally, 9 % of respondents associate NMT with cycling, and 4 % mention other modes, such as skateboarding, indicating that these forms of NMT are less common and poorly understood. The limited recognition of cycling is consistent with the findings by Okoyo (2019), who attributes this to its low visibility in most urban areas, reinforcing a reliance on walking as the primary mode of NMT.

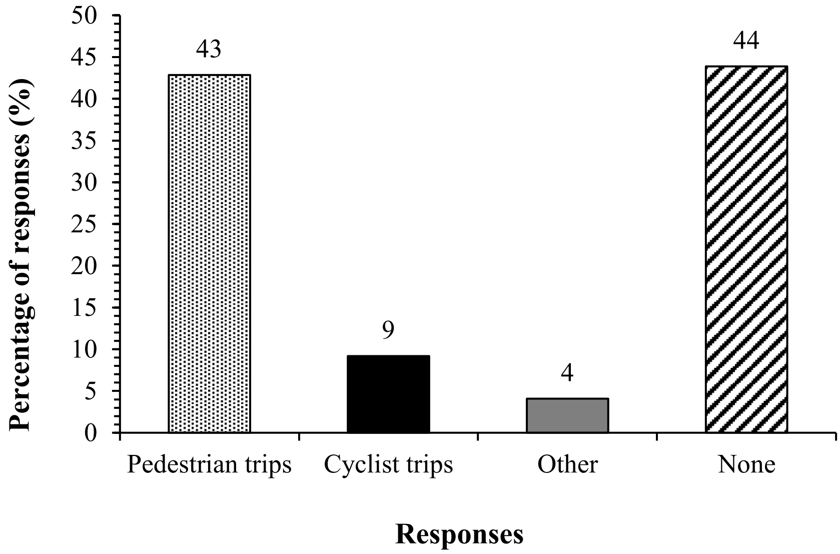


Figure 5.36: Users understanding of NMT in Walvis Bay

2. What is the status/condition of NMT infrastructure in your town?

Nearly half of the respondents (49 %) rated the infrastructure in Tsumeb as moderate, while 34 % considered the infrastructure as bad – as shown in Figure 5.37. The sense of ‘moderate’ may conceal major usability flaws that emerge only during actual usage, such as poor surface conditions or a lack of continuity. With a combined 83 % expressing dissatisfaction, the findings highlight widespread concerns about inadequate infrastructure. This aligns with the findings by MWT *et al*. (2013) which identifies a similar lack of adequate infrastructure across Namibian towns, pointing to fragmented and unsafe walkways and cycle paths. Moreover, 17 % of respondents rated the infrastructure as good, suggesting the presence of some facilities, however, they are insufficient or poorly maintained. The negative perceptions, among residents, of poor NMT infrastructure conditions are consistent with the findings by Cooke *et al*. (2022), which note that NMT infrastructure in major cities such as Cape Town suffer from low quality service, particularly in low-income areas. The limited satisfaction with NMT infrastructure in Tsumeb (17 %) also reflects the findings by MWT and GIZ GmbH (2017), who report limited sidewalks or dedicated lanes in many parts of Namibia.

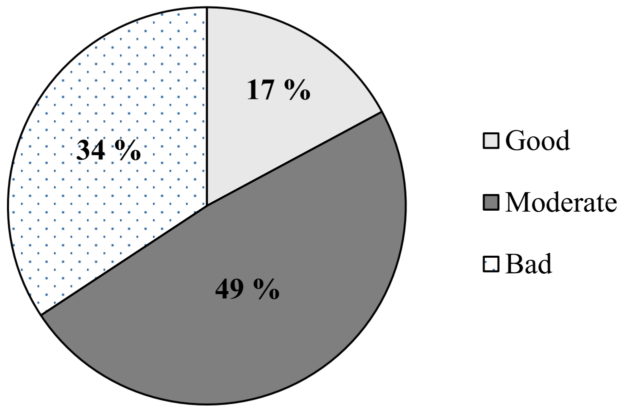


Figure 5.37: Users view of NMT infrastructure conditions in Tsumeb

From Figure 5.38, it can be observed that 18 % of respondents rated the infrastructure conditions in Walvis Bay as good. This suggests that only a minor portion of the NMT facilities meet high quality and safety standards. This low figure raises concerns about the viability of NMT investments and the equity of transportation services. Furthermore, 41 % of respondents equally perceived the infrastructure as either moderate or bad. The equal split between moderate and bad perceptions reveals stagnation, with users reporting no tangible improvements in their NMT experience. An Equal split between moderate and bad ratings also indicates significant concerns about the quality of NMT infrastructure in Walvis Bay, an observation which consistent with the findings by MWT *et al*. (2013), who reported a common dissatisfaction with NMT infrastructure due to poorly maintained and fragmented NMT facilities that lack continuity and safety, especially for pedestrians and cyclists. Cooke *et al*. (2022) describes similar issues in urban NMT infrastructure, where poor maintenance, inadequate pathways, and obstructions hinder safe and efficient NMT usage. Additionally, this reflects the broader trend across Namibian towns as highlighted by ITS and BP consulting engineers (2018), where the lack of dedicated and continuous pathways leads to low infrastructure quality ratings and contributes to user dissatisfaction.

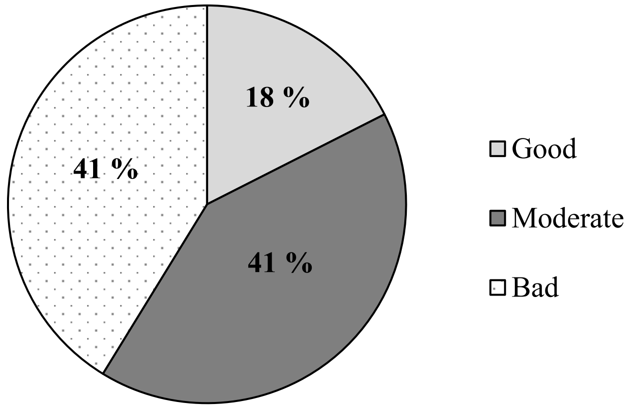


Figure 5.38: Users view of NMT infrastructure conditions in Walvis Bay

3. In which spaces in town is NMT the most dominant?

Nearly half of the respondents (41 %) in Tsumeb identified informal settlements, particularly Kuvukiland and Soweto, as areas with the highest NMT usage, as shown Figure 5.39. Many respondents noted significant movement along routes from these settlements to urban centres, likely driven by commuting needs between home and work. This dominance implies that NMT is a necessity, not a choice, fuelled by financial constraints. It stresses socioeconomic gaps and the need for better transportation equality and infrastructure in these locations. High NMT usage in informal settlements may also be attributed to low vehicle ownership, an observation that is consistent with the findings by ITS and BP consulting engineers (2018), which emphasise the importance of arterial roads as key corridors for pedestrians and cyclists. Additionally, 34 % of respondents reported that NMT is most dominant around town, while 14 % highlighted the central business district (CBD) as a focal point for NMT, reflecting local usage patterns centred around services, commercial activities, and employment opportunities, similar to the findings by Cooke *et al.* (2022). Overall, 89 % of respondents indicated high NMT usage in informal settlements, town, and the CBD, which indicates the socioeconomic factors driving reliance on NMT, as supported by MWT *et al.* (2013). Furthermore, 6 % of respondents identified NMT as dominant throughout the entire town, particularly near schools and higher learning institutions, suggesting that NMT is the primary mode of transportation and indicates that NMT is more localised, while 4 % were unaware of any NMT-dominant areas in Tsumeb. These findings suggest a gap in integrated infrastructure, aligning with findings by MWT and GIZ GmbH (2017), which highlight fragmented and poorly connected NMT network across Namibia.

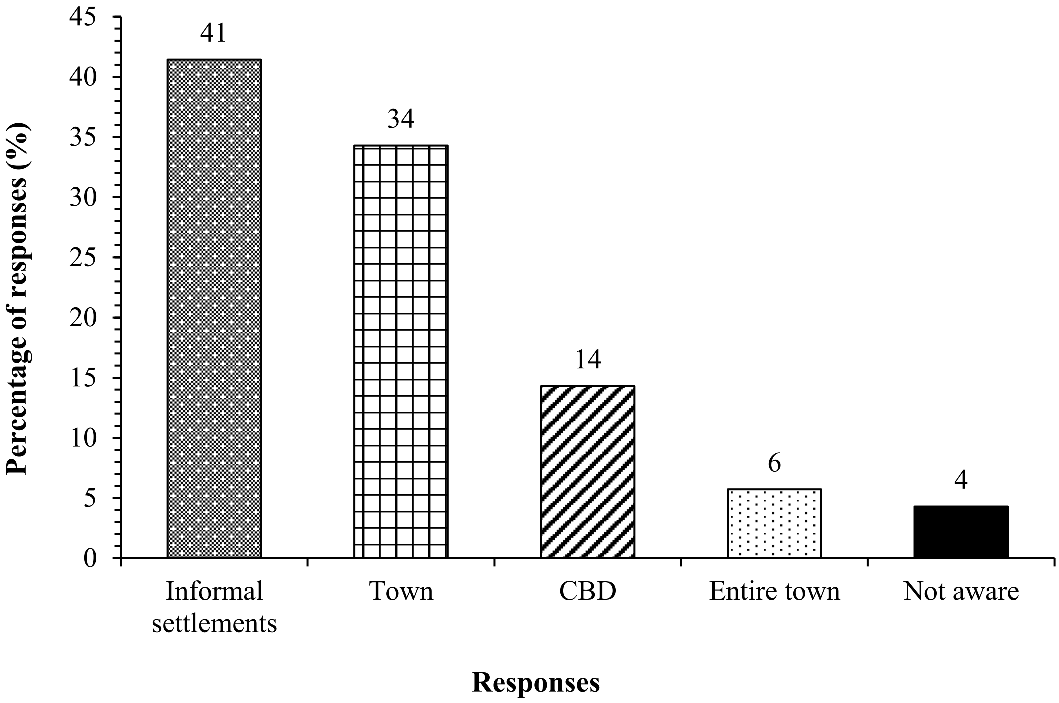


Figure 5.39: Users' responses on NMT dominant spaces in Tsumeb

The findings in Figure 5.40 indicate that about half of the respondents (48 %) in Walvis Bay identified informal settlements, particularly Kuisebmond and Tutaleni, as areas with the highest NMT activity, similar to the case in Tsumeb, where locations such as the informal settlement and town centres were reported as primary NMT hotspots. Some respondents reported significant NMT usage along routes from Kuisebmond to town for commuting between home and work. This reliance stresses the critical need for focused investment in safe and accessible infrastructure in low-income communities where transportation options are few. The high reliance on NMT in these areas can be attributed to socioeconomic factors, such as low vehicle ownership. This response is consistent with the findings by MWT *et al*. (2013) who reported high NMT usage in low-income areas. Additionally, 33 % of respondents reported NMT dominance in town, and 13 % indicated high NMT prevalence in the CBD, reflecting patterns noted by Cooke *et al*. (2022). Moreover, 4 % of respondents identified the lagoon and beach as NMT hotspots, likely due to recreational activities. Lastly, only 2 % of respondents reported NMT dominance across the entire town, suggesting that NMT is confined to specific areas rather than being a town-wide phenomenon.

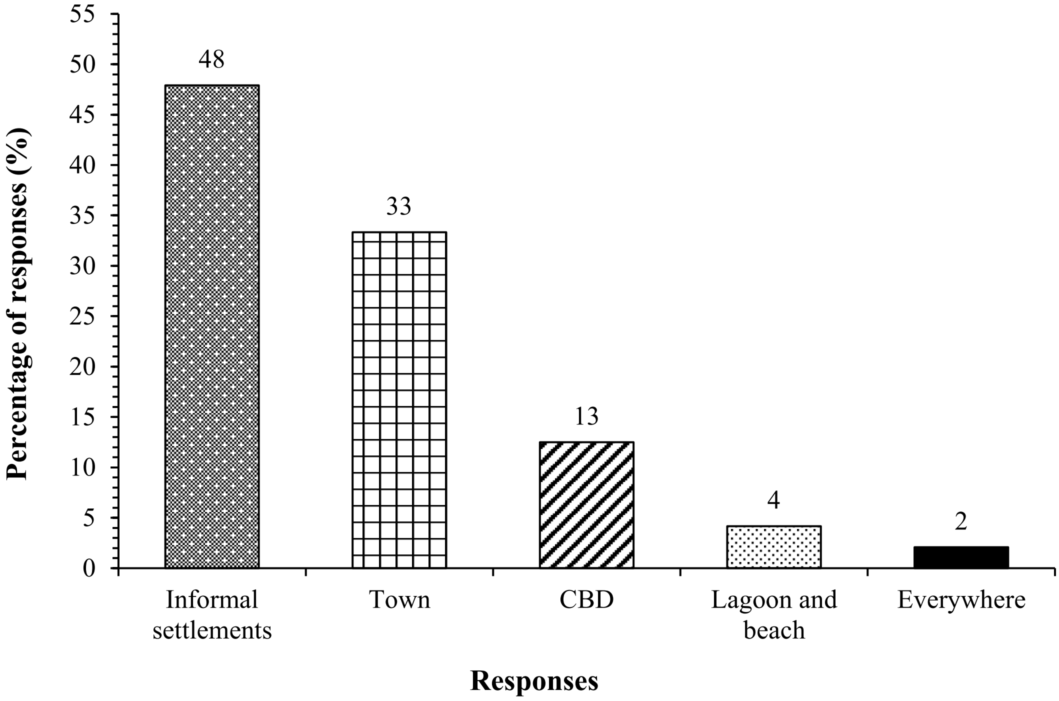


Figure 5.40: Users' responses on NMT dominant spaces in Walvis Bay

4. What role do you think NMT is playing/has to play in the town?

Figure 5.41 indicates that 37 % of respondents in Tsumeb reported that NMT plays an important role, citing benefits such as improved accessibility, health promotion, safety, and exercise. Similar observations were reported in the findings by Oviedo *et al*. (2021). Among this group, some emphasised the potential of NMT to reduce driver-user conflicts. Additionally, 29 % of respondents note that NMT serves commuters by helping them travel between home and work, an observation that reflects the findings by MWT *et al*. (2013), while 20 % noted its safety benefits, echoing the findings by Cooke *et al*. (2022). A small fraction (1 %) linked NMT usage to reduced accidents. This suggests that NMT is among the safest modes of transportation in the town. Other respondents noted that NMT improves accessibility (8 %), health (4 %), and saves cost (1 %). These modest recognitions are consistent with the findings by UNEP and UNHSP (2022), which note that increased public education on the health, environmental, and cost saving benefits of NMT can promote wider acceptance and adoption. Lastly, 3 % of respondents indicated that NMT does not play an important role in the town, reflecting a broader lack of awareness regarding its benefits.

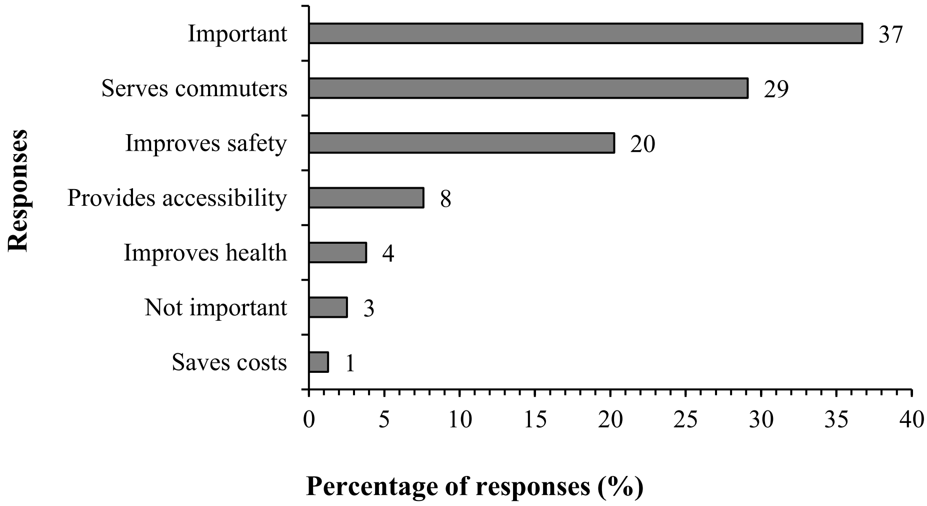


Figure 5.41: Users' view on the role of NMT in Tsumeb

Figure 5.42 indicates that an equal split (21 %) of respondents note that NMT plays a big role and serves commuters in Walvis Bay, highlighting its importance for individuals without access to motorised vehicles, an observation that is consistent with the findings by MWT *et al*. (2013). Additionally, 16 % of respondents cited improved safety, reflecting awareness of the potential of NMT to enhance road safety, as noted by Oviedo *et al*. (2021), while 8 % cited improved accessibility. Furthermore, 7 % of respondents cited that NMT "Provides walking spaces for pedestrians", and 10 % acknowledged its health and cost-saving benefits, with 5 % reporting either one of those responses. The limited recognition of health benefits and cost savings associated with NMT indicates a lack of awareness about its potential advantages and suggests that these advantages are underappreciated, as observed by UNEP and UNHSP (2022), who argue that promoting the benefits of NMT can improve public perception and support for NMT initiatives. Additionally, high reliance on NMT due to low vehicle ownership and the need for affordable transportation is consistent with the volume counts presented in Section 5.2.2, which shows significant pedestrian and cyclist activity in areas like Kuisebmond (Walvis Bay) and Kuvukiland (Tsumeb). Among the respondents, 5 % do not consider NMT as important, indicating mixed perceptions and 4 % are unaware of the role that NMT plays in the town. An equal split, 3 %, of participants reported that NMT improves development or reduces accidents, 2 % cited that NMT "Serves disabled people" and an equal split (1 %) indicated that NMT either improves sustainability or reduces the number of vehicles on the road.

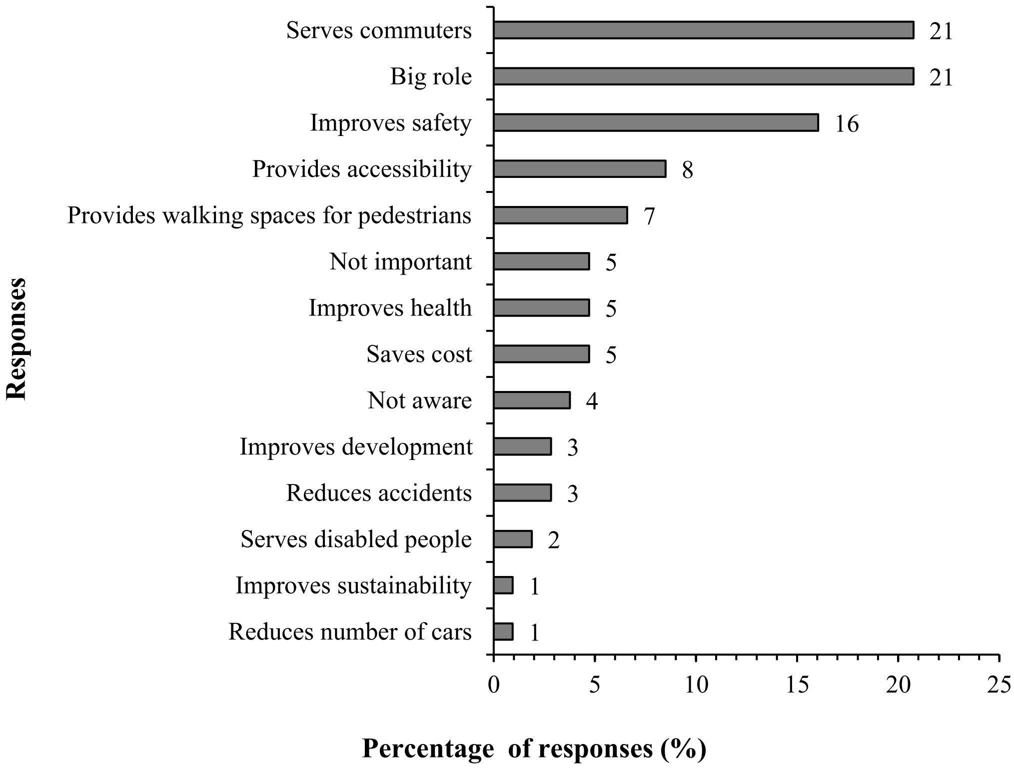


Figure 5.42: Users' view on the role of NMT in Walvis Bay

5. What are the challenges faced by the various NMT users in the town?

Figure 5.43 shows that limited walking space on NMT infrastructure was viewed as the most significant challenge for NMT users in Tsumeb, cited by 15 % of respondents. This reveals a structural weakness in urban planning that deprioritises NMT users. The various challenges that stem from this deprioritisation require both physical and behavioural adaptations. This response aligns with the findings by MWT *et al*. (2013), which identified inadequate walkway widths and discontinuous pedestrian paths as common issues in Namibian towns. Also, 13 % cited accidents and poor NMT infrastructure as major challenges, reflecting concerns about infrastructure and driver behaviour, an observation that is consistent with the findings by ITS and BP consulting engineers (2018). This suggests that a cycle in which poor facilities cause safety issues, discourages use, and limits the viability of NMT. Additionally, 12 % of respondents reported a lack of NMT infrastructure as a challenge, an argument which has also been prioritised by policy makers, who emphasised the need for targeted interventions in underserved areas, as discussed in Section 5.5. Meanwhile, 11 % reported no significant barriers, suggesting acceptance of current NMT infrastructure conditions and lack of NMT usage, which aligns with findings by Oviedo *et al*. (2021) and Cooke *et al*. (2022). This may indicate user resilience or adaptation, but it could also reflect a normalisation of poor conditions, which can reduce improvement requests and influence policy priorities. Infrastructure-related issues, including limited space, poor conditions, and lack of

NMT facilities, dominate challenges in Tsumeb, particularly in informal settlements, as highlighted in Section 5.3.1.2. Other challenges include obstructions (6 %), Safety concerns, ignorance, lack of lighting, and driver attitudes (5 % each), and obstructions such as dustbins, tree branches, construction debris, and parked vehicles. These findings align with ITS and BP consulting engineers (2018) who noted negative driver attitudes and limited enforcement as barriers to NMT adoption. Among the 5 % of participants who cited "Safety concerns" as a challenge, 2 % mentioned robberies and lack of law enforcements, and 1 % highlighted the lack of helmets as a challenge. The user-reported safety issues are acknowledged by policy makers in Section 5.5.1 as critical areas requiring urgent intervention. Lastly, a 3 % split from the responses highlighted weather and climate, long distance trips, and a lack of user awareness as barriers, observations that are consistent with the findings by Cooke *et al*. (2022), which noted environmental constraints and inadequate policing as factors impacting NMT safety and usability.

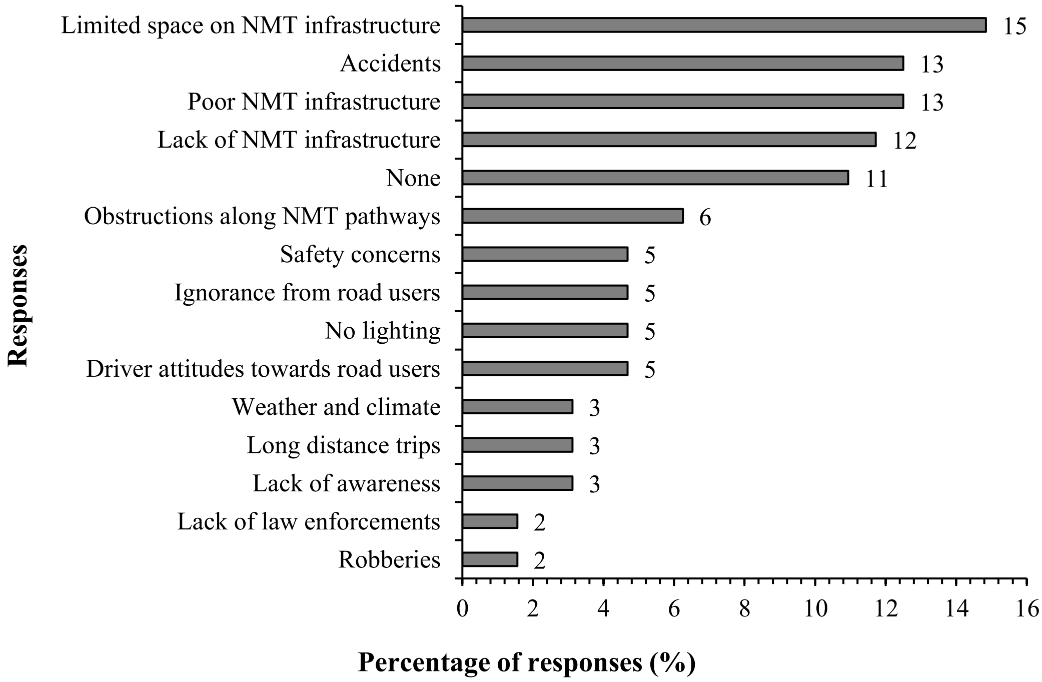


Figure 5.43: NMT challenges in Tsumeb

Accidents have been identified as the most significant challenge in Walvis Bay, with 22 % of respondents citing that as their primary concern as shown in Figure 5.44. Similar findings have been reported by MWT *et al*. (2013). The high percentage of responses may be attributed to poor driver behaviour. Additionally, 19 % reported poor NMT infrastructure as the major challenge, aligning with observations by ITS and BP consulting engineers (2018) and MWT *et al*. (2013). An equal split (10 %) of respondents indicated limited walking spaces or lack of NMT facilities as key challenges. Furthermore, 6 % cited poor driver attitudes or long-distance trips as obstacles, reflecting findings by Oviedo *et al*. (2021). Safety concerns were noted by 5 % of respondents, while 3 % reported lack of law enforcements, growing populations, weather and climate, or theft as NMT barriers. Furthermore, 2 % of respondents were unaware of any NMT barriers, and 3 % identified industrial facilities, ignorance from road users (including NMT users and motorised vehicle users), or general lack of awareness as their primary concerns, with 1 % reporting either one of the challenges.

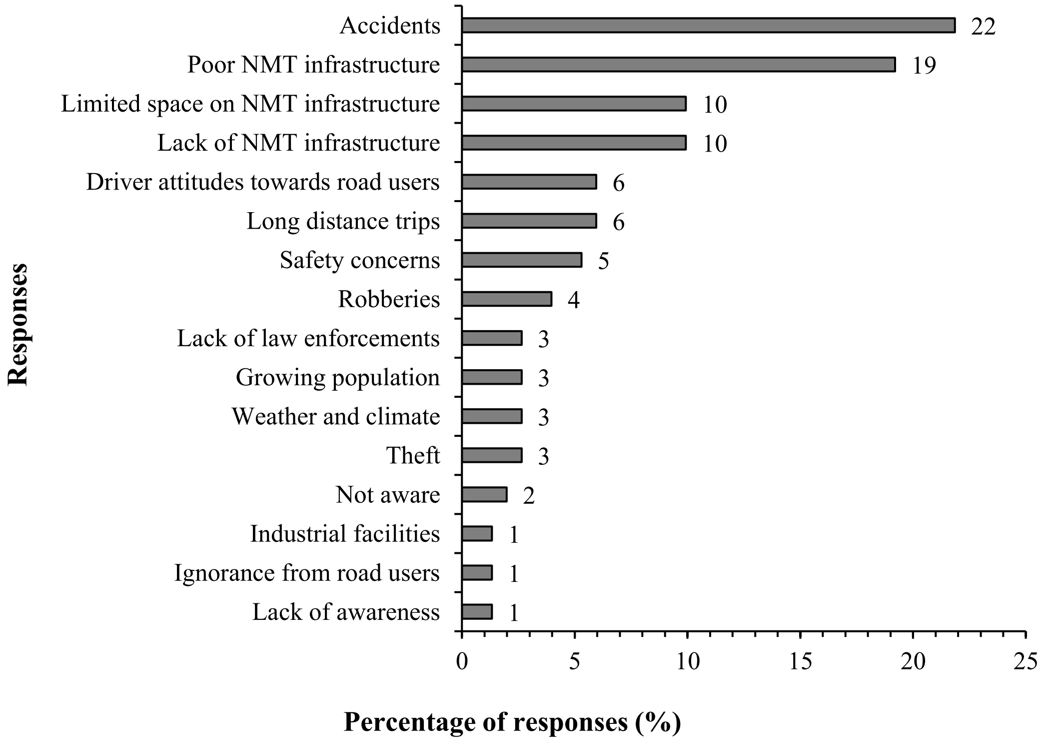


Figure 5.44: NMT challenges in Walvis Bay

6. What measures are the council putting in place to address these challenges?

The findings in Figure 5.45 indicate that 74 % of respondents in Tsumeb reported no action by the town council to address NMT infrastructure and user challenges, contributing to widespread dissatisfaction with the state of infrastructure and safety. Majority of respondents in Walvis Bay also felt that the Town Council were not taking adequate measures to address NMT challenges. ITS and BP consulting engineers (2018) and MWT *et al*. (2013) similarly highlight a lack of proactive measures in Namibian towns, where limited NMT infrastructure and delayed action on necessary upgrades often intensify safety and accessibility concerns. Additionally, 16 % of respondents were unaware of any actions taken, while 1 % cited minor measures such as speed humps and suggestion boxes for NMT user feedback. The lack of actions by the town council raises concerns about its capability and commitment, potentially undermining public trust and deterring civic engagement, both of which are crucial for long-term NMT growth. Moreover, the lack of public engagement reveals communication gaps and a mismatch between municipal priorities and community demands, which impedes user-centred transportation solutions. This lack of public engagement reflects findings by Cooke *et al*. (2022), who reported that inadequate public involvement and communication can lead to low public awareness and perception of government efforts. Meanwhile, 7 % acknowledged recent NMT infrastructure upgrades, however, minimal recognition suggests either poor communication or limited action, an observation that aligns with the findings by Oviedo *et al*. (2021). The limited efforts in addressing these challenges appear to be inconsistent with the scale of the issues identified by the users.

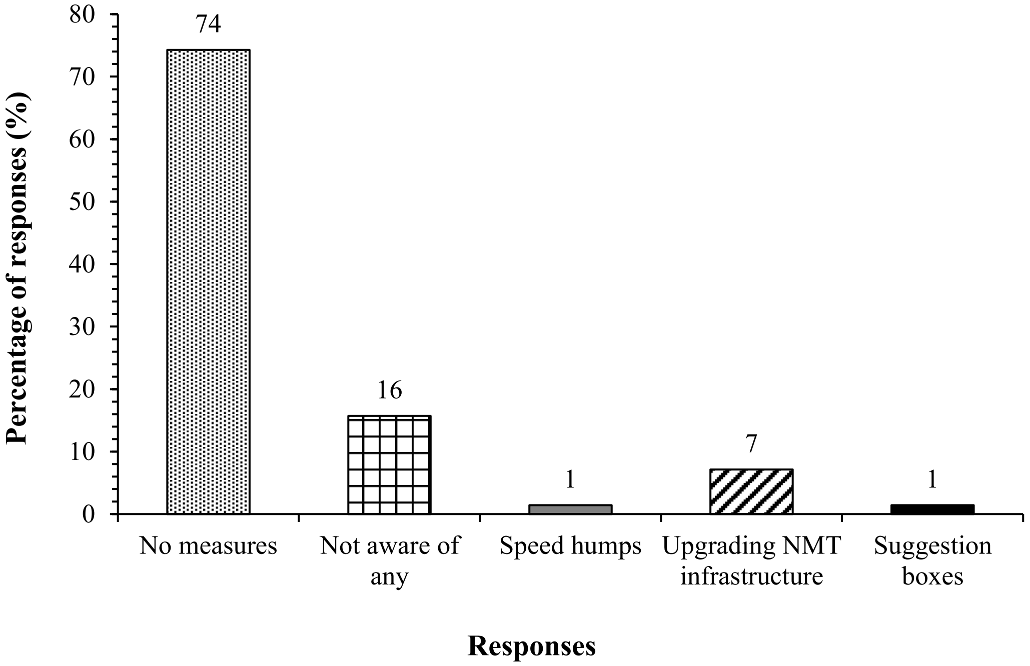


Figure 5.45: Measures to address NMT challenges from Tsumeb Town Council

From Figure 5.46, it can be observed that 60 % of respondents in Walvis Bay reported no action by the town council to address NMT-related challenges, while 25 % were unaware of any actions taken. This combined 85 % of responses indicate a significant lack of action or awareness, an observation that is consistent with the findings by ITS and BP consulting engineers (2018) and MWT *et al*. (2013), as discussed in the findings in Tsumeb. Moreover, 13 % of respondents reported that some NMT infrastructure has been upgraded as part of the measures to ensure safe and comfortable pathways for NMT users. Limited awareness implies that the actions taken may be too minor or insufficiently articulated, reducing their impact and raising questions about transparency and engagement. The few respondents who noted some infrastructure upgrades suggest that some improvements are underway, but these efforts are minimal or likely insufficient, an observation which is consistent with the findings by Oviedo *et al*. (2021) as discussed earlier. Lastly, 1 % of the respondents indicate that awareness meetings have been conducted, and cleaning campaigns have been held to ensure adequate maintenance of existing NMT facilities. However, Cooke *et al*. (2022) note that limited communication efforts and minor initiatives can be insufficient if not paired with substantial infrastructure and safety improvements.

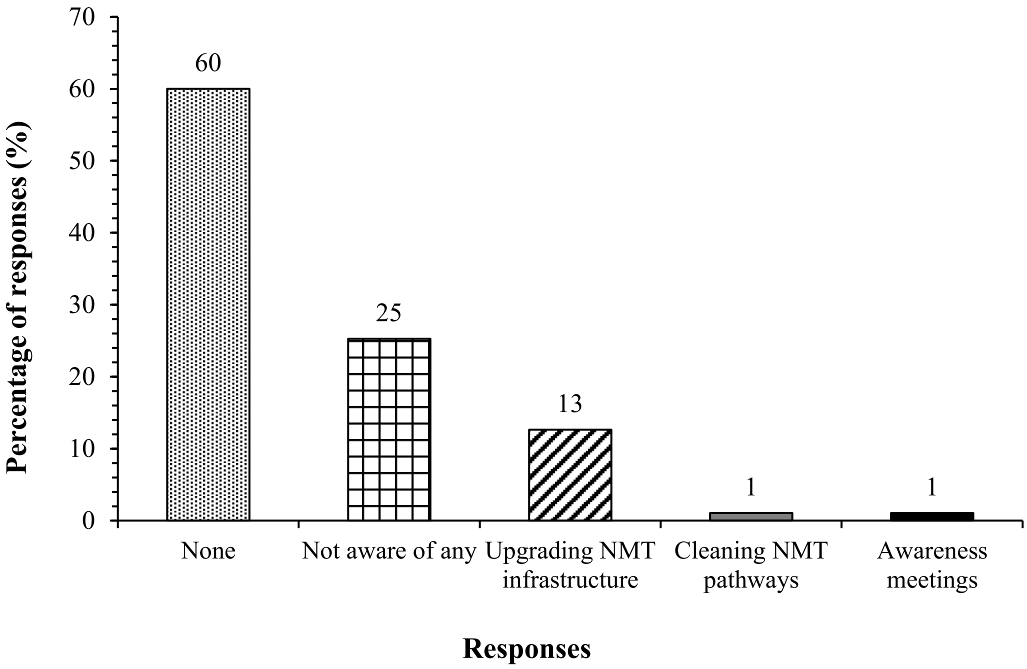


Figure 5.46: Measures to address NMT challenges from Walvis Bay Town Council

7. How important is NMT provision to the current/future development of the town?

Figure 5.47 shows that majority of the respondents (81 %) in Tsumeb cited the provision of NMT as "Very important" for the development of the town. Additionally, 13 % do not consider NMT provision as a high priority but cited the provision of NMT infrastructure as "Important". Overall, 94 % of respondents consider NMT provision as very important or important, reflecting a strong community support for NMT development, consistent with the findings by MWT *et al*. (2013). The combined 94 % agreement suggests a readiness for NMT-focused initiatives, consistent with the discussions in the Sustainable Urban Transport Master Plan for the city of Windhoek by MWT *et al*. (2013), which emphasises the role of NMT in equitable urban development and sustainability. However, the strong community support contrasts sharply with the limited infrastructural provisions discussed earlier, revealing a mismatch between public priorities and implementation that risks wasting public excitement for meaningful improvements. Furthermore, 6 % of respondents to not recognise the significance of NMT provision, stating that the provision of NMT infrastructure is "Not important" for the current or future development of the town. This could reflect rooted doubt stemming from ongoing neglect, implying that changing attitudes requires more than upgrades – consistent dedication and education are essential. This response is consistent with findings by Oviedo *et al*. (2021), who note that negative perceptions often arise from inadequate infrastructure and limited education about NMT benefits.

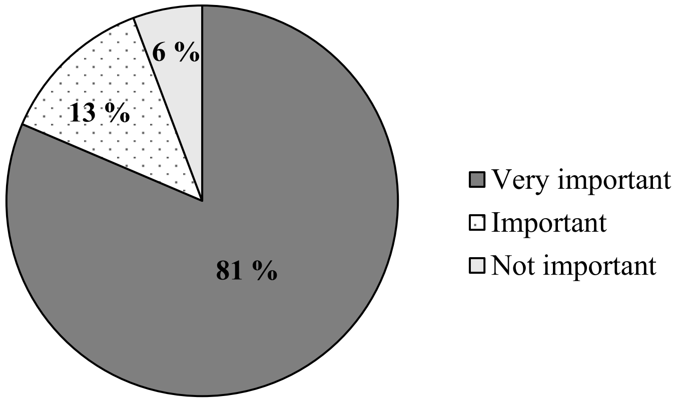


Figure 5.47: Importance of NMT provision in Tsumeb

Figure 5.48 shows that 65 % of respondents in Walvis Bay perceive NMT provision as "Very important" for the development of the town. Additionally, 31 % of respondents cite that NMT provision is "Important", while 1 % cite that NMT provision is "Slightly important" for the development of the town. Moreover, 97 % of respondents view NMT provision as important to some extent, an observation that is consistent with the findings by MWT *et al*. (2013) as discussed with the case in Tsumeb. Furthermore, 3 % of respondents do not acknowledge the importance of NMT and they cite that NMT provision is "Not important" to the current or future development of the town, which is consistent with the findings by Oviedo *et al*. (2021) as discussed earlier.

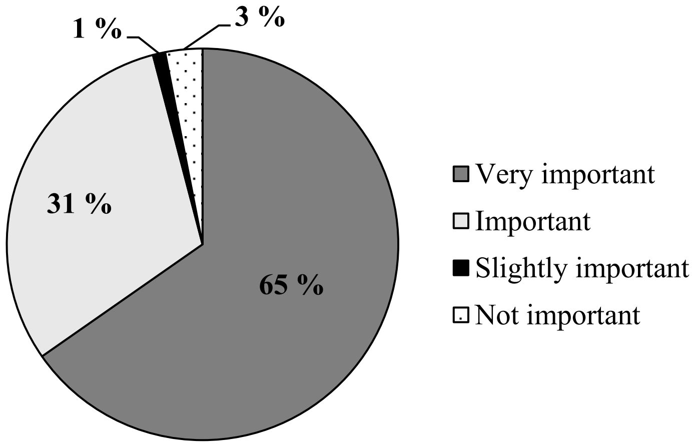


Figure 5.48: Importance of NMT provision in Walvis Bay

8. Do you think NMT will have any potential benefits if prioritised in the town?

The findings in Figure 5.49 reveals that 97 % of respondents in Tsumeb agree that prioritising NMT provision will have potential benefits for them as NMT users. Overwhelming agreement on the potential benefits of prioritising NMT indicates readiness among residents for NMT-focused initiatives. This readiness provides a framework for long-term NMT policies; neglecting it risks additional inaction and marginalisation of NMT users. Moreover, 3 % of the participants do not recognise any potential benefits from prioritising NMT provision, indicating a lack of awareness regarding the advantages of using NMT modes, an observation that is consistent with the findings by ITS and BP consulting engineers (2018).

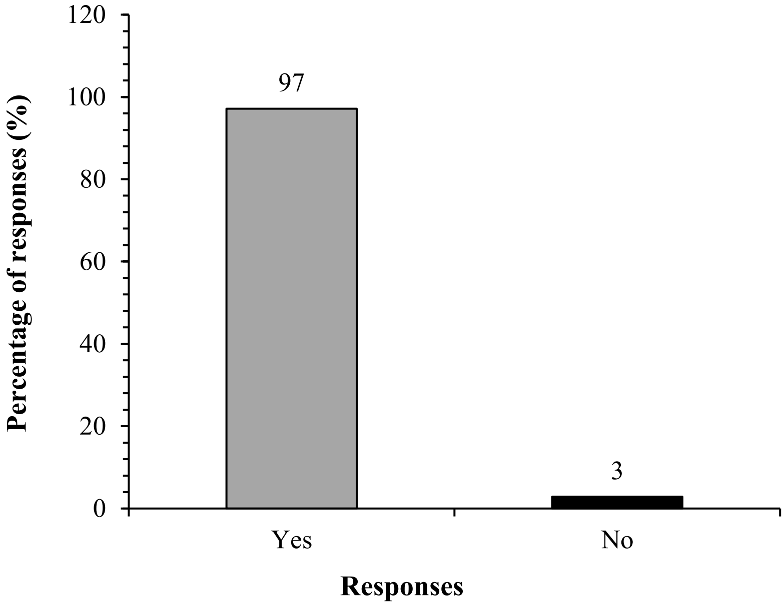


Figure 5.49: Participants perspectives on benefits of NMT in Tsumeb

The participants in Tsumeb provided 70 responses describing the potential benefits of utilising NMT modes. Notable responses included benefits such as serving commuters, enhancing safety, reducing accidents. The key benefits are consistent with the literature by MWT *et al*. (2013) which emphasise the socioeconomic and safety advantages of NMT modes. Similar findings have also been reported by Oviedo *et al*. (2021). The potential benefits of utilising NMT modes as reported by the participants are presented in Table 5.5.

Table 5.5: Potential benefits of NMT in Tsumeb

Benefits	Number of responses
Serves commuters	21
Enhances safety	21
Reduces accidents	7
Improves accessibility	4
Cost effective	4
Reduces carbon emissions	2
Improves aesthetics and town structure	2
Reduces traffic congestion	1
Improves ease of driving motorised vehicles	1
Improves health	1
Enhances NMT infrastructure	1
Benefits people with disabilities (PWDs)	1
Reduces obstructions on the NMT pathways	1
Enhances tourism	1
Saves time	1
Reduces theft experienced by bicycle users	1

From Figure 5.50, it can be observed that 98 % of respondents in Walvis Bay agree that prioritising NMT provision will have potential benefits for NMT users, indicating that participants recognise the advantages of using NMT and suggesting a strong belief in its positive impact on community well-being and overall transportation efficiency, which aligns with the findings by MWT *et al*. (2013). Widespread support for NMT provides an opportunity for local authorities to refocus priorities and capitalise on community momentum; delay may worsen discontent and mobility disparities. Moreover, 2 % of the participants cited that NMT provision will "Not" have any potential benefits, consistent with the findings by Oviedo *et al*. (2021). The negative outlook on the potential benefits of NMT usage may be attributed to negative experiences or existing barriers that have shaped their views on NMT and implies that reactive planning – responding mainly to crises or outcry – may worsen such issues and prevent long-term shift toward NMT.

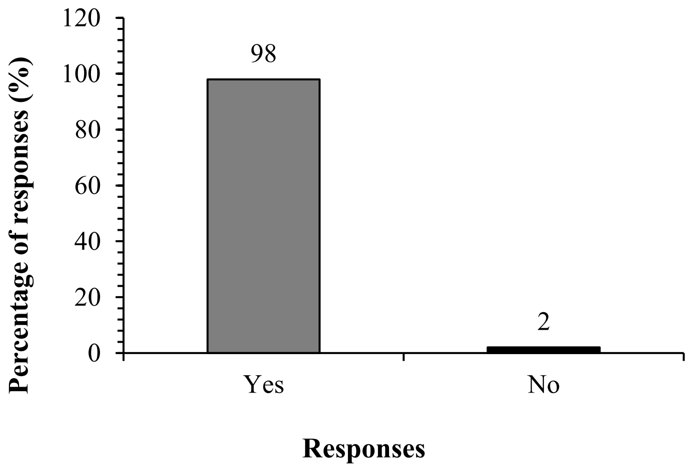


Figure 5.50: Participants perspectives on benefits of NMT in Walvis Bay

The participants in Walvis Bay provided 97 responses describing the potential benefits of utilising NMT modes. Notable responses included benefits such as improving safety, reducing accidents, being cost-effective, and improving accessibility. The potential benefits of utilising NMT modes as reported by the participants are presented in Table 5.6.

Table 5.6: Potential benefits of NMT in Walvis Bay

Benefits	**Number of responses**
Improves safety	53
Reduces accidents	18
Cost effective	9
Improves accessibility	5
Saves time	4
Serves commuters	4
Improves health	4
Reduces emissions	3
Increases walking space for pedestrians	1
Reduces traffic congestion	1

5.5. Evaluation of NMT planning

Non-Motorised Transport (NMT) planning in the selected study towns was evaluated via focus group discussions and an online survey with NMT policy makers. The following subsections present insights from policy makers on the state of NMT infrastructure and planning capacity in the selected study towns, along with an analysis of NMT expert perception data (NMT-related factors) based on the analytical hierarchy process (AHP).

5.5.1. Policy makers planning tools (approaches) and perceptions

During the engagements with Tsumeb Town Council officials, key insights into the current state of non-motorised transport (NMT) infrastructure and planning were reported by NMT policy makers. The policy makers noted that NMT infrastructure in Tsumeb, built primarily in the 1970s and 1980s, were largely outdated, fragmented, and limited to pedestrian walkways, with minimal dedicated facilities for cyclists. Similar findings were noted during infrastructure audits discussed in Section 5.3.1. NMT usage was reported to be high among residents of informal settlements commuting to key areas such as markets, educational institutions, and the central business district, as observed during NMT volume counts discussed in Section 5.2.2, yet these routes often lacked connectivity and safety measures. Moreover, policy makers reported poor accessibility for people with disabilities, with major intersections and routes from informal areas presenting safety risks. The municipality faces funding and maintenance challenges because NMT infrastructure development is not prioritised in the current budget. While previous attempts, such as a GIZ-led project, initiated plans for NMT improvements, a lack of stakeholder engagement and implementations strategies hindered progress. Moving forwards, officials stressed the need for better planning models, community involvements, and long-term funding sources to address these gaps.

During engagements with town planners and policy makers in Walvis Bay Town Council, numerous challenges related to NMT planning and infrastructure were noted. There has been a shortage of allocated funding for the development, maintenance, and upgrade of NMT facilities which limits the ability to upgrade current facilities and construct new ones, as was the case in Tsumeb. The municipality authorities also stated that the priority is to provide serviced land to residents (and developers), but they lack the policy framework to ensure new developments include NMT provisions. Regular maintenance of pathways is frequently insufficient, resulting in deterioration and decreased usability over time. Additionally, the planning and construction of NMT facilities frequently excluded community input, similar to the case in Tsumeb, resulting in solutions that are underutilised and fail to meet local needs. Involving locals in the planning process could lead to more effective and user-friendly NMT solutions. Inadequate planning in Walvis Bay has also neglected the needs of NMT users, such as cyclists and pedestrians, leaving them disconnected from the broader transportation network and compromising safe and efficient travel. Furthermore, the lack of comprehensive policies and guidelines from the municipality raises serious concerns about prioritising NMT users in future development initiatives.

5.5.2. NMT Analytical Hierarchy Process – policy makers survey

The derived relative weights of infrastructure indicators attributes based on Tsumeb policy maker surveys are presented in Table 5.7. Tsumeb officials prioritised safe and comfortable crosswalks, ranking top with a weight of 0.19888, followed by accessibility (0.18334) and crosswalk availability (0.15894). Observations such as poor crosswalk visibility and the absence of dedicated cycling lanes, discussed in Section 5.3.1.3, align with the AHP emphasis on safety and comfort. Lower weights were allocated to crosswalk alignment with pedestrian desired lines (0.11549) and visible road markings and signage (0.06964). The priority placed on comfort and accessibility reflects a rising realisation among decision-makers that user experience, particularly for vulnerable groups, must inform infrastructure investments. However, the low ranking of elements such as signs and line marking indicates a lack of awareness about the cumulative safety benefits of seemingly simple initiatives. For sidewalk assessments, safe and comfortable conditions were highly prioritised with a weight of 0.32204, an indicator that also received the highest priority by Walvis Bay officials. The highest rated indicator in Tsumeb was followed by availability (0.17901) and accessibility (0.16226) of sidewalks. Emphasis, by policy makers, on the need for safe and accessible facilities reflect safety concerns about the lack of lowered kerbs, fragmented pathways, and obstructions on NMT infrastructure, as highlighted in Section 5.3.1.1. Vehicle parking along sidewalks (0.08705) and shared bicycle usage (0.03449) received less importance. Shared bicycle usage on sidewalks was also perceived with the least importance by policy makers in Walvis Bay. For bikeway assessment, officials prioritised availability (0.16860), with minimum width (0.15048) as the next priority, followed by safety and comfort (0.14450). Vehicle parking along bikeway (0.05957) was perceived as the least important indicator, as was the case in Walvis Bay.

Table 5.7: AHP Average Weights and Ranking of NMT Indicators in Tsumeb

Indicators	**Average weight**	**Rank**
Crosswalk - Five (5) main crosswalk assessment indicators		
Safe and comfortable crosswalk – a condition	0.19888	1
Accessibility of crosswalk to pedestrians and persons with disabilities (PWDs)	0.18334	2
Availability of crosswalk	0.15894	3
Crosswalk along pedestrian crossing desire lines	0.11549	4
Visible crosswalk markings and road (motorist) warning signage	0.06964	5
Sidewalk - Five (5) main sidewalk assessment indicators		
Safe and comfortable sidewalk – a condition	0.32204	1
Availability of sidewalk	0.17901	2
Accessibility of sidewalk	0.16226	3
Vehicle parking along the sidewalk	0.08705	4
Sidewalk shared with bicycles	0.03449	5
Bikeway - Five (4) main bikeway assessment indicators		
Availability of bikeway (separate)	0.16860	1
Minimum required width as per the guideline	0.15048	2
Safe and comfortable bikeway	0.14450	3
Vehicle parking along bikeway	0.05957	4

The derived relative weights of infrastructure indicators attributes, from policy maker surveys in Walvis Bay are presented in Table 5.8. In Walvis Bay, policy makers assigned visible crosswalk markings and signage with the highest priority (0.18983), followed by alignment with pedestrian crossing desired lines (0.17543), and safe and comfortable crosswalk conditions (0.15266). Tsumeb officials, however, highly prioritised safe and comfortable crosswalk. Accessibility (0.13652) and crosswalk availability (0.12369) were rated as less important. For sidewalk assessments, safe and comfortable sidewalk conditions received the most weight (0.29166), followed by concerns about vehicle parking along the sidewalk (0.17161), accessibility (0.14678), and availability (0.12608). The priority of infrastructure (by policy makers) that ensures safe and comfort for NMT users aligns with challenges identified in sections 5.3.2.1 and 5.4. This prioritisation represents an ongoing trend toward evidence-based policy, but it also highlights how lived realities – such as poor lighting, disoriented signals, and limited paths – continue to receive insufficient attention. To bridge this gap, AHP findings must be translated into precise, quantifiable action plans with allocated funding and community monitoring. Additionally, the absence of lowered kerbs, fragmented sidewalks, and poor crosswalk visibility in areas such as Kuisebmod and Naraville (detailed in sections 5.3.2.2 and 5.3.2.3) directly reflects AHP indicators such as accessibility and clear cross markings. Bicycle-shared walkways received the least importance (0.02838). Bikeways were rated similarly based on availability (0.16519), safety and comfort (0.15266), and minimum required width (0.12145). Similarly, Tsumeb officials rated the availability of bikeways with the highest perceived importance. Despite the availability of some facilities, users continue to face major issues due to inadequate maintenance and connectivity across areas in Walvis Bay.

Table 5.8: AHP Average Weights and Ranking of NMT Indicators in Walvis Bay

Indicators	Average weight	Rank
Crosswalk - Five (5) main crosswalk assessment indicators		
Visible crosswalk markings and road (motorist) warning signage	0.18983	1
Crosswalk along pedestrian crossing desire lines	0.17543	2
Safe and comfortable crosswalk – a condition	0.15266	3
Accessibility of crosswalk to pedestrians and persons with disabilities (PWDs)	0.13652	4
Availability of crosswalk	0.12369	5
Sidewalk - Five (5) main sidewalk assessment indicators		
Safe and comfortable sidewalk – a condition	0.29166	1
Vehicle parking along the sidewalk	0.17161	2
Accessibility of sidewalk	0.14678	3
Availability of sidewalk	0.12608	4

Sidewalk shared with bicycles	0.02838	5
Bikeway - Five (4) main bikeway assessment indicators		
Availability of bikeway (separate)	0.16519	1
Safe and comfortable bikeway	0.15266	2
Minimum required width as per the guideline	0.12145	3
Vehicle parking along bikeway	0.06644	4

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusions drawn from this study along with recommendations for further research.

6.1. Introduction

The primary objective of this study was to investigate the current state of NMT provision, challenges, and opportunities in the towns of Tsumeb and Walvis Bay. This study also aimed to achieve the following sub-objectives:

i. To evaluate the extent of NMT networks in the selected towns.
ii. To examine NMT infrastructure conditions in the selected towns.
iii. To evaluate NMT user safety and perceptions in the selected towns.
iv. To evaluate NMT planning (policies, frameworks, and strategies).
v. To evaluate the capacity for the provision of NMT infrastructure and planning (human resource and financial).
vi. To develop phased strategies for NMT in the selected towns.

These objectives were achieved through a critical review of literature, assessments of NMT infrastructure, engagements with NMT users (via interviews) and policy makers (via focus group discussions), and online surveys provided to policy makers in the selected study towns. The conclusions of this study relate to three specific aspects:

i. Evaluation of NMT networks
ii. NMT infrastructure audits
iii. NMT user safety and perceptions
iv. NMT planning and provision

The above conclusions are discussed in the subsequent subsections.

6.2. Evaluation of NMT networks

The scope of non-motorised transport (NMT) networks in the selected study towns was assessed by mapping the availability of NMT infrastructure and conducting NMT traffic volumes during peak hours.

An evaluation of the NMT network in Tsumeb resulted in the following conclusions:

i. The NMT network was characterised by disconnected and incomplete pathways, particularly in informal settlements and high-income areas, limiting the usability of existing facilities. This reflects a larger planning gap and stresses the need for integrated, interconnected systems that prioritise vulnerable users.

ii. There was minimal focus on interconnected pedestrian and cycling facilities, resulting in unsafe conditions, especially on major roads like Hage Geingob Drive and Leevi Mueshekele Street. Such circumstances not only threaten users but also reveal fundamental deign biases that exclude NMT users, prolonging transport inequality.

iii. Key areas such as the central business district (CBD) and informal settlements saw significant pedestrian and cyclist traffic, with over 1,500 NMT users observed during morning peak hours at **Location 1** (CBD). Informal settlements (**Location 2**) showed notable activity, primarily driven by commuting and school-related movements.

iv. Shared use of pathways between pedestrians, cyclists, and vehicles increases accident risks, compounded by poor infrastructure design, such as obstructions and lack of lowered kerbs.

v. Policy implications such as addressing infrastructure fragmentation and enhancing connectivity can significantly improve safety and accessibility for the growing NMT user base in Tsumeb.

An evaluation of the NMT network in Walvis Bay resulted in the following conclusions:

i. Pedestrian and cyclist volumes were highest in the informal settlements during afternoon peak hours, reflecting high reliance on NMT for commuting between residential and commercial areas. This stresses the significance of investing in safe and reliable infrastructure in areas where dependency is highest, particularly in low-income populations.

ii. Strategic investments in interconnected and safe NMT pathways, particularly in informal settlements and the CBD, would enhance mobility and safety for vulnerable users. Without such investments, current usage patterns will continue to ecpose users to avoidable risks and hinder overall urban accessibility.

6.3. NMT infrastructure audits

The following subsections present a summary of the findings from NMT infrastructure audits conducted in the selected study towns.

6.3.1. Tsumeb

i. Across all the assessed locations, NMT infrastructure was found to be fragmented and inconsistent, with issues such as absence of lowered kerbs, vehicles parked on sidewalks, and obstructive road signs, which were observed to hinder the usability of NMT facilities. This suggests not just design flaws but a lack of institutional oversight and standards.

ii. Despite the presence of sidewalks at the CBD (**Location 1**), poor crosswalk visibility, non-functional pedestrian signals, and obstructions such as parked vehicles and street vendors were observed. Cyclists and pedestrians often shared pathways, increasing accident risks. This indicates competition for limited space and poot spatial regulation, endangering users and discouraging walking and cycling.

iii. At the informal settlements (**Location 2**), poorly designed drainage systems and the lack of ramps forced cyclists and pedestrians to share roads with vehicles, posing serious safety risks. Gaps between crosswalks and sidewalks were observed.

iv. NMT infrastructure in high-income areas (**Location 3**) was fragmented and poorly maintained, with obstructions such as poles and parked vehicles on NMT pathways. NMT facilities on entire roads, such as 1st Avenue, was non-existent, forcing pedestrians and cyclists onto motorised vehicle lanes. This shows that even locations with more municipal resources are not immune to neglect, implying that development priorities continuously favour automobiles across income levels.

6.3.2. Walvis Bay

The findings from NMT infrastructure audits conducted in Walvis Bay are hereby presented.

Central Business District (CBD) – Location 1

i. There was a lack of essential NMT facilities in the CBD, including bikeways and consistent lowered kerbs at intersections, prioritising vehicle needs over pedestrian and cyclist needs.

ii. Poor visibility of crosswalks, pavement failures, and fragmented sidewalks were observed; compounded by obstruction of pedestrian pathways by poles, construction debris, and infrastructure elements, limiting usability and forcing pedestrians onto vehicular roadways. This reveals that infrastructure provision without upkeep limits long-term effectiveness and user comfort.

Kuisebmond informal settlement – Location 2

i. The location suffered from a lack of lowered kerbs, fragmented sidewalks, and limited crosswalks, forcing NMT users to share roads with vehicles, increasing accident risks.

ii. Pedestrian pathways were obstructed by street vendors, parked vehicles, and infrastructure (poles), which created safety hazards and limited the availability of walking space.

iii. Non-functional pedestrian signals and poorly maintained NMT facilities were noted, which intensified challenges for NMT users, particularly those with disabilities.

Naraville residential area – Location 3

i. NMT infrastructure was poorly maintained, with challenges such sand accumulation, potholes, and uneven surfaces, which posed safety risks for pedestrians and cyclists.
ii. Gaps between sidewalks and crosswalks, absence of lowered kerbs, and fragmented infrastructure were noted, which restricted movement and safety for NMT users.
iii. Pathways were obstructed by poles, vehicles, and dustbins, while crosswalk markings were often faded or poorly visible.
iv. Some sections featured well-paved sidewalks meeting minimum width requirements, which indicated isolated improvements.

6.4. NMT user safety and perceptions

A summary of the responses from NMT user interviews in the selected study towns is discussed in the following subsections.

6.4.1. Tsumeb

The findings of this study provide insights on the current state of non-motorised transport (NMT) in Tsumeb, stressing key issues related to awareness, infrastructure, and community perceptions. The majority of respondents associate NMT with walking, which emphasises its role in daily transportation. However, limited visibility for cycling and narrow understanding of NMT concepts among residents point to a larger problem with infrastructure development and public education. NMT infrastructure is mostly inadequate, with 83 % of respondents rating it as moderate or poor. While informal settlements and the central business district (CBD) experience high NMT usage, poor infrastructure conditions, such as the lack of continuous and safe paths have been reported, which is worsened by safety concerns and poor driver behaviour. Despite these challenges, most respondents acknowledge the benefits of prioritising NMT, such as improved accessibility, safety, and health, as well as reduced traffic congestion and accidents. However, the response from the Town Council has been modest, with most respondents reporting a lack of meaningful actions to resolve NMT concerns. This lack of government engagement, combined with the positive view, from residents, about the potential of NMT, emphasises the need for more proactive measures, such as better infrastructure development, campaigns about public awareness, and safety improvements.

6.4.2. Walvis Bay

Significant gaps in awareness, infrastructure, and NMT support were highlighted in Walvis Bay. Nearly half of the respondents misunderstand or lack knowledge of NMT, revealing a widespread knowledge gap consistent with broader challenges in Namibia. Infrastructure conditions remain a major issue, with only 18 % rating it as satisfactory and many citing poor upkeep, limited space, and safety concerns as barriers. NMT activity was highest in informal settlements due to socioeconomic factors, while town centres and the CBD were key NMT centres. Despite these patterns, safety concerns, accidents, and insufficient infrastructure were reported, consistent with data about similar urban areas in Namibia. While most respondents recognised the importance of NMT for commuters and its potential to improve safety, accessibility, and cost efficiency, awareness of its health and environmental benefits remain limited. Accidents, poor infrastructure, and safety concerns are all reported barriers to NMT adoption, and the lack of action by the Town Council intensifies the issue. Although certain infrastructure upgrades and other initiatives have been implemented, they were insufficient to address the scale of the issues indicated. Finally, respondents (97 %) strongly agree on the importance of NMT provision for the development of the town, with 98 % recognising its potential benefits. Prioritising NMT could lead to improved safety, fewer accidents, reduce adoption barriers while promoting a sustainable, efficient urban transportation system.

6.5. NMT planning and provision

An analysis of insights from policy makers on the state of NMT infrastructure and planning capacity in the selected study towns, along with NMT expert perception data resulted in the following conclusions:

i. Poor planning and maintenance of NMT infrastructure in Tsumeb contributed to the underutilisation of existing facilities. This stresses the need for frequent audits and clear maintenance duties.

ii. There was a lack of policy prioritisation and funding allocation for NMT development in the town of Tsumeb. Greater budget allocation is required to align policy aims with on-the-ground action.

iii. Policy gaps were observed in Walvis Bay, which hindered the integration of NMT into urban planning, resulting in inconsistencies in infrastructure provision.

iv. Policy makers in both towns prioritised safety and accessibility in NMT planning based on the AHP results. This provides a strong foundation for advanced inclusive, user-focused transport systems.

6.6. NMT proposed strategy

The study identified specific priority areas and overall strategies for the towns of Tsumeb and Walvis Bay are developed and detailed in Table 6.1 and Table 6.2.

Table 6.1: Tsumeb NMT proposed roadmap

Tsumeb			
1	**Institutional Aspects and NMT Awareness**	**Short**	Create initiatives to promote awareness about the significance of maintaining NMT facilities, particularly among street vendors in the CBD.
2	**Data Drive Initiative**	**Short**	Use manual counts and surveys to monitor NMT usage and infrastructure conditions in areas like Hage Geingob Drive and Leevi Mueshekele Street.
3	**NMT User Perspectives**	**Medium**	Conduct user surveys on accessibility barriers, particularly near schools and hospitals.
4	**Identification of NMT activity (demand) hubs (and physical barriers) and propose NMT Network**	**Short**	Focus on demand points in informal areas like Soweto to improve essential links to urban centres.
5	**Prioritising Network Development Projects**	**Medium**	Develop safer school routes and improve infrastructure on busy corridors like Ilse Schatz Street.
6	**NMT Guideline Review (Contextualise)**	**Long**	Revise design guidelines to account for unique barriers such as street vendors and improperly installed signage.
7	**Structuring Informality**	**Medium**	Create formal trading zones near demand hotspots to eliminate pathway obstructions.

Table 6.2: Walvis Bay NMT proposed roadmap

Walvis Bay			
1	**Institutional Aspects and NMT Awareness**	**Short**	Engage stakeholder to emphasise safety and infrastructure improvements in the informal settlements of Kuisebmond.
2	**Data Drive Initiative**	**Short**	Establish automated methods to monitor NMT activities on Nathaniel Maxuilili Avenue and other high-traffic roads.
3	**NMT User Perspectives**	**Medium**	Conduct regular community engagement to identify unique challenges in the informal settlements of Kuisebmond.
4	**Identification of NMT activity (demand) hubs (and physical barriers) and propose NMT Network**	**Short**	Identify key NMT hubs like Agaat Street to target for immediate improvements of NMT infrastructure.
5	**Prioritising Network Development Projects**	**Medium**	Provide NMT pathways along informal tracks between the CBD and informal settlements to ensure safe and direct routes.
6	**NMT Guideline Review (Contextualise)**	**Long**	Upgrade guidelines to address accessibility and maintenance issues, particularly in informal settlements.
7	**Structuring Informality**	**Medium**	Collaborate with vendors along Nathaniel Maxuilili Avenue to reduce pathway obstacles by establishing approved vending zones.

6.7. Recommendations for further research

Based on the results and limitations of the study, several recommendations for local authorities (decision-makers) in the study towns are hereby given:

i. The towns need to develop and adopt comprehensive NMT policies tailored to the specific needs of small and medium-sized towns. This ought to be complemented with establishments of dedicated NMT units within local governments to ensure consistent planning, implementation, and monitoring.

ii. Prioritise the construction of continuous, and accessible pedestrian and bicycle lanes (especially in areas with high NMT usage), and integrate NMT facilities with existing motorised transport networks to ensure seamless mobility across urban areas.

iii. Conduct awareness campaigns to promote the benefits of NMT and build a culture of respect among all road users, coupled with the involvement of local communities in the planning processes to ensure that interventions meet user needs.

iv. Allocate dedicated funding streams for NMT development in municipal budgets and explore partnerships with international organisations and private sector stakeholders to mobilise additional resources.

v. Develop tools and methodologies to regularly assess NMT infrastructure conditions and user experiences and leverage data-driven insights to refine policies and adapt strategies to changing urban dynamics.

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APPENDICES

A. Ethical clearance certificate

RESEARCH ETHICS CLEARANCE CERTIFICATE

Reference Number: JED0425A

Date: 15 September 2025

Dear Kevin Sebastien Chomore,

This is to inform you that your application for research ethics approval has been approved for the duration of your studies. **You are required to apply for permission to conduct research from the relevant ministry/institution, if applicable, in addition to this ethical clearance.** You may contact the Ethics office (ethics@unam.na) for additional information.

Project title: An Investigation on Non-Motorised Transport in Small and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift
Student number: 202085732
Level of degree: Masters
Name of degree: Master of Science in Civil Engineering
Email address: **kevinchomore@gmail.com**
Supervisor(s): Dr. Robert Ambunda

Please note the following standard requirements for approval:
This ethical approval is issued by the University of Namibia's Research Ethics Committee following the University of Namibia's Research Ethics Policy and Guidelines. Ethical approval is given in respect of undertakings contained in the research ethics guidelines outlined below:

1. Any significant changes in the conditions or undertakings outlined in the approved Proposal must be communicated to the ethics committee. An application to make amendments may be necessary.
2. Any breaches of ethical undertakings or practices that have an impact on the ethical conduct of the research must be reported to the ethics committee.
3. The Principal Researcher must report issues of ethical compliance to the ethics committee (through the Chairperson) at the end of the Project or as may be requested by the ethics committee.
4. The ethics committee retains the right to:

i) Withdraw or amend this Ethical Clearance if any unethical practices (as outlined in the Research Ethics Policy) have been detected or suspected,

ii) Request for an ethical compliance report at any point during the research.

The ethics committee wishes you the best in your research.

Yours sincerely

Dr. Erasmus Shaanika (Chairperson: School of Engineering and the Built Environment DEC)

Prof. Davis Mumbengegwi (Head of MRS, Centre for Research Services)

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B. NMT volume counts

The level of non-motorised transport (NMT) activities – pedestrian and cyclists volume counts – in Tsumeb and Walvis Bay are summarised in Table B.1 and Table B.2 respectively.

Table B.1: Pedestrian and cyclist volume count in Tsumeb

Location	Street (route)	NMT mode	Peak hour	NMT count
1	Hage Geingob Drive (B1)	Walking	AM	1658
			PM	1462
		Cycling	AM	41
			PM	32
2	Leevi Mueshekele Street	Walking	AM	520
		Walking	PM	266
3	Ilse Schatz Street	Walking	AM	480
		Cycling	AM	2
	1st Avenue	Walking	AM	447

Table B.2: Pedestrian and cyclist volume count in Walvis Bay

Location	Street (route)	NMT mode	Peak hour	NMT count
1	Nathaniel Maxuilili Avenue (Kuisebmond)	Walking	PM	2188
		Cycling	PM	17
2	Kuisebmond to CBD/Town	Walking	AM	1976
		Cycling	AM	15

C. NMT infrastructure audit

Urban Infrastructure Audit: Tsumeb – Hage Geingob Drive (RHS) – Location 1

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 26 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes			√	
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes			√	
Are the NMT facilities paved	Yes			√	Some facilities
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes			√	
How are the conditions of the NMT facilities	Yes			√	
Are NMT routes continuous/ fragmented (Are there missing links)	Yes			√	Fragmented
Are the sufficient NMT crossings along the route	Yes			√	
Are the NMT crossing points located at the appropriate points	Yes			√	
Are there any traffic calming measures along the routes?	Yes		√		
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	No				
Are NMT facilities protected from vehicles	Yes		√		
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes		√		Street vendors
Are the NMT facilities accessible to people with disabilities?	No				
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes			√	
LIGHTING					
Are the streetlights available on the routes	Yes	√			
Is there sufficient lighting after dark	Yes		√		
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes		√		
Is the NMT facility free of obstructions that interfere with illumination	Yes		√		

Urban Infrastructure Audit: Tsumeb – Hage Geingob Drive (LHS) – Location 1

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 26 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes		√		
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes		√		
Are the NMT facilities paved	Yes		√		Some facilities
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes	√			
How are the conditions of the NMT facilities	Yes		√		
Are NMT routes continuous/ fragmented (Are there missing links)	Yes		√		Fragmented
Are the sufficient NMT crossings along the route	Yes			√	
Are the NMT crossing points located at the appropriate points	Yes			√	
Are there any traffic calming measures along the routes?	Yes			√	
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	Yes			√	
Are NMT facilities protected from vehicles	Yes		√		Some spaces
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes			√	Vehicles and street vendors
Are the NMT facilities accessible to people with disabilities?	No				
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes		√		
LIGHTING					
Are the streetlights available on the routes	Yes		√		Not enough
Is there sufficient lighting after dark	Yes			√	
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes			√	
Is the NMT facility free of obstructions that interfere with illumination	Yes			√	

Urban Infrastructure Audit: Tsumeb – Leevi Mueshekele Street (Location 2)

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 27 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes			√	
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes			√	
Are the NMT facilities paved	Yes		√		
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes		√		
How are the conditions of the NMT facilities	Yes			√	
Are NMT routes continuous/ fragmented (Are there missing links)	Yes			√	Fragmented
Are the sufficient NMT crossings along the route	Yes		√		Few crossings
Are the NMT crossing points located at the appropriate points	Yes			√	
Are there any traffic calming measures along the routes?	Yes		√		Speed bumps
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	No				
Are NMT facilities protected from vehicles	Yes		√		Raised sidewalks
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes			√	Vehicles and poles
Are the NMT facilities accessible to people with disabilities?	No				
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes		√		
LIGHTING					
Are the streetlights available on the routes	Yes		√		Few
Is there sufficient lighting after dark	Yes		√		
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes		√		
Is the NMT facility free of obstructions that interfere with illumination	Yes	√			

Urban Infrastructure Audit: Tsumeb – Ilse Schatz Street (Location 3)

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 27 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes			√	
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes			√	
Are the NMT facilities paved	Yes			√	Potholes
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes		√		Uneven
How are the conditions of the NMT facilities	Yes			√	
Are NMT routes continuous/ fragmented (Are there missing links)	Yes			√	Fragmented
Are the sufficient NMT crossings along the route	Yes			√	
Are the NMT crossing points located at the appropriate points	Yes			√	
Are there any traffic calming measures along the routes?	Yes		√		
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	No				
Are NMT facilities protected from vehicles	Yes		√		Some spaces
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes			√	Vehicles, trees, and poles
Are the NMT facilities accessible to people with disabilities?	No				
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes			√	
LIGHTING					
Are the streetlights available on the routes	No				
Is there sufficient lighting after dark	No				
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	No				
Is the NMT facility free of obstructions that interfere with illumination	Yes			√	Tress present

Urban Infrastructure Audit: Walvis Bay – 6th Street (CBD) – Location 1

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 31 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes		√		
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes		√		
Are the NMT facilities paved	Yes		√		Potholes
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes	√			
How are the conditions of the NMT facilities	Yes			√	
Are NMT routes continuous/ fragmented (Are there missing links)	Yes			√	Potholes
Are the sufficient NMT crossings along the route	Yes			√	
Are the NMT crossing points located at the appropriate points	Yes			√	
Are there any traffic calming measures along the routes?	No				
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	Yes		√		Some intersections
Are NMT facilities protected from vehicles	Yes		√		Raised kerbs
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes			√	
Are the NMT facilities accessible to people with disabilities?	Yes			√	
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes			√	
LIGHTING					
Are the streetlights available on the routes	Yes		√		
Is there sufficient lighting after dark	Yes			√	Inadequate
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes			√	
Is the NMT facility free of obstructions that interfere with illumination	Yes	√			

Urban Infrastructure Audit: Walvis Bay – Sam Nujoma Avenue (CBD) – Location 1

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 31 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes		√		
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes			√	
Are the NMT facilities paved	Yes	√			
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes		√		
How are the conditions of the NMT facilities	Yes		√		
Are NMT routes continuous/ fragmented (Are there missing links)	Yes		√		
Are the sufficient NMT crossings along the route	Yes			√	
Are the NMT crossing points located at the appropriate points	Yes		√		Only at intersections
Are there any traffic calming measures along the routes?	Yes			√	
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	Yes		√		
Are NMT facilities protected from vehicles	Yes		√		Raised kerbs
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes			√	
Are the NMT facilities accessible to people with disabilities?	Yes			√	Partially
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes			√	
LIGHTING					
Are the streetlights available on the routes	Yes	√			
Is there sufficient lighting after dark	Yes	√			
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes	√			
Is the NMT facility free of obstructions that interfere with illumination	Yes	√			

Urban Infrastructure Audit: Walvis Bay – Hage Geingob Street (CBD) – Location 1

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 31 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes		√		
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes		√		
Are the NMT facilities paved	Yes		√		
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes		√		
How are the conditions of the NMT facilities	Yes			√	
Are NMT routes continuous/ fragmented (Are there missing links)	Yes			√	
Are the sufficient NMT crossings along the route	Yes			√	
Are the NMT crossing points located at the appropriate points	Yes		√		
Are there any traffic calming measures along the routes?	Yes			√	
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	Yes			√	
Are NMT facilities protected from vehicles	Yes		√		
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes		√		
Are the NMT facilities accessible to people with disabilities?	Yes			√	
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes			√	
LIGHTING					
Are the streetlights available on the routes	Yes	√			Only on one side
Is there sufficient lighting after dark	Yes		√		
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes		√		
Is the NMT facility free of obstructions that interfere with illumination	Yes		√		

Urban Infrastructure Audit: Walvis Bay – Theo-Ben Gurirab Street (CBD) – Location 1

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 31 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes		√		
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes			√	
Are the NMT facilities paved	Yes	√			
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes	√			
How are the conditions of the NMT facilities	Yes		√		
Are NMT routes continuous/ fragmented (Are there missing links)	Yes	√			
Are the sufficient NMT crossings along the route	No				
Are the NMT crossing points located at the appropriate points	Yes	√			
Are there any traffic calming measures along the routes?	No				
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	Yes			√	Partial
Are NMT facilities protected from vehicles	Yes	√			
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes		√		Partial
Are the NMT facilities accessible to people with disabilities?	Yes		√		Partial
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes	√			
LIGHTING					
Are the streetlights available on the routes	Yes	√			Only on one side
Is there sufficient lighting after dark	Yes		√		
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes		√		
Is the NMT facility free of obstructions that interfere with illumination	Yes		√		

Urban Infrastructure Audit: Walvis Bay – Nathaniel Maxuilili Avenue – Location 2

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 31 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes		√		
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes		√		
Are the NMT facilities paved	Yes		√		
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes	√			Wide
How are the conditions of the NMT facilities	Yes			√	Obstructions
Are NMT routes continuous/ fragmented (Are there missing links)	Yes	√			Continuous
Are the sufficient NMT crossings along the route	Yes			√	Lack of many signs
Are the NMT crossing points located at the appropriate points	Yes			√	
Are there any traffic calming measures along the routes?	No				
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	No				
Are NMT facilities protected from vehicles	Yes	√			
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes			√	Hawkers
Are the NMT facilities accessible to people with disabilities?	No				
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes			√	
LIGHTING					
Are the streetlights available on the routes	Yes	√			
Is there sufficient lighting after dark	Yes		√		
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes		√		
Is the NMT facility free of obstructions that interfere with illumination	Yes		√		

Urban Infrastructure Audit: Walvis Bay – Agaat Street – Location 2

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 31 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes			√	
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes			√	
Are the NMT facilities paved	Yes			√	
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes		√		Inadequate spacing
How are the conditions of the NMT facilities	Yes			√	
Are NMT routes continuous/ fragmented (Are there missing links)	Yes			√	
Are the sufficient NMT crossings along the route	Yes			√	
Are the NMT crossing points located at the appropriate points	Yes			√	
Are there any traffic calming measures along the routes?	Yes		√		
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	Yes			√	
Are NMT facilities protected from vehicles	Yes			√	
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes			√	Hawkers and vehicles
Are the NMT facilities accessible to people with disabilities?	Yes			√	
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes			√	
LIGHTING					
Are the streetlights available on the routes	Yes			√	Certain sections
Is there sufficient lighting after dark	Yes			√	
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes			√	
Is the NMT facility free of obstructions that interfere with illumination	Yes	√			

Urban Infrastructure Audit: Walvis Bay – Sam Nujoma Avenue – Location 3

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 31 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes		√		
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes			√	
Are the NMT facilities paved	Yes		√		partial
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes		√		
How are the conditions of the NMT facilities	Yes			√	
Are NMT routes continuous/ fragmented (Are there missing links)	Yes			√	
Are the sufficient NMT crossings along the route	Yes		√		Poor visibility
Are the NMT crossing points located at the appropriate points	Yes	√			
Are there any traffic calming measures along the routes?	Yes		√		
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	Yes		√		
Are NMT facilities protected from vehicles	Yes		√		
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes			√	
Are the NMT facilities accessible to people with disabilities?	Yes			√	
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes			√	
LIGHTING					
Are the streetlights available on the routes	Yes			√	
Is there sufficient lighting after dark	Yes			√	
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes			√	
Is the NMT facility free of obstructions that interfere with illumination	Yes		√		

Urban Infrastructure Audit: Walvis Bay – Namib Street – Location 3

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 31 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes		√		
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes		√		
Are the NMT facilities paved	Yes	√			
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes	√			On one side only
How are the conditions of the NMT facilities	Yes	√			
Are NMT routes continuous/ fragmented (Are there missing links)	Yes			√	Fragmented
Are the sufficient NMT crossings along the route	yes			√	Insufficient
Are the NMT crossing points located at the appropriate points	No				
Are there any traffic calming measures along the routes?	No				
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	No				
Are NMT facilities protected from vehicles	Yes		√		Raised kerbs
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes			√	Poles, dustbins
Are the NMT facilities accessible to people with disabilities?	No				
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes			√	Fragmented
LIGHTING					
Are the streetlights available on the routes	No				
Is there sufficient lighting after dark	No				
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	No				
Is the NMT facility free of obstructions that interfere with illumination	No				

Urban Infrastructure Audit: Walvis Bay – Caesar Martin Street – Location 3

Project Name: An Investigation on Non-Motorised Transport in Small- and Medium-Sized Towns in Namibia: Planning and Policy Paradigm Shift

Date: 31 August 2024

SSA SMALL- AND MEDIUM-SIZED TOWNS INFRASTRUCTURE AUDIT TOOLKIT

Element	Applicable/ Not Applicable	Quality			Comment
		Good	Fair	Poor	
GENERAL ISSUES AND CONDITIONS					
Are NMT facilities available	Yes		√		
Are the NMT facilities (routes) shared between different NMT modes (pedestrians, cyclists, etc.)	Yes			√	
Are the NMT facilities paved	Yes	√			partial
Are the NMT facilities wide enough (or as per adopted guidelines) 2-3 m, 1.2 m if space constraints	Yes	√			
How are the conditions of the NMT facilities	Yes		√		
Are NMT routes continuous/ fragmented (Are there missing links)	Yes		√		
Are the sufficient NMT crossings along the route	Yes		√		Poor visibility
Are the NMT crossing points located at the appropriate points	Yes	√			
Are there any traffic calming measures along the routes?	Yes		√		
Are there dropped kerbs at intersections and midblock to allow access for pedestrians/ cyclists	Yes		√		
Are NMT facilities protected from vehicles	Yes		√		
Are there any obstructions on the NMT facilities (obstructions such as trees, parking, hawkers/ vendors, etc.)	Yes			√	
Are the NMT facilities accessible to people with disabilities?	Yes			√	
How well do NMT routes connect to major destinations (e.g., public transport, schools)	Yes		√		
LIGHTING					
Are the streetlights available on the routes	Yes		√		
Is there sufficient lighting after dark	Yes			√	
Are the lighting levels adequate to enhance the feeling of safety for users during nighttime.	Yes			√	
Is the NMT facility free of obstructions that interfere with illumination	Yes		√		

D. NMT user interviews – survey

The subsequent subsections present the questionnaire and responses from interviews obtained through interactions with NMT users in the selected study towns.

D.1. Survey questions (Questionnaire)

The NMT user interview questions are hereby presented.

1. What is your understanding of Non-Motorised Transport (NMT)?
   - o Pedestrian trips
   - o Cyclist trips
   - o Other
   - o None
2. What is the status/condition of NMT infrastructure in your town?
   - o Good
   - o Moderate
   - o Bad
3. In which spaces in town is NMT the most dominant?
4. What role do you think NMT is playing/has to play in the town?
5. What are the challenges faced by the various NMT users in the town?
6. What measures are the council putting in place to address these challenges?
7. How important is NMT provision to the current/future development of the town?
   - o Very important
   - o Important
   - o Slightly important
   - o Not important
8. Do you think NMT will have any potential benefits if prioritised in the town? If so, how will NMT prioritisation benefit you?
   - o Yes
   - o No

D.2. Survey responses

The responses gathered from NMT user interviews conducted in Tsumeb and Walvis Bay are presented in the following subsections.

D.2.1. Tsumeb

Responses from NMT user interviews conducted in Tsumeb are hereby presented:

Table D.1: Responses on users understanding of NMT in Tsumeb

1. What is your understanding of Non-Motorised Transport (NMT)?			
Responses	Frequency	Percentage	Cumulative percentage
Pedestrian trips	47	67.14	67.14
Cyclist trips	3	4.29	71.43
Other	5	7.14	78.57
None	15	21.43	100
Total	70	100	

Table D.2: Responses on NMT infrastructure conditions in Tsumeb

2. What is the status/condition of NMT infrastructure in your town?			
Responses	Frequency	Percentage	Cumulative percentage
Good	12	17.14	17.14
Moderate	34	48.57	65.71
Bad	24	34.29	100
Total	70	100	

Table D.3: Responses on NMT dominant spaces in Tsumeb

3. In which spaces in town is NMT the most dominant?			
Responses	Frequency	Percentage	Cumulative percentage
Informal settlements	29	41.43	41.43
Town	24	34.29	75.72
CBD	10	14.29	90.01
Entire town	4	5.71	95.72
Not aware	3	4.29	100.01
Total	70	100.01	

Table D.4: Responses on the role of NMT in Tsumeb

4. What role do you think NMT is playing/has to play in the town?			
Responses	Frequency	Percentage	Cumulative percentage
Important	29	36.25	36.25
Serves commuters	23	28.75	65.00
Improves safety	16	20.00	85.00
Provides accessibility	6	7.50	92.50
Improves health	3	3.75	96.25
Not important	2	2.50	98.75
Cost effective	1	1.25	100
Total	80	100	

Table D.5: Responses on NMT challenges in Tsumeb

5. What are the challenges faced by the various NMT users in the town?			
Responses	Frequency	Percentage	Cumulative percentage
Limited spaces on NMT infrastructure	19	14.84	14.84
Accidents	16	12.50	27.34
Poor NMT infrastructure	16	12.50	39.84
Lack of NMT infrastructure	15	11.72	51.56
None	14	10.94	62.50
Obstructions on NMT pathways	8	6.25	68.75
Safety concerns	6	4.69	73.44
Ignorance from road users	6	4.69	78.13
No lighting	6	4.69	82.82
Driver attitudes towards road users	6	4.69	87.51
Weather and climate	4	3.13	90.64
Long distance trips	4	3.13	93.77
Lack of awareness	4	3.13	96.90
Lack of law enforcements	2	1.56	98.46
Robberies	2	1.56	100.02
Total	128	100	

Table D.6: Responses on measures put in place by Tsumeb Town Council to address NMT challenges

6. What measures are the council putting in place to address these challenges?

Responses	Frequency	Percentage	Cumulative percentage
No measures	52	74.29	74.29
Not aware of any	11	15.71	90
Speed humps	1	1.43	91.43
Upgrading NMT infrastructure	5	7.14	98.57
Suggestion boxes	1	1.43	100
Total	70	100	

Table D.7: Responses on importance of NMT in Tsumeb

7. How important is NMT provision to the current/future development of the town?

Responses	Frequency	Percentage	Cumulative percentage
Very important	57	81.43	81.43
Important	9	12.86	94.29
Not important	4	5.71	100
Total	70	100	

Table D.8: Responses on benefits of NMT in Tsumeb

8. Do you think NMT will have any potential benefits if prioritised in the town?

Responses	Frequency	Percentage	Cumulative percentage
Yes	68	97.14	97.14
No	2	2.86	100
Total	70	100	

D.2.2. Walvis Bay

Responses from NMT user interviews conducted in Walvis Bay are hereby presented.

Table D.9: Responses on users understanding of NMT in Walvis Bay

1. What is your understanding of Non-Motorised Transport (NMT)?

Responses	Frequency	Percentage	Cumulative percentage
Pedestrian trips	42	42.86	42.86
Cyclist trips	9	9.18	52.04
Other	4	4.08	56.12
None	43	43.88	100
Total	98	100	

Table D.10: Responses on NMT infrastructure conditions in Walvis Bay

2. What is the status/condition of NMT infrastructure in your town?

Responses	Frequency	Percentage	Cumulative percentage
Good	17	17.53	17.53
Moderate	40	41.24	58.77
Bad	40	41.24	100.01
Total	97	100.01	

Table D.11: Responses on NMT dominant spaces in Walvis Bay

3. In which spaces in town is NMT the most dominant?

Responses	Frequency	Percentage	Cumulative percentage
Informal settlements	46	47.92	47.92
Town	32	33.33	81.25
CBD	12	12.50	93.75
Lagoon and beach	4	4.17	97.92
Everywhere	2	2.08	100
Total	96	100	

Table D.12: Responses on the role of NMT in Walvis Bay

4. What role do you think NMT is playing/has to play in the town?

Responses	Frequency	Percentage	Cumulative percentage
Serves commuters	22	20.75	20.75
Big role	22	20.75	41.50
Improves safety	17	16.04	57.54
provides accessibility	9	8.49	66.03
Provides walking spaces for pedestrians	7	6.60	72.63
Not important	5	4.72	77.35
Improves health	5	4.72	82.07
Cost effective	5	4.72	86.79
Not aware	4	3.77	90.56
Improves development	3	2.83	93.39
Reduces accidents	3	2.83	96.22
Served disabled people	2	1.89	98.11
Improves sustainability	1	0.94	99.05
Reduces number of cars	1	0.94	99.99
Total	106	100	

Table D.13: Responses on NMT challenges in Walvis Bay

5. What are the challenges faced by the various NMT users in the town?

Responses	Frequency	Percentage	Cumulative percentage
Accidents	33	22.15	22.15
Poor NMT infrastructure	29	19.46	41.61
Limited spaces on NMT infrastructure	15	10.07	51.68
Lack of NMT infrastructure	15	10.07	61.75
Driver attitudes towards road users	9	6.04	67.79
Long distance trips	9	6.04	73.83
Safety concerns	8	5.37	79.20
Robberies	6	4.03	83.23
Lack of law enforcements	4	2.68	85.91
Growing populations	4	2.68	88.59
Weather and climate	4	2.68	91.27
Theft	3	2.68	93.95
Not aware	3	2.01	95.96
Industrial facilities	2	1.34	97.30
Ignorance from road users	2	1.34	98.64
Lack of awareness	2	1.34	99.98
Total	112	100	

Table D.14: Responses on measures put in place by Walvis Bay Town Council to address NMT challenges

6. What measures are the council putting in place to address these challenges?			
Responses	Frequency	Percentage	Cumulative percentage
None	57	60.00	60.00
Not aware of any	24	25.26	85.26
Upgrading NMT infrastructure	12	12.63	97.89
Cleaning NMT infrastructure	1	1.05	98.94
Awareness meetings	1	1.05	99.99
Total	95	100	

Table D.15: Responses on importance of NMT in Walvis Bay

7. How important is NMT provision to the current/future development of the town?			
Responses	Frequency	Percentage	Cumulative percentage
Very important	64	65.31	65.31
Important	30	30.61	95.92
Slightly important	1	1.02	96.94
Not important	3	3.06	100
Total	98	100	

Table D.16: Responses on benefits of NMT in Walvis Bay

8. Do you think NMT will have any potential benefits if prioritised in the town?			
Responses	Frequency	Percentage	Cumulative percentage
Yes	96	97.96	97.96
No	2	2.04	100
Total	98	100	

E. NMT policy maker interviews – survey

This section presents the AHP survey tools and responses collected from NMT policy makers in the selected study towns.

E.1. AHP survey

The questionnaire that was utilised to gather data from policy makers is hereby presented.

AHP SURVEY: NMT INFRASTRUCTURE ASSESSMENT

AIM: To investigate the current state of NMT provision, challenges, and opportunities in the towns of Tsumeb and Walvis Bay

INSTRUCTIONS FOR PROVIDING RESPONSES:

Please write your response in the corresponding box according to the numerical scale (Saaty's scale) provided below to represent how important ATTRIBUTE A is compared to ATTRIBUTE B (Please find the example showing how to write a score) about the accidents.

1- Equally important, 3-Moderately important, 5-Strongly important, 7-Very strongly important, 9- Extremely important.

Table E.1: Numerical scale (Saaty's scale)

No	Attribute A	Ranking Attribute A					Ranking Attribute B				Attribute B	Remarks
		9	7	5	3	1	3	5	7	9		
01	Attribute 1					●					Attribute 2	Attribute 1 and Attribute 2 are equally important.
02	Attribute 2								●		Attribute 3	Attribute 3 is very strongly important than Attribute 2.
03	Attribute 3	●									Attribute 4	Attribute 3 is extremely important than Attribute 4

Personal Details
Respondent Name:
Work Designation:
Experience in Road Safety and Planning:
Level of understanding of the Study location on a 5-scale point:
Years of experience:

CROSSWALK ASSESSMENT

Table E.2: Crosswalk – Five (5) main intersections and midblock crossing assessment indicators

No	Indicator A	Ranking Indicator A over B					Ranking Indicator B over A				Indicator B
		9	7	5	3	1	3	5	7	9	
01	Availability of crosswalk										Crosswalk along pedestrian crossing desire lines
02	Availability of crosswalk										Accessibility of crosswalk to pedestrians and persons with disabilities (PWDs),
03	Availability of crosswalk										Safe and comfortable crosswalk – a condition
04	Availability of crosswalk										Visible crosswalk markings and road (motorist) warning signage
05	Crosswalk along pedestrian crossing desire lines										Accessibility of crosswalk to pedestrians and persons with disabilities (PWDs),
06	Crosswalk along pedestrian crossing desire lines										Safe and comfortable crosswalk – condition
07	Crosswalk along pedestrian crossing desire lines										Visible crosswalk markings and road (motorist) warning signage
08	Accessibility of crosswalk to pedestrians and persons with disabilities (PWDs),										Safe and comfortable crosswalk – a condition
09	Accessibility of crosswalk to pedestrians and persons with disabilities (PWDs),										Visible crosswalk markings and road (motorist) warning signage
10	Safe and comfortable crosswalk – a condition										Visible crosswalk markings and road (motorist) warning signage

SIDEWALK ASSESSMENT

Table E.3: Sidewalk - Five (5) main sidewalk assessment indicators

No	Indicator A	Ranking Indicator A over B					Ranking Indicator B over A			Indicator B
		9	7	5	3	1	3	5	7	9	
01	Availability of sidewalk										Sidewalk shared with bicycles
02	Availability of sidewalk										Accessibility of sidewalk,
03	Availability of sidewalk										Safe and comfortable sidewalk – a condition
04	Availability of sidewalk										Vehicle parking along the sidewalk
05	Sidewalk shared with bicycles										Accessibility of sidewalk
06	Sidewalk shared with bicycles										Safe and comfortable sidewalk – a condition
07	Sidewalk shared with bicycles										Vehicle parking along the sidewalk
08	Accessibility of sidewalk,										Safe and comfortable sidewalk – a condition
09	Accessibility of sidewalk,										Vehicle parking along the sidewalk
10	Safe and comfortable sidewalk – a condition										Vehicle parking along the sidewalk

BIKEWAY ASSESSMENT

Table E.4: Bikeway (if not shared with sidewalk) – Four (4) main bikeway assessment indicators

No	Indicator A	Ranking Indicator A over B					Ranking Indicator B over A				Indicator B
		9	7	5	3	1	3	5	7	9	
01	Availability of bikeway (separate)										Minimum required width as per the guideline
02	Availability of bikeway (separate)										Safe and comfortable bikeway
03	Availability of bikeway (separate)										Vehicle parking along bikeway
04	Minimum required width as per the guideline										Safe and comfortable bikeway
05	Minimum required width as per the guideline										Vehicle parking along bikeway
06	Safe and comfortable bikeway										Vehicle parking along bikeway

E.2. AHP results

Results from the online survey that was undertaken by the town planners and policy (decision) makers are hereby presented.

Table E.5: Tsumeb AHP results

		Idealised Weights									
No	**Attributes**	**Respondents**									
A	**Crosswalk - Five (5) main crosswalk assessment indicators:**	**R2**	**R3**	**R5**	**R6**	**R7**	**R9**	**R10**	**R11**	**R12**	**Avg**
1	Accessibility of crosswalk to pedestrians and persons with disabilities (PWDs),	0.24811	0.21395	0.24843	0.15417	0.24630	0.10096	0.10268	0.13044	0.20498	**0.18334**
2	Availability of crosswalk	0.10971	0.22911	0.30811	0.21129	0.08322	0.10587	0.03060	0.09134	0.26123	**0.15894**
3	Crosswalk along pedestrian crossing desire lines	0.26990	0.17638	0.03847	0.01152	0.11063	0.03111	0.25891	0.10538	0.03711	**0.11549**

4	Safe and comfortable crosswalk – a condition	0.21851	0.19632	0.38611	0.04869	0.22144	0.17627	0.18350	0.17622	0.18288	**0.19888**
5	Visible crosswalk markings and road (motorist) warning signage	0.05327	0.06715	0.04325	0.07320	0.04312	0.09694	0.13119	0.09451	0.02411	**0.06964**
	Inconsistency	0.08113	0.09113	0.08118	0.05251	0.07418	0.05381	0.07441	0.06294	0.07477	**0.07178**
B	**Sidewalk - Five (5) main sidewalk assessment indicators:**	**R2**	**R3**	**R5**	**R6**	**R7**	**R9**	**R10**	**R11**	**R12**	**Avg**
1	Accessibility of sidewalk	0.20411	0.10964	0.14722	0.19259	0.29513	0.11172	0.10106	0.09822	0.20068	**0.16226**
2	Availability of sidewalk	0.25077	0.11256	0.13001	0.15403	0.22174	0.10092	0.20328	0.19284	0.24498	**0.17901**
3	Safe and comfortable sidewalk – a condition	0.28148	0.20876	0.498123	0.35932	0.24498	0.39693	0.46956	0.30301	0.31224	**0.32204**
4	Sidewalk shared with bicycles	0.04327	0.02144	0.03881	0.05274	0.04312	0.05862	0.02016	0.01430	0.01793	**0.03449**
5	Vehicle parking along the sidewalk	0.12526	0.11244	0.13604	0.12931	0.04737	0.06745	0.04912	0.01721	0.09924	**0.08705**
	Inconsistency	0.09525	0.05946	0.05948	0.09347	0.08972	0.07744	0.08876	0.06585	0.09211	**0.08017**
C	**Bikeway - Five (4) main bikeway assessment indicators:**	**R2**	**R3**	**R5**	**R6**	**R7**	**R9**	**R10**	**R11**	**R12**	**Avg**
1	Availability of bikeway (separate)	0.01273	0.18990	0.17355	0.21003	0.10321	0.38299	0.19649	0.10022	0.14830	**0.16860**
2	Minimum required width as per the guideline	0.14822	0.12974	0.14501	0.09211	0.20013	0.14632	0.19328	0.09213	0.20734	**0.15048**
3	Safe and comfortable bikeway	0.12847	0.12955	0.21879	0.14958	0.15064	0.09422	0.20037	0.12034	0.10856	**0.14450**
4	Vehicle parking along bikeway	0.03705	0.05237	0.03111	0.04992	0.08344	0.05387	0.04394	0.09803	0.08643	**0.05957**
	Inconsistency	0.04296	0.06599	0.07480	0.06600	0.07071	0.08913	0.08343	0.05404	0.07245	**0.06884**

Table E.6: Walvis Bay AHP results

		Idealised Weights									
No	**Attributes**	**Respondents**									
A	**Crosswalk - Five (5) main crosswalk assessment indicators:**	**R1**	**R2**	**R4**	**R5**	**R6**	**R7**	**R9**	**R10**	**R13**	**Avg**
1	Accessibility of crosswalk to pedestrians and persons with disabilities (PWDs),	0.13886	0.16901	0.20224	0.10532	0.19000	0.11472	0.09860	0.12666	0.08324	**0.13652**
2	Availability of crosswalk	0.05349	0.10662	0.15901	0.19430	0.13588	0.10587	0.07332	0.08430	0.20045	**0.12369**
3	Crosswalk along pedestrian crossing desire lines	0.19882	0.27640	0.17774	0.18339	0.11943	0.10041	0.18324	0.21004	0.12943	**0.17543**
4	Safe and comfortable crosswalk – a condition	0.19456	0.17075	0.21943	0.09765	0.09117	0.18773	0.11943	0.16320	0.13006	**0.15266**
5	Visible crosswalk markings and road (motorist) warning signage	0.23762	0.19645	0.20018	0.16069	0.28470	0.10033	0.15984	0.17909	0.18959	**0.18983**
	Inconsistency	0.07123	0.08116	0.09552	0.07804	0.08644	0.06411	0.06678	0.08035	0.07713	**0.07786**
B	**Sidewalk - Five (5) main sidewalk assessment indicators:**	**R1**	**R2**	**R4**	**R5**	**R6**	**R7**	**R9**	**R10**	**R13**	**Avg**
1	Accessibility of sidewalk	0.15497	0.10049	0.15849	0.11860	0.20755	0.13111	0.10275	0.07245	0.27458	**0.14678**
2	Availability of sidewalk	0.18648	0.12847	0.09635	0.10648	0.09644	0.14895	0.10358	0.11846	0.14946	**0.12608**
3	Safe and comfortable sidewalk – a condition	0.30155	0.21067	0.30853	0.40027	0.20011	0.38984	0.30672	0.21599	0.29123	**0.29166**
4	Sidewalk shared with bicycles	0.02768	0.01857	0.04214	0.03549	0.03946	0.02757	0.01856	0.02746	0.01847	**0.02838**
5	Vehicle parking along the sidewalk	0.20134	0.10069	0.17642	0.12931	0.20542	0.14324	0.12999	0.17232	0.28578	**0.17161**
	Inconsistency	0.09179	0.05883	0.08231	0.08317	0.07884	0.08850	0.06964	0.06386	0.10732	**0.08047**
C	**Bikeway - Five (4) main bikeway assessment indicators:**	**R1**	**R2**	**R4**	**R5**	**R6**	**R7**	**R9**	**R10**	**R13**	**Avg**
1	Availability of bikeway (separate)	0.10747	0.18547	0.19749	0.19645	0.14850	0.24185	0.14948	0.10047	0.15950	**0.16519**
2	Minimum required width as per the guideline	0.10875	0.09255	0.09275	0.10035	0.15938	0.09285	0.17550	0.17850	0.09245	**0.12145**
3	Safe and comfortable bikeway	0.16429	0.09327	0.20479	0.19584	0.01277	0.10065	0.21195	0.11645	0.27395	**0.15266**
4	Vehicle parking along bikeway	0.09648	0.03948	0.06495	0.09263	0.06937	0.04399	0.08353	0.04373	0.06383	**0.06644**
	Inconsistency	0.06276	0.05405	0.07368	0.07701	0.05132	0.06307	0.08164	0.05778	0.07759	**0.06655**