IMPROVING INTRA-URBAN PEDESTRIAN SAFETY IN THE LAGOS METROPOLITAN AREA
(CASE STUDY OF LAGOS ISLAND CENTRAL BUSINESS DISTRICT)

by

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ABSTRACT

This study investigated ways to improve intra-urban pedestrian safety in the Lagos metropolitan area. The study aimed to encourage increased pedestrian activity by identifying the practical steps that would result in significant improvements to pedestrian amenity, safety and linkages within Lagos Island CBD and the metropolitan area in general.

To achieving these objectives, this study employed the use of scientific research methodologies. Data were collected in two phases: secondary and primary data sources. Secondary data includes review of relevant literatures. Quantitative data was gathered, primarily through a field survey (questionnaire), which proved efficient in gathering contemporary data on traffic and pedestrian characteristics. This sample size had 95% level of confidence with disproportionate 5% sampling error. Primary traffic and pedestrian data (including socio-economic and demographic characteristics, and an origin and destination count, etc.) at an aggregated level. Traffic and pedestrian datasets from the field study were adjusted by means of normalization, which enabled amalgamation of these datasets. Data analysis mainly involved statistical methods and the use of computer technology.

The study's findings show there has been a significant increase in the number of private cars on the roads. While the traditional pedestrian system is regarded as a way of life worldwide, in Lagos Island CBD, walking and pedestrians seem to be regarded as subservient and an inconvenience to the flow of automobiles. The empirical analysis revealed overdependence on motorization in all spheres of city life, with significant negative effects on existing road design and the future of Lagos. The study confirmed that the Lagos metropolitan area's road network is old, outdated and dysfunctional, lacks pedestrian space and utilities. This is slowing down city activities and cannot support the ever-increasing pedestrian population.

The study proposes modern intra-urban pedestrian transportation system and other NMT as an efficient alternative means of mobility. It notes that one of the most effective ways to reduce overdependence on motorized transportation is reduce the desire for such and embrace environmentally acceptable means such as a pedestrian system. Overall, this study seeks to enhance the quality of life and create a healthier city that is aesthetically balanced and sustainable.

PREFACE

The experimental work described in this thesis was carried out in the School of Development Studies, University of KwaZulu-Natal, Howard College Campus, Durban, from October 2013 to November 2017, under the supervision of Professor Matthew Dayomi. These studies represent original work by the author and have not otherwise been submitted in any form for any degree or diploma to any tertiary institution. Where use has been made of the work of others it is duly acknowledged in the text. As the candidate's supervisor, I have approved this thesis/dissertation for submission.

Date:

Name: Professor Matthew Dayomi

Signed:

____

Signatur

DECLARATION

I **Babatunde Kayode Tugbobo** declare that

(i) The research reported in this thesis, except where otherwise indicated, is my original work.
(ii) This thesis has not been submitted for any degree or examination at any other university.
(iii) This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons.
(iv) This thesis does not contain other persons' writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:

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Signature: Date:

Author: Babatunde Kayode Tugbobo

Signature: **Date:**

Supervisor: Professor Matthews Dayomi

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DEDICATION

This study is dedicated to GOD almighty and my wife, children, and memory of my late parents (Mr. and Mrs. Olugbuyi Tugbobo)

Road Map for improving pedestrian safety in Lagos Metropolis

SECTION 1:BACKGROUND TO THE STUDY AND METHODOLOGY	
Chapter 1 Introduction Chapter 2 Research Methodology	This section provides sequential and general overview of intra-urban pedestrian safety. Salient parts of this section include problem statement, study Justification, Aim and objectives, underlying research questions, hypothesis, and structure of thesis. This section gives a review, sufficient detail of research design, highlights methods used and reasons for using certain methods. This section includes identifying study participants, instruments, materials, a procedure for data collection, and data analysis.
SECTION 2: LITERATURE REVIEW	
Chapter 3 Conceptual and Theoretical framework Chapter 4 Land use and Transportation Chapter 5 Pedestrian safety	This section is a combination of two parts. The section provides the evaluation of previous research relevant to improving intra-urban pedestrian safety. It also provides comprehensive theoretical and conceptual background to understand the study. More emphasize on land use/transportation relationship. An in-depth study of Global, African, Nigerian, and Lagos road traffic accidents trends. Precedent studies conducted to examine intra-urban pedestrian safety in Europe, Africa, America and Asia. The section concludes with a concise summary of the entire three chapters.
SECTION 3: STUDY AREA	
Chapter 6 Preview of the study area	This section is exclusively dedicated to understudying Lagos-metropolis in general, and Lagos Island CBD. It provides general characterization of the study area. Area covered includes Geographical boundaries, economic growth and development pattern, land use, mobility and general transportation.
SECTION 4: EMPIRICAL FINDINGS	
Chapter 7 Socio-economic features Chapter 8 Pedestrian Safety Chapter 9 Other modes of transportation	As parts of the study, this section is a combination of three chapters. These chapters represent one of the most important sections of the study. It involves scientifically and statistically analyzing data set from the field survey and develop studies/reviews. Discussing results in a non-statistical manner, interpreting results by considering the research questions and examined in conjunction with other relevant pieces of literature. The significant finding of this section covers the contextual understanding of intra-urban pedestrian safety problems such as; obvious overdependence cars on the roadways, narrow and overcrowding pedestrian walkways. Other challenges of pedestrian security system include no adequate road crossing the facilities streets. In the most roadways, there is poor signage problem. The un-aesthetically environment (due to poor planning) for vulnerable road users is another fundamental problem. Pathetic Traffic /circulation Safety situations that cumulates to noise and air pollution. Unattractive traffic streets and pedestrian links which lack character, identity, and comfort (shade, seating, plants, etc.)
SECTION 5 :CONCLUSIONS AND RECOMMENDATIONS	
Chapter 10	This part among other things highlights significant findings, Identify contributions to knowledge, the future direction of complementary studies/research . This study ends with concluding remarks. The resulting conclusion and synchronization helps in the process of improving pedestrian safety, increase road efficiency, save resources, and produce the better environmental outcome.

SECTION 1:
BACKGROUND TO STUDY & RESEARCH METHODOLOGY :
Provides sequential and the general overview of intra-urban pedestrian safety & Discusses the research methodology employed to conduct this study.

CHAPTER 1-BACKGROUND TO THE STUDY

- Introduction
- Motivation for the study
- Problem Statement
- Aim and objectives
- Justification for the study
- Research Questions
- Underlying hypothesis
- Structure of the thesis

Presents a brief outline of the research. It sets out the research topic, background to the study, the motivation for the study, the problem statement, the study justification, aim and objectives, research questions and underlying hypothesis. It is concluded by outlining the structure of the thesis.

CHAPTER 2 RESEARCH METHODOLOGY

- Research Design approach
- Methods
- Data Required
- Procedures of survey administration
- Sampling methods
- Ethical Consideration
- Data Storage

This chapter highlights in sufficient detail the research design, methods used and reasons for using certain methods. It includes identifying study participants, instruments, materials, a procedure for data collection, and data analysis

SECTION 2: LITERATURE REVIEW

It is a combination of three parts. It evaluates relevant research to improving intra-urban pedestrian safety. The section concludes with a concise summary of the entire three chapters

CHAPTER 3 CONCEPTUAL & THEORETICAL FRAMEWORK	CHAPTER 4 LAND USE/ TRANSPORTATION	CHAPTER 5 PEDESTRIAN SAFETY SYSTEM	
Conceptual framework Ecosystem Walkability Sustainable Transport Concentric zone model Sector Model	Land use	Preview of Global traffic injuries Share of Africa, Nigeria and Lagos traffic injuries	
Theoretical framework Pedestrian level of service (PLOS)	Transportation	Precedent studies	

Chapter 3 delves into a comprehensive theoretical and conceptual perspective. It discusses the application of theoretical and conceptual perspectives to explaining the relationship between the intra-urban pedestrian system and peri-urban CBD districts and land use therein

Chapter 4 provides more emphasize on land use transportation relationship.

Chapter 5 provides an in-depth study of Global, Africa, Nigeria, and Lagos road traffic accidents. It discusses precedent studies and examine pedestrian sustainability assessment and experience of intra-urban pedestrian safety in Europe, Africa, America and Asia.

SECTION 3 : LAGOS METROPOLITAN AREA AND LAGOS ISLAND CBD

It exclusively dedicated to understudying Lagos Nigeria in general, and Lagos Island CBD. It provides the general characterization of the survey area.

CHAPTER 6: STUDY AREA

Lagos in National setting	Lagos Island Local Govt.	Lagos Island CBD
Growth	Growth	Growth
Economic and population	Economic and population	Economic and population
Land use and Planning	Land use and Planning	Land use and Planning
Transport modes	Transport modes	Transport modes

Extends the discussion by exploring the study area and evaluation of intra-urban sustainability. It focuses on existing planning and management efforts in the study area. The area covered includes land use, and mobility pattern. Also, focuses on the socioeconomic development; institutional frameworks; spatial planning and sustainable modes of living

SECTION 4-EMPIRICAL FINDINGS

As parts of the nomothetic study, this section is a combination of three chapters. At present, interpret and discuss the results of the research survey on achieving pedestrian sustainability from a CBD community viewpoint.

Chapter 7 Socio-economic characteristics	Chapter 8 Transportation modes	Chapter 9 Challenges of pedestrian system
Household composition Education qualifications Employment status Per capita income Per capita income of the household head Ethnicity	Vehicular mode Walking mode Other modes	Reasons why pedestrians do not enjoy walking frequently in the Lagos Island CBD What can be done to improve walkability in the Lagos Island CBD Walkability audit

Chapter 8: Involves scientifically and statistically analyzing socioeconomic data set from the field survey. Discussing results in a non-statistical manner, interpreting results by considering the research questions in conjunction with other relevant pieces of literature

Chapter 8: Provides specific and additional empirical findings on study area transportation modes.

Chapter 9: Covers the contextual understanding of intra-urban pedestrian safety problems. Under this chapter, several transportation-related problems identified. Prominently, over-dependence cars on the roadways, narrow and overcrowding pedestrian walkways. Other challenges of the pedestrian security system, no adequate road crossing the facilities streets and lack and poor signage. The un-aesthetically pleasant environment for vulnerable road users and pathetic Traffic Safety situations that cumulates to noise and air pollution. Unattractive traffic streets and pedestrian links which lack character, identity, and comfort (shade, seating, plants, etc.). Overall, this chapter employs statistical tools to establish residents' levels of satisfaction using a set of pedestrian quality measures used in the questionnaire. It also comparatively reviews and ranks community pedestrian sustainability.

SECTION 5- CONCLUSIONS AND RECOMMENDATIONS

Concludes this thesis by drawing together the study's main findings. The end sets out the main implications for both theory and practice argues for the need for integrated and improved neighborhoods to promote sustainability initiatives.

Chapter 10
the summary of principal findings, recommendation & suggestions for future research

Summary of findings	Design Plan	Recommendations
Original contributions to knowledge	Suggestion for future study	Concluding Remarks

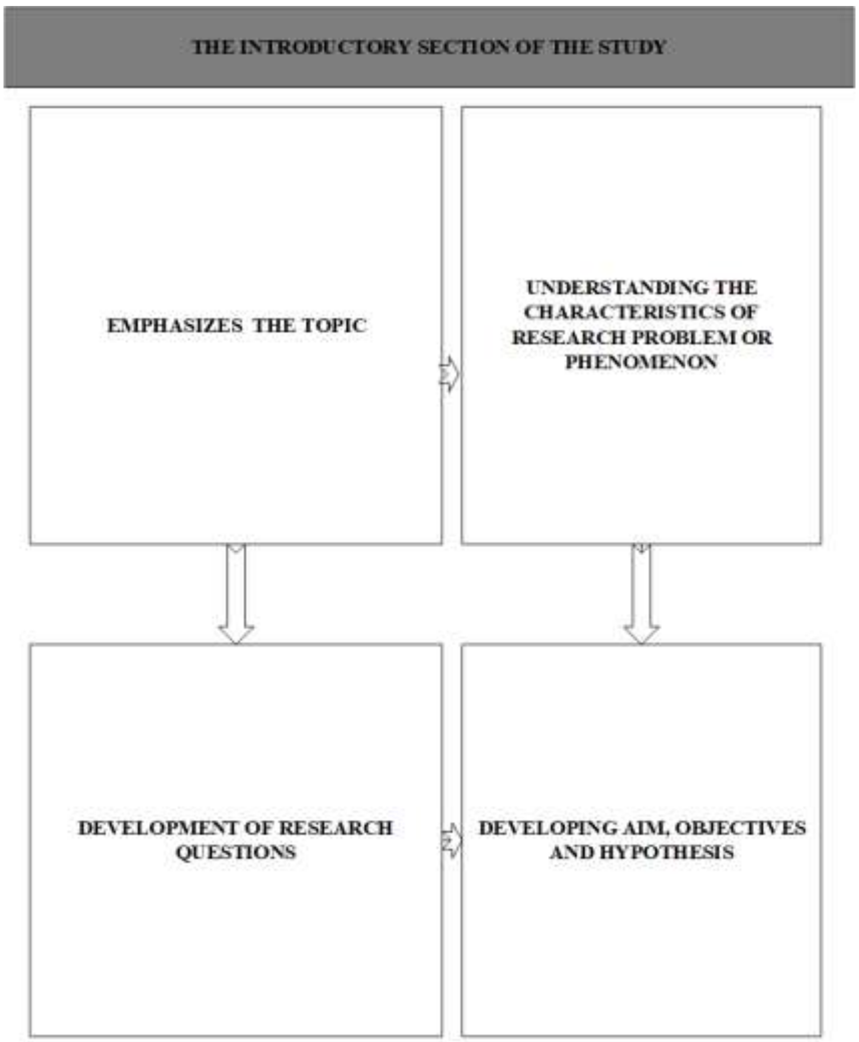
Highlights the study's contribution to the body of knowledge. Also, emphasizes significant findings, the future direction of complementary studies. ends with a concluding remark. The resulting conclusion helps in the process of improving pedestrian safety, increases road efficiency, saves resources, and produces the better environment in Lagos metropolis.

1. CHAPTER ONE: INTRODUCTION

1.1: Chapter outline

Figure 1 below presents the process followed to understand the research topic (improving pedestrian and other NMT safety in a common core central area). It shows how the research problem was formulated and the development of the research questions to address the study's objectives. The workflow is presented in this chapter, followed by the justification for the study. The study's limitations are explored as well as how these were overcome.

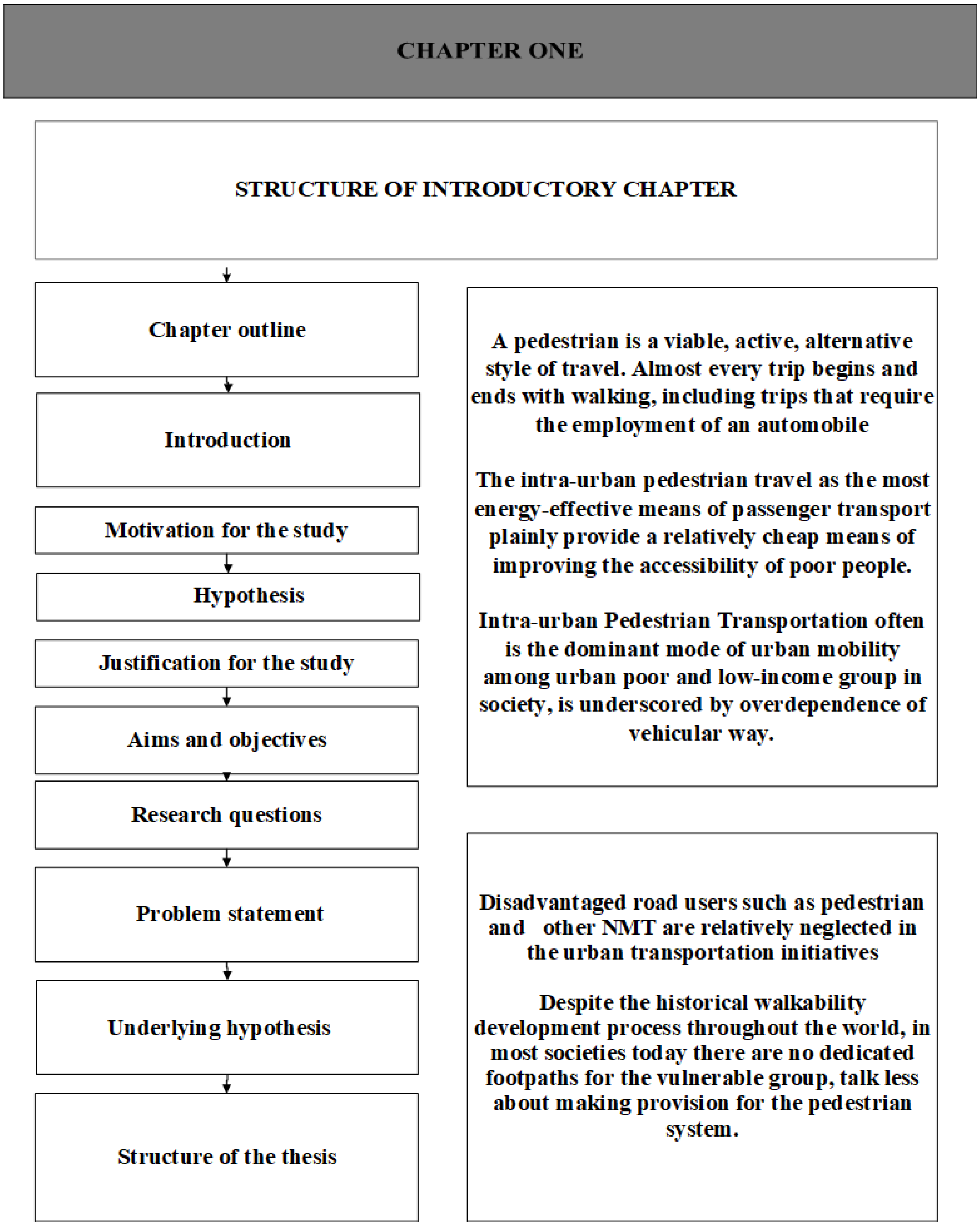
Figure 1: The introductory section of the study



Source: Author's construction (2016) ©

The structure of this chapter is presented in Figure 2 below.

Figure 2: Structure of introductory Chapter



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1.2: Introduction

Intra-urban pedestrian travel or other NMT is energy-efficient and offers a relatively cheap means of accessible transport to the poor ((Litman, 2002, Litman and Laube, 2002, Litman, 2003, Pucher and Dijkstra, 2003b, Buehler et al., 2009, Pucher and Buehler, 2003). The decline in such transport, which in the past was the dominant mode of urban mobility, especially among the urban poor and the low-income group, is due to overdependence on vehicular transport (Litman, 2012, Lynch, 2011b, Lynch, 2011a, Buehler et al., 2016b). Studies by the United Nations revealed that, in 2005 approximately 37% of urban trips were taken by foot. Furthermore, they found that, for each short journey, the intra-urban pedestrian system was the primary mode of transport in both developed and developing countries(World Health Organization, 2013, Africa Transport Policy Program, 2015). Similar reviews by the (Africa Transport Policy Program, 2015), and (United Nations Human Settlements Programme, 2014c) confirm that the modal share of walking is very high in developing countries. In African cities, for instance, walking accounts for 60%-80% of all intra-urban trips. Amoako et al. (2014:235) found that in Dakar (Senegal) and Douala (Cameroon) the share is much higher, at over 60%.

Evidence shows that intra-urban pedestrian transportation is a major mode of transport in poorer and smaller cities, covering as much as 90% of all person-trips (Njoh, 2007, Adam, 2011, United Nations Human Settlements Programme, 2014b). Historically, pedestrian systems and other NMT have been of particular importance in African and Asian cities (Replogle, 1991, Leather et al., 2007, Gota et al., 2012, World Health Organization, 2013, Atubi, 2012b). Cohort analyses indicate that intra-urban pedestrian transport as a percentage of all modes is highest in smaller cities on these continents, in the range of 70% to 80%. Case studies in Africa and Asia show that, in cities with high population densities that experience high levels of congestion, more than 50% of all passenger and goods trips are by foot (Murguía and United Nations Environment Programme Division of Technology, 2014). Numerous studies on these continents note that intra-urban pedestrian and NMT transportation is often the only form of transport for the poor when weather and topography permit. Again, some studies have found that many people in developing countries are ‘captive walkers,’ meaning that they walk because alternative modes of transport are unaffordable (Njoh, 2007, Adam, 2011, United Nations Human Settlements Programme, 2014a, Anciães, 2011, Besussi et al., 2010, Buehle and Pucher, 2012).

Despite the historical importance of pedestrian mobility throughout the world, in most societies today there are no dedicated footpaths. This is due to the dominance of motor vehicles and intra-urban travel. Studies (Peter & Jeff, 1989, 2000a, 2000b, 2006; Ping et al., 2012) show that 84% of the road networks in low- and middle-income countries that previously highly favored pedestrianization are now experiencing heavy vehicular flow and resulting traffic congestion. Traffic engineers and urban planners such as (Conley and Mclaren, 2008, Steg, 2004, Davison, 2004, Dick and Rimmer, 2003, Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), 2000)have expressed concern at these developments. Furthermore, it is argued that the cruising speed limit is too high, raising safety concerns in relation to intra-urban pedestrian and NMT travel. According to some erudite scholar and transportation organizations such as (Fabian et al., 2010, Federal Highway Administration(FHWA), 2010, Geertman, 2010, Kellese et al., 1996) this testifies to neglect of the vulnerable in our society. These researchers note that the average travel speed is approximately 40 km/h or more due to policies that support motorized transportation. Commenting on traffic congestion and uncontrolled traveling speed limits on roadways today, the IRAP and World Health Organization (WHO) (2007) acknowledge that this reflects blatant disregard for pedestrian transportation. The literature notes that modern cities' land use and transportation systems promote dependence on vehicular travel. Thus, at the global level, the built environment, land use and transport focus on cars rather than on people

In the recent past, land use-transportation planning has tended to be monolithic in nature, with a focus on intra-urban motorized transportation rather than an integrated system with particular consideration for pedestrian and vehicular traffic (Otegbulu, 2011, Ford, 2011, Francois-Joseph and Ralf, 2014). In most cases, it renders cars the most efficient mode of transportation and decreases viable options for walking. This is unsustainable. Automobile-oriented land use reduces intra-urban transport alternatives and compromises safety due to traffic congestion and high-speed limits between destinations. It thus fails to address the needs of the most vulnerable in society. Inappropriate intra-urban land use-transportation planning indicates inconsistent progression from the Neolithic era (a walking city) to a more sprawling and very dense, car-dependent city. These and many more scenarios dictate the nature of contemporary cities. (Burgess, 1925, Cabrera, 2010, Cambra, 2012a). Studies identify several practical measures to salvage intra-urban pedestrian and NMT safety on roadways. These include living streets. The Pedestrians' Association (2015) project suggests a drastically reduced speed limit of 20 mph in major city centers across the globe. It notes that, this would promote environmentally friendly cities and improve pedestrian safety in core centers. In light of the benefits of the pedestrian system more scholars are endorsing a return to the "reset mode" of travel (the Neolithic era). They argue that such a system offers environmental, public health, and social benefits and creates safe and people-centered streets. Urban planners and social scientists agree that a well-connected and safe intra-urban pedestrian environment is critical in ensuring pedestrian safety. Roads need to balance people’s needs and those of vehicular traffic(City of Toronto Council, 1999, Consortium, 2009, COST 358, 2010, Dunn, 1978). While vibrant, effective and walkable environments that operate in tandem with transportation systems are common in developed countries, there is a paucity of research on how to achieve this in developing countries. This study thus examined ways to improve the pedestrian system in the Lagos metropolitan area in order to inform future practice.

1.3: Motivation for the study

Walking is a viable, active, alternative style of travel. Almost every trip begins and ends with walking, including those that require the use of an automobile. An intra-urban pedestrian system enriches the livability of a residential area and reduces congestion, improves mobility and enhances residents’ overall quality of life. For the past century, the urban planning and applied scientific fields have been concerned with the dramatic increase in personal car usage in core cities, especially CBDs (Newman and Kenworthy, 2000, Peter and Jeff, 2000, Newman and Jeffery Kenworthy, 1989 , Newman and Kenworthy, 2006). Personal car usage is an integral part of socioeconomic life in developing countries, particularly Lagos State and the intra-urban mobility system of the core CBD in the Lagos Metropolitan area. A number of recent longitudinal studies on pedestrian safety emphasize the benefits of pedestrian activity and the negative consequences of car dependence in developing and developed countries. Research by the Victoria Transport Policy Institute (2014); United Nations Human Settlements Program (2014) and WHO (2013) identifies the unique benefits of pedestrian activity. The WHO (2013) and Victoria Transport Policy Institute (2014) (Singh and Singh 2014) studies highlight the benefits of pedestrian and NMT systems and the challenges of over dependence on cars on main streets. The literature reveals the problematic, complex and expanding role of car dependence in shaping the nature of cities' intra-urban mobility systems (Pucher and Buehler, 2003, Pucher and Dijkstra, 2000, Pucher and Dijkstra, 2003a, Pucher and Dijkstra, 2003b, Punte, 2010).

The question is, what is responsible for car dependence on roads in the world's core cities, especially in Lagos State? The answer is very simple. For most people, car travel fulfills their need for intra-urban mobility, and enhances their sense of autonomy, thus promoting emotional well-being. Equally important is pride of ownership and appreciation and enjoyment of vehicular transport's luxury features. Thus, many people aspire to an intra-urban vehicular system even when it is unnecessary. In the words of a renowned and prolific urban sociologist (Urry, 2011, Urry, 2010, Urry, 2007, Urry, 2003), automobility is now becoming a self-organizing, self-generating, non-linear worldwide system of cars. However, disenchantment with the effects of this phenomenon, coupled with globalization, decentralization and rapid population growth, is fast becoming a feature of modern society. Recent evidence suggests that personal car usage in core CBDs is a serious issue and a worldwide public health concern(Kari and Pentti, 1974, Keith, 2004, Keith and Rio, 2003, Khisty, 1994, Mateo-Babiano and Ieda, 2005, Manum and Nordstrom, 2013, Minnesota Metropolitan Council, 2006).

Globally there is an alarming increase in citizens' desire for car ownership, with severe effects on the environment. The alarming increase in the number of cars in most CBDs accompanied by a declining pedestrian system has attracted the attention of the professionals, academicians and non-governmental organizations (NGOs) such as (Peter and Jeff, 2000, Newman and Kenworthy, 2013, Niedermeyer, 2011, Nuriye et al., 2014).For instance, a 2005 World Bank report notes that, nearly half of all urban trips worldwide are made by private automobiles to the CBD, mainly due to the increase in the number of cars. The UN estimates that by the year 2035, the number of light-duty motor vehicles – cars, SUVs, light trucks and minivans in both developing and developed nations – will reach around 1.6 billion, with developing countries accounting for nearly 40%. The World Bank and the UN also predict that developing nations will have highest automobile level per capita in the not too distant future.

These projections are extremely worrying. Of further concern is that, while the cities of developed nations are moving towards reducing car dependency and focusing on pedestrian systems, this is not the case in developing countries. Moreover, there is no consensus on how to reduce the socioeconomic and environmental strain that automobile dependence creates. Globally, contemporary road construction technologies are not complementing traditional pedestrian systems (Replogle, 1991, Victoria Transport Policy Institute (VTPI), 2014c).

The justification for this study is that worldwide, and especially in Lagos State, pedestrianization is slowly but steadily changing and becoming more sophisticated. The potential of intra-urban pedestrian and NMT travel to enhance mobility, reduce congestion, improve environmental quality, and promote public health has been undermined by increasing automobile use. This study argues that a pedestrian system is a fundamental mode of transportation in Lagos State and other developing countries. However, most studies on the characteristics of pedestrianization have focused on developed countries(Pace et al., 2012, Rees, 2010, Reyer et al., 2014, Spek, 2011, Stewar, 2010). While pedestrian and NMT systems are thriving in the advanced nations, they are lagging behind in developing countries. Moreover, while methods to improve intra-urban pedestrian safety have made steady progress in the former in the past decade, they have been slow to gain ground in the latter. This study thus seeks to fill this gap.

Few studies have been conducted on pedestrianization in Lagos State. Promoting intra-urban pedestrian system technologies in this State is essential given its growing population. Planners, academics and professionals thus need to make every effort to fill this gap. This requires the development of sound methodologies and theoretical parameters. The current planning parameters, design characteristics and basic theoretical parameters with regard to the intra-urban pedestrian system currently in use in developing countries, especially Lagos State are imported and are often misapplied. Debate continues on the suitability of these methods in developing countries given local environmental, economic and spatial characteristics. Communities in developing countries have raised concerns about adopting these methodologies and theoretical frameworks without testing their validity. The actual risks faced by pedestrians in particular localities need to be addressed rather than copying ideas that could be inappropriate. A comprehensive study is required to close this gap.

Developing countries' (in this case Lagos State) enduring fascination with the automobile and uncoordinated land use that results in urban sprawl facilities car usage. This has created a culture of not walking from place to place. Addressing these issues calls for thorough needs analysis before determining the suitability or otherwise, of technological advancements. Planners and policymakers have made some efforts to improve intra-urban pedestrian travel in Lagos State and this study will draw on previous surveys. Its findings will also inform policy on intra-urban pedestrian travel in other developing nations. As noted previously, available scientific and empirical data on intra-urban pedestrian systems focus on developed states. There is thus a disconnect between developing nations and developed countries in terms of data collection, analysis, and monitoring. The available data on socioeconomic and travel characteristics and safety and user preferences in Lagos State is imperfect.

1.4: Problem Statement

Numerous indigenous urban transportation such as (Filani, 2012, George, 2010, Ayeni, 1981, Fapohunda, 1985, Aderamo, 2012) studies affirm growing car dependence in Lagos State, especially in core CBDs, is destroying urban centers. According to (Atubi, 2012b) and (Alli, 2002), this is negatively impacting commuters' quality of life. Automobile dependence has negative environmental effects and is destroying the ecosystem in the Lagos metropolitan area. Greenhouse gas emissions that cause climate change such as global heating, and depletion of oil reserves are some examples of the environmental effects of overdependence on cars and the neglect of the pedestrian system in the core CBD in Lagos. (Atubi, 2013) and (Adedamila, 1977) found a positive correlation between living conditions and car dependence in Lagos State. For example, the health effects of noise and air contamination caused by over-usage of cars compared to conventional manufacturing plants in Lagos State are very evident. It is also creating generations of overweight people (Tugbobo, 2004, Braimoh and Onishi, 2007, Ajose, 2010, Oduwaye et al., 2011).Substantial sums of money are lost every day in Lagos State due to declining economic productivity caused by traffic congestion. Businesses, workers, and households suffer in terms of the time and cost of travelling. Traffic gridlocks are an everyday occurrence and tens of thousands of preventable road accidents lead to premature deaths. The public is demanding effective responses from governmental agencies, built environment professionals, the academic community and NGOs (Atubi, 2012b, Filani, 2012, Fom, 2012).It is in light of this situation that this study examined how best to reduce overdependence on automobiles and improve the pedestrian system in a typical CBD in Lagos State. The city of interest is Lagos. Lagos is typical of cities in developing nations that have experienced rapid population growth, especially in the CBD, and faces a multitude of challenges, one of which is excessive automobile dependence (Tugbobo, 2000, Atubi, 2013, Otegbulu, 2011).

In principle, the consequence of depending on the motorcar as a means of movement and neglecting the pedestrian transport system is hypothesized to be impractical in promoting sustainability in developing countries. As noted earlier, the vulnerable group of road users has been ignored in the intra-urban travel system of Lagos State. Indeed, there has been outright neglect of the traditional mode of commuting in this State. This calls for an improved intra-urban pedestrian system in the Lagos CBD. Time is of the essence in replacing overdependence on automobiles with more sustainable urban mobility policies such as improving intra-urban pedestrian safety. The question is thus, what are the best ways of revolutionizing intra-urban pedestrian transportation and shaping its future? Another critical issue posed in this study is how and to what extent the built environment can encourage people to walk, and how to assess the success of walkability. Since people are the principal reason d'être for cities, they need to be designed to promote well-being. The safety of the vulnerable group of road users must be guaranteed. This study is thus significant and timely.

1.5: Justification for the study

As noted earlier, walking is the most sustainable means of daily intra-urban travel not only in Lagos State but worldwide. The benefits range from reducing traffic congestion as less space will be required for operating and parking cars, to using less non-renewable energy (the energy used to walk, and cycle is provided by the traveler). Other advantages include less noise or air pollution and promoting a healthy lifestyle. Walking is also regarded as an indispensable element in the creation of livable, sustainable communities(Curtis, 2008).Given these benefits, there is growing interest worldwide in NMT and pedestrian-friendly residential and commercial areas. Medical professionals highlight that walking promotes psychological and physical health. Many urban planners, geographers and allied professions also emphasize the need for an intra-urban pedestrian transportation system to promote sustainable CBD development. Vulnerable groups, governmental and non-governmental establishments, community organizations and ordinary citizens have added their voice to calls to make streets more walkable.

However, the literature on intra-urban walkability, sustainability, livability and a broader range of transportation choices notes that achieving these objectives is a Herculean task. This is underscored by continuous pressure to make intra-urban roadways accessible only to auto users. This is another justification for this study. While some professionals and researchers propose reinventing the wheel to restore pedestrianization, others are unsure how to achieve a pedestrian friendly intra-urban environment. Methods suggested by urban analysts to revolutionize and shape pedestrian transportation in the 21st century and beyond include but are not limited to reinventing the street system without cars. According to these erudite environmental planners (Christiansen, 2013, George, 2013, GIZ-SUTP et al., 2013, ICLEI Local Governmnets for sustainability, 2010, Jain, 2007, Jaffe, 2014). This suggests using the reset button (as in the case of most computer systems). However, a sustainable transportation system calls for nothing short of a revolution. Traditionally, roads were more humane and environmentally friendly than they are today. Other urban planning analysts such as (John, 1978, Hillman, 1977, Hitchcock and Hughes, 1995, Hodgkinson and Walton-Ellery, 2006, Hodgkinson and Walton-Ellery, 2008, George, 2013, GIZ-SUTP et al., 2013, Kubat et al., 2013) are of the opinion that, integrating the pedestrian and NMT system with intra-urban car-dominated transportation is the key.

The researcher supports this viewpoint. This study thus seeks to identify the measures that could be adopted to stem unlimited use of vehicles in congested urban centers. As the previous discussion, has shown, this is a major challenge, particularly if it is to be sustained in the future. Relevant authorities and professionals in the built environment are thus called upon to support this quest. A spatial and operational analysis of both motorized and pedestrian systems was required to achieve the study's objectives. It focused on de-emphasizing motorized transportation in polycentric and monocentric city centers in Lagos State. A shift from the territorial dominance of automobiles to a healthy pedestrian transportation system will offer many benefits. This research is timely and appropriate as intra-urban pedestrianization is a global issue. The study will thus enrich urban design knowledge. Furthermore, it will assist in improving the intra-urban pedestrian system by redefining the methods and criteria used to investigate the relationship between walking behavior and the physical environment.

1.6: Aims & objectives:

1.6.1: Aims:

The central aim of this study is to encourage greater pedestrian activity by suggesting practical measures that would result in substantial improvements in pedestrian safety and offer pleasant, secure and attractive pedestrian linkages.

1.6.2: Objectives:

i. To examine available transportation modes and their characteristics;
ii. To identify the socioeconomic features of the participants (residents, traders, shoppers, motorists, and transients)
iii. To evaluate the economic contribution of the activities in the metropolitan area;
iv. To identify the impact of human and vehicular interactions in the study area;
v. To address the issue of physical expansion and conversion of building use on the Island (the density of commercial buildings in the traditional/ancient parts of the CBD and the modern section);
vi. To conduct an inventory of pedestrian infrastructure and service facilities;
vii. To identify the key challenges facing the pedestrian system and other NMT systems;
viii. To recommend measures to integrate marginalized pedestrians into urban planning and schemes in the Lagos metropolitan area (in this case, streets traders).

1.7: Research questions

The following central research questions were prepared to achieve these objectives:

1.7.1: Main research question

How can pedestrian safety be improved in the study area?

1.7.2: Secondary research questions

(i) What are the travel origin, destination, reasons and purpose of travel?

(ii) How adequate and safe are these modes of transportation?

(iii) What are the participants' socio-economic features?

(iv) What are the particular behavioral characteristics of the participants in the study area?

(v) Are there clashes between vehicles and the pedestrian system (what is the current status of pedestrian safety in the study area)?

(vi) What are the purpose and reasons for the pedestrian system?

(vii) Are there physical barriers that prevent a convenient pedestrian system that enables access and allows people to cross the streets?

(viii) What is the intensity of walkability?

(ix) What is the current status of pedestrian safety in the study area?

(x) What types of pedestrian and other NMT facilities exist in the study area?

(xi) What are the land-use types (buildings use) and how do they impact travel patterns?

(xii) How and to what extent is the built environment (land use characteristics) of Lagos Island attractive to buyers and sellers?

(xiii) What have past, and present governments done to address pedestrian safety in Lagos?

(xiv) Is there any legislation that protects and promotes pedestrian safety?

(xv) What are the best ways to improve pedestrian transportation to make Lagos State pedestrian friendly?

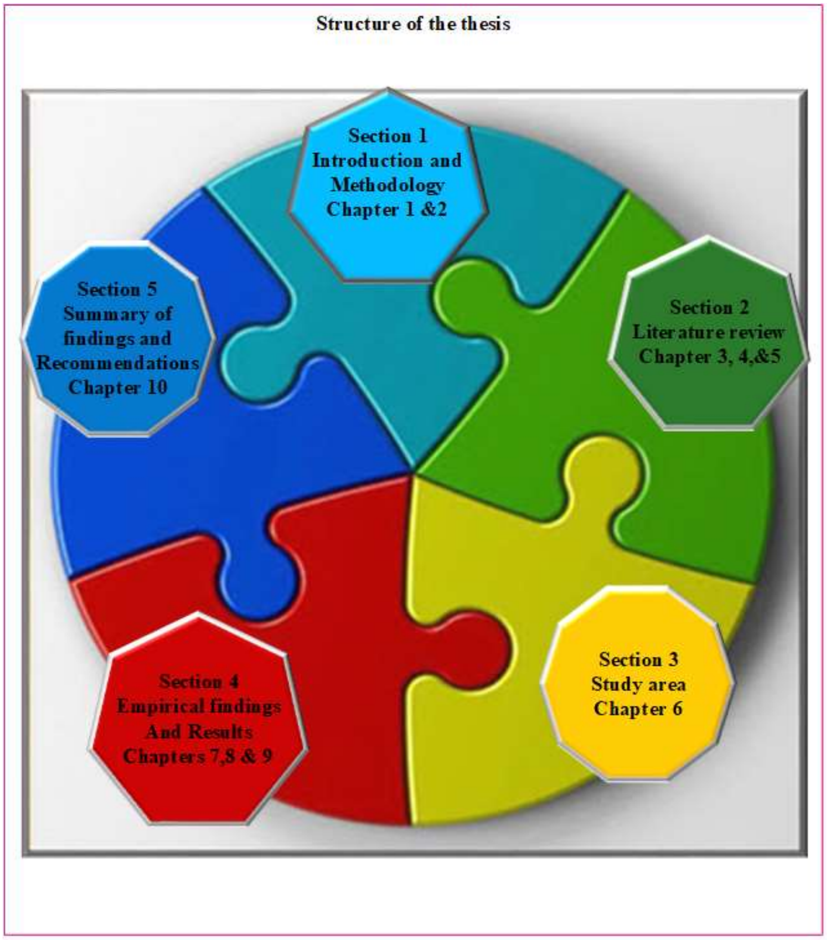
(xvi) What is the immediate and long-term recourse in the case of pedestrian and other traffic-related accidents?

(xvii) What are the policy implications of the study's findings in improving intra-urban pedestrian travel?

1.8: Structure of the thesis

Scientific research is just like a puzzle that entails putting pieces together. Examining and re-examining each piece to understand and attain a perfect fit. Sometimes looking at a little differently to find its place. Some parts even have a piece that fits, only to get another piece later that fits even better, causing getting rid of the former part. Figure 3 above sets out the structure of the thesis in a typical puzzle. The figure shows interconnectivity of various stages of the research.

Figure 3: Structure of the thesis



Source: Author's construction (2016) ©

SECTION 1- BACKGROUND TO STUDY AND RESEARCH METHODOLOGY: Provides sequential and the general overview of intra-urban pedestrian safety. It also discusses the research methodology employed to conduct this study.

Chapter 1: Presents a brief outline of the research. It set out the research topic, background to the study, the motivation for the study, the problem statement, the study justification, aim and objectives, research questions and underlying hypothesis. It concluded by outlining the structure of the thesis.

Chapter 2: It highlights the importance of applying performance assessment tools to achieve sustainable pedestrian system. Besides, it gives a synchronized review, sufficient detail of research design, highlights methods used and reasons for using certain methods. This section includes identifying study participants, instruments, materials, a procedure for data collection, and data analysis.

SECTION 2- LITERATURE REVIEW:

It is a combination of two parts (Chapters 3 and 4). It evaluates previous relevant research to improving intra-urban pedestrian safety. The section concludes with a concise summary of the entire two chapters.

Chapter 3: Introduces the reader to a comprehensive theoretical and conceptual perspective. It discusses the application of theoretical and conceptual perspectives to explaining the relationship between the intra-urban pedestrian system and peri-urban CBD districts.

Chapter 4: Provides more emphasize on land use transportation relationship.

chapter 5: Reviews safety challenges of pedestrian mode of transportation. It focusses on an in-depth study of Global, Africa, Nigeria, and Lagos road traffic accidents trends. Discusses a precedent study examine pedestrian sustainability assessment and experience of intra-urban pedestrian safety in Europe, Africa, America and Asia.

SECTION 3- STUDY AREA:

it exclusively dedicated to understudying Lagos Nigeria in general, and Lagos Island CBD. It provides the general characterization of the survey area.

Chapters 6: Extends the discussion by exploring the study area and evaluation of intra-urban sustainability. It focuses on existing planning and management efforts in the study area. The area covered includes geographical boundaries, land use, and mobility pattern. Also, focuses on the socioeconomic development; institutional frameworks; spatial planning and sustainable modes of living.

SECTION 4- EMPIRICAL FINDINGS-RESULTS:

As parts of the study, this section is a combination of three chapters. At present, interpret and discuss the results of the research survey on achieving pedestrian sustainability.

Chapter 7: Involves scientifically and statistically analyzing socioeconomic data set from the field survey. Discussing results in a non-statistical manner, interpreting results by considering the research questions in conjunction with other relevant pieces of literature.

Chapter 8: Provides specific and additional empirical findings on study area transportation modes.

Chapter 9: Covers the contextual understanding of intra-urban pedestrian safety problems. Under this chapter, several transportation-related problems identified. Prominently, over-dependence cars on the roadways, narrow and overcrowding pedestrian walkways. Other challenges of the pedestrian security system, no adequate road crossing the facilities streets and lack and poor signage (vertical and horizontal). Unattractive traffic streets and pedestrian links which lack character, identity, and comfort (shade, seating, plants, etc.). Overall, this chapter employs statistical tools to establish residents' levels of satisfaction using a set of pedestrian quality measures used in the questionnaire. It also comparatively reviews and ranks community pedestrian sustainability.

SECTION 5-THE SUMMARY OF PRINCIPAL FINDINGS, RECOMMENDATION, AND SUGGESTIONS FOR FUTURE RESEARCH:

Concludes this thesis by drawing together the study's main findings. The end sets out the need for integrated and improved neighborhoods to promote sustainability initiatives.

Chapter 10: Highlights the study's contribution to the body of knowledge. Also, emphasizes significant findings, the future direction of complementary studies. ends with a concluding remark. The resulting conclusion and synchronization helps in the process of improving pedestrian safety, increase road efficiency, save resources, and produce the better environmental outcome in Lagos metropolis.

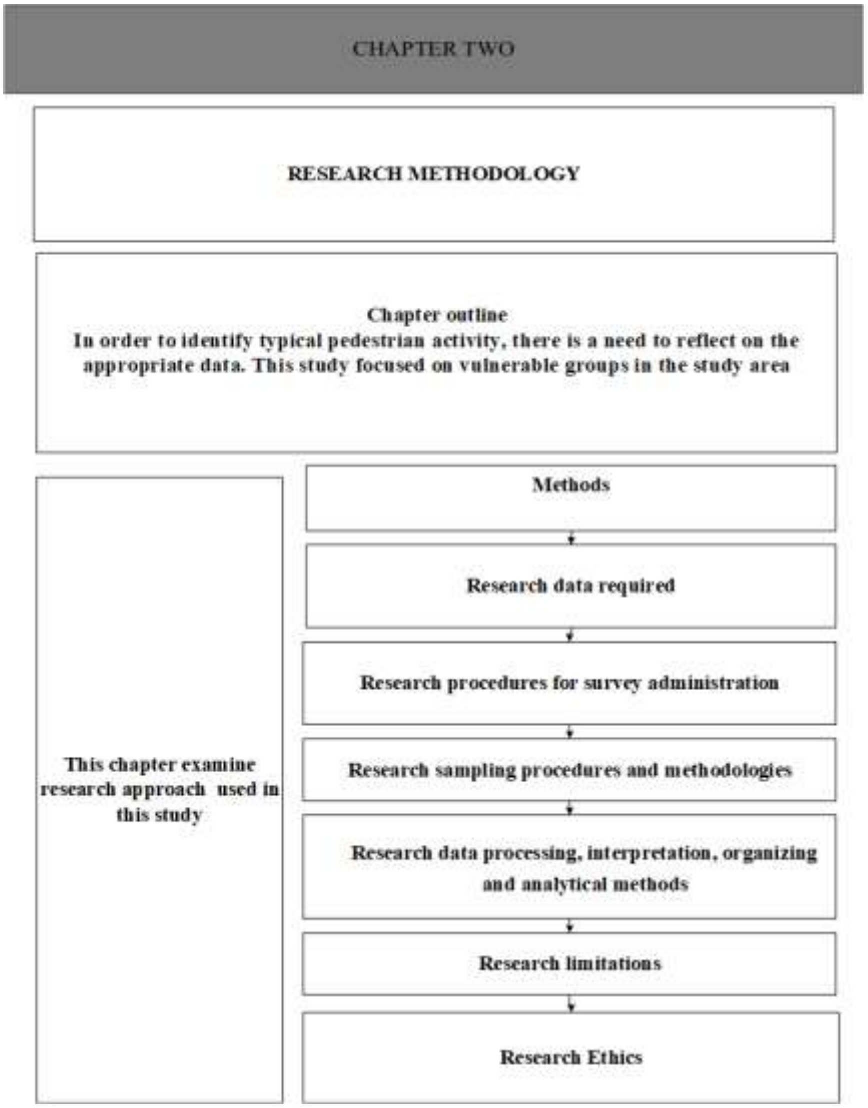
1.9: The Chapter Summary:

This is an introductory chapter which covers a wide range of issues among which are the research background, research problem and its justification. The chapter with ideas well-linked and provides the general direction of the thesis.

2. CHAPTER TWO: RESEARCH METHODOLOGY

2.1: Chapter Outline

Figure 4: Chapter two outline



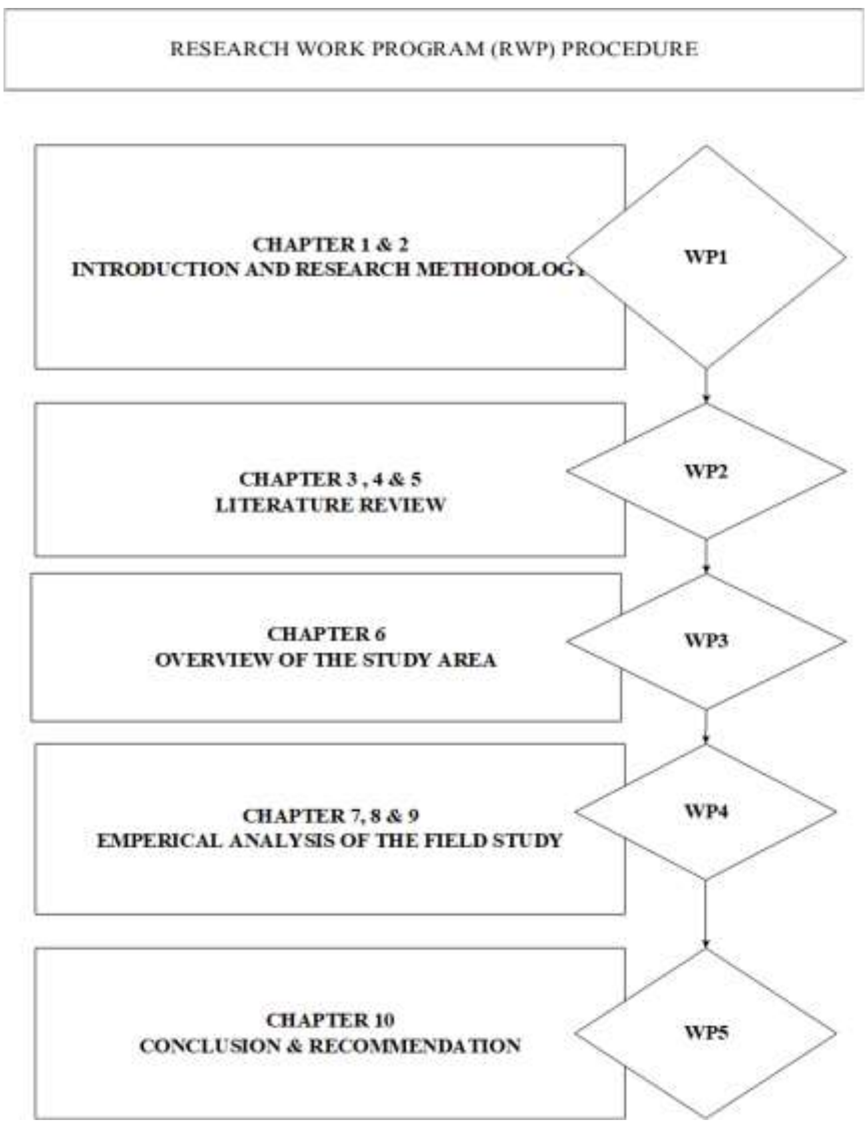
Source: Author's construction (2016) ©

The research methodology is the overall scientific philosophy underpinning a study. A research methodology is important for four reasons. The first is to explain the rationale for the specific procedures used to identify, select and analyze information in order to understand the research problem. Secondly, setting out the research methodology enables the reader to critically evaluate the study's overall validity, credibility, and reliability. Thirdly, the methodology enables a researcher to answer the primary and subsidiary questions systematically. Finally, it enables the researcher to clarify ideas and identify topics for future research. This chapter also highlights the scope of the research, the ethical considerations taken into account in conducting the study, and its limitations. Figure 4 presents Chapter two outline

2.2: **Research design approach**

The goal of conducting a research survey is to determine the relationship between an independent variable and a dependent variable within a population (Wijk and Harrison, 2013). According to (Trépanier et al., 2008), this approach provides a chronological and scientific, systematic method of identifying and solving problems relating to the phenomenon under consideration.

Figure 5: The Research work program (RWP) procedure



Source: Author's construction (2016) ©

The research design is a critical and scientific method to evaluate an issue in keeping with professional and academic standards. An experimental research design enables the researcher to identify a problem as unequivocally as possible. If the research design process is faulty, the study's results could suffer. To avoid this problem, the researcher adopted scientific procedures to develop the research Work Program (WP) in Figure 5.

The Research Work Program **(RWP)**

Figure 5 shows the relationships and interaction among the various chapters. It enabled the researcher to ensure consistency, and the neutrality of this scientific study and produce substantial results. The WP is broken down into tasks and appropriate methodologies in Table 2. The table identifies five interrelated and integrated components of this study, from problem identification to recommendations for improvement of the pedestrian system in the study area.

TABLE 1:WORK PROGRAM (WP) TASKS AND METHODOLOGIES

WP	Chapter	Tasks	Methodologies
WP1-Intoduction & Methodology	**Chapter one & two –** INTRODUCTION	Understanding the problem, background to study, justification for the study, aim and objectives, research questions and underlying hypothesis.	Initial review of the relevant literature in electronic or paper form. The internet was a valuable source.
	Chapter Two: RESEARCH METHODOLOGY	Outlining the step by step research process. Determining if there are any overlapping activities rather than following a strictly prescribed sequence.	Preparing the research design; determining the sampling plan and collecting the data; data analysis; hypothesis testing; interpretation and preparation of the report. Development of schematic layout and charts
WP2 -Literature Review literature	**Chapter Three:** THEORETICAL AND CONCEPTUAL FRAMEWORKS	An extensive review of the theoretical and conceptual frameworks related to the research problem.	Extensive literature survey and content analysis.
	Chapter four: LAND USE AND TRANSPORTATION	A comprehensive review of the relevant literature on the phenomenon under study. Determining the focus and searching literature databases electronically or manually. Compiling and analyzing previous research to identify different schools of thought and the research gaps.	Reviewing relevant journal articles, books, papers and other published or unpublished material.

WP	Chapter	Tasks	Methodologies
	Chapter 5: THE PEDESTRIAN SAFETY CHALLENGES AND GOOD PRACTICE EXAMPLES FOR IMPROVEMENTS	A comprehensive review of the relevant literature on the phenomenon under study (pedestrian safety)	Reviewing relevant journal articles, books, papers and other published or unpublished material
WP3 -Study Area	**Chapter Six** - OVERVIEW OF THE STUDY AREA	Discussion on the study area. Identifying the primary reasons for the choice of the survey area. Describing the pedestrian system and examining past efforts such as planning, policies and frameworks and development control mechanisms to improve intra-urban pedestrian travel in Lagos Island CBD.	Historical records and other information about Lagos State and the study area.
WP4-Findings	**Chapter Seven:** EXISTING TRANSPORTATION MODES IN THE STUDY AREA	Identifying various transportation modes in the study area and their characteristics.	Reconnaissance surveys, primary and secondary surveys questionnaire content, observation, physical inventories, question types, format, wording, ordering, and instructions.
	Chapter Eight: PEDESTRIAN TRANSPORTATION CHARCATERSTICS	Identifying and examining pedestrian transportation characteristics in the study area.	\Interactional activities, taking photographs, and use of videotape to record pedestrian activities. Survey to gather information and follow-up on the questionnaire. Cross-sectional collection of data for intensive analysis; longitudinal collection of data for detailed characteristics.
	Chapter Nine: A CASE STUDY OF PEDESTRIAN EXPERIENCES	A case study of pedestrian activities in a typical developing and developed country in order to draw lessons to formulate a model to improve the pedestrian system in the study area.	Literature review
WP5	**Chapter Ten:** RECOMMENDATIONS TO IMPROVE PEDESTRIAN SAFETY IN THE STUDY AREA AND CONCLUSION	Improving intra-urban security in the study area.	Case studies

Source: Authors' construction (2016) ©

2.3: Methodology

2.3.1: Research data required

In order to gather information on typical pedestrian activity, there is a need to reflect on the ideal data required. This study focused on vulnerable groups in the study area. The justification for the study, problem statement and research questions were used to formulate the research design.

Socioeconomic data

To avoid over-generalization, information was gathered on the socio-demographic variables and characteristics of both pedestrian and automobile users in the study area. These included, but were not limited to age, race, gender, educational level, employment-related factors such as income, family size, and duration of residence. These data sets were required to address pressing problems previously identified among different groups within the study area.

Inventory of transport system

The survey also covered the travel patterns of residents and transients in the study area. It examined the factors that influence travel behavior such as trip generation, attractions, and transportation modes as well as the origin-destination (OD) characteristics of both residents and transients. This data covered the reason for travel, the level of car ownership, household travel patterns, walking speed and the rate of accidents. The regularity of usage of pedestrian facilities and individual perceptions of road infrastructure in the study area were also examined. This exposed the barriers to pedestrianization in the study area. The field survey took stock of existing pedestrian facilities, the rate of utilization and level of maintenance. Inventories were compiled of parking space in the study area and region and the researcher observed vehicles using spaces earmarked for this purpose and the relationship with pedestrian movement (Transportation Research Board, 2008).

Land-use surveys

Land-use surveys are an integral part of transportation planning (Warsh, 2012). Travel and land-use characteristics are known as derived demand. Travel in itself has no inherent value; it is useful in that it facilitates participation in other activities. If the land-use activities did not exist, there would be no need for travel. The number of trips between land-uses depends on the type of transfer system, which connects the land-uses (Angotti, 2010).

Information from Government and non-governmental organizations:

Relevant information was obtained from public officials and law enforcement agencies on previous and current policies affecting pedestrian transport in the study area and Lagos Metropolitan area.

2.3.2: Research procedures for survey administration:

Three valid scientific methods were used to collect information on pedestrian systems, namely, primary, secondary and tertiary data techniques. Table 3 below lists these sources.

Table 2: Synopsis of primary and secondary data sources

Sources	Primary	Secondary	Tertiary
Research data collection	Pilot survey Observational surveys Intercept surveys/ In-depth surveys	Documentary searches, Project plans National policy documents, Theses Maps	Documentary searches
Tools for data collection	Portable counters Questionnaire	Books & the internet	Internet

Source: Author's construction (2016) ©

Tertiary data

Tertiary sources provide overviews of topics by synthesizing information gathered from other sources. They provide data in a convenient form or provide information in a particular context so that it can be easily interpreted. Examples include dictionaries, encyclopedias, handbooks and websites such as Google and Wikipedia.

Secondary data

Secondary data include books, project plans, municipal and national policy documents, relevant unpublished theses, maps and trends in current developments on the phenomenon under study. Other sources are biographies, dissertation indexes, abstracts, bibliographies (used to locate a secondary source), and searches of existing published and unpublished documents and databases. Published and unpublished material related to this research included but were not restricted to documentary information from the Lagos State Government; previous empirical studies on the phenomenon and accident statistics from the Federal Road Safety Commission and Nigerian Police Authority. Historical photographs and maps enhanced visual understanding. Before evaluating secondary sources, the questions to be asked include: (1) what was the purpose of the study? (2) Who collected the information? (3) What information was gathered? (4) When was, the information obtained? (5) How was the information received? (6) How consistent is the information with other sources? The reason for these questions is that regular users of such sources often develop healthy skepticism about the information provided by others.

Primary sources

A survey was the primary data collection tool used for this study. Observation, pre-test or reconnaissance, and an intercept and in-depth survey were employed. The main objective of the pedestrian survey was to investigate their perceptions of and the effects of improvements to pedestrian facilities in the study area. Primary sources provide first-hand or direct evidence on the topic under investigation. Scientific research techniques employed included field observation, a reconnaissance survey, intercept surveys and in-depth survey (structured and unstructured).

Observation:

Observation is the process of studying the subjects or target group by observing their activities. Additional information was obtained through field observation to augment the data from the interviews. For example, roadside features such as pedestrian flow and motorist activities were observed without the subjects (pedestrians) necessarily being aware of the observation.

Pretesting or Reconnaissance Survey

The pretesting or reconnaissance survey included an initial visit to the study location to determine the general character of the area and the most important issues for further investigation. A pretest or reconnaissance survey involves trial administration of an instrument such as a questionnaire to identify flaws. It determines the adequacy of the sampling frames and variability within the study population and estimates the potential response rate. The size of the pilot study, suitability of the inquiry method, adequacy of the questionnaire (schedule), and effectiveness of interviewer training are also tested. While a questionnaire is a useful information-gathering tool, it is necessary to pilot it to determine whether the questions and instructions are suitable. The pilot study involved 20 respondents using same selection criteria as the main study. All 20 returned the questionnaire.

Intercept surveys and in-depth survey

In Africa, data are typically gathered using an intercept survey that uses a questionnaire to collect information on a particular subject. The information is obtained on the roadway. In this study, the intercept survey posed questions to pedestrians and those using private cars. This kind of survey is not simply a byproduct of a study but is a feature of contemporary urban and regional planning studies. Respondents are contacted directly by either distributing a questionnaire or asking a series of structured questions. For the purposes of the current study, personal interviews were conducted with pedestrians (residents, traders, informal traders, artisan and civil servants) and drivers of vehicles or travelers as they stopped at the intercept point. They were stopped by a field worker who briefly explained the purpose of the study and asked them a series of questions on the origin, destination and times of travel, as well as some social-demographic details. Landmarks such as bus stops, shops and workplaces were targeted. Literate respondents were asked to complete the survey form and return it on the spot.

Primary data gathering instruments

Questionnaires, portable counters and photographs were used to gather primary data.

Portable counters

Portable counters were used as one of the data collection tools. Hand counting is still one of the best methodologies to count pedestrians. Using a counter, the trained field workers were able to count around 3,000 to 5,000 pedestrians per hour. It was also easy to count cars simultaneously.

Photographic and video recording

Photographs were also taken to recording pedestrians and motorists' activities on the roadways in the study area.

Questionnaires

Three sets of questionnaires were administered to take an inventory and collect information on existing pedestrian facilities in the study area. This assisted in establishing the level of usage of current facilities, when they were constructed, the mode of transportation and other relevant information. Questionnaires were the primary survey tool as they ensure a high response rate and require less time and energy to administer. They also enable the respondents to remain anonymous; the respondents were not asked to include their names on the completed questionnaires. Questionnaires also reduce the possibility of researcher bias and promote consistency. The questions were designed to obtain pedestrians and motorists' views on existing facilities focusing on the three key attributes of perceived safety, delay, and directness. The respondents were also asked to rate the importance of each of these attributes on a seven-point scale from -5 (weak/not necessary) to +5 (excellent/imperative). As noted earlier, three different questionnaires (Appendices A, B and C) were administered by trained field workers through face-to-face interviews. Table 4 provides snapshot of questionnaire type, methodology and fundamental questions.

Table 3: Questionnaire type, methodology and fundamental questions

TYPE	PURPOSE	THE METHOD USED TO GATHER INFORMATION	THE FUNDAMENTAL QUESTIONS
A	This questionnaire was designed for pedestrians, mainly residents and transients	Structured open-ended and unstructured questions through face-to-face interviews.	This first set of questionnaires (see Appendix A) was designed to solicit information on pedestrians' (residents and transients) socio-economic characteristics. Information was gathered on demographic features and socio-economic features such as income, gender, age, employment and marital status, place of residence, religion, educational level and ethnic group. This questionnaire also sought the respondents' views on the current transportation options available in the study area and their expectations. Information was obtained on individual transportation preferences, choices, options and characteristics as well as travel information, generation, and distribution.
B	Questionnaire designed for government officials at both state and local levels	Face-to-face interviews and professional input from Lagos State and Lagos Island government officials on the issue of pedestrian safety in Lagos State and ways of achieving walkability in the	Key questions were posed to determine the effectiveness of the pedestrian system in the study corridor and how it could assist in designing a more modern pedestrian facility that will stimulate and encourage walkability within the city. These interviews were conducted using a semi-structured questionnaire.

TYPE	PURPOSE	THE METHOD USED TO GATHER INFORMATION	THE FUNDAMENTAL QUESTIONS
		study area. These officials have knowledge of past and current pedestrian planning development trends as well as the use of pedestrian facilities in the study area.	
C	Questionnaire to gather information on land utilization and transportation	A review of existing land uses and transportation facilities. The questionnaire sought to measure residents and transients' travel behavior in the study area, with special consideration for the effects of land-use characteristics on trip time and length, choice of transportation mode and route (both spatial and timing) in and trip frequency. An inventory was also conducted of pedestrian facilities, including sidewalks along roadways, walkways located outside a street right-of-way, crosswalks, pedestrian islands and medians, overpasses and underpasses, and signs and other traffic control devices intended to assist pedestrians.	

Source: Authors' construction (2016) ©

As noted earlier, the questionnaires were administered by trained field workers with at least a National Diploma in Urban and Regional Planning. Since the survey involved adults between the ages of 18 and 75, there was no need for parental consent. English is the official language of Lagos State. The surveys were thus developed in English and were designed for self-completion. The field workers assisted non-English speakers to complete the questionnaires. To facilitate understanding, the questions were posed in a straightforward manner in plain English.

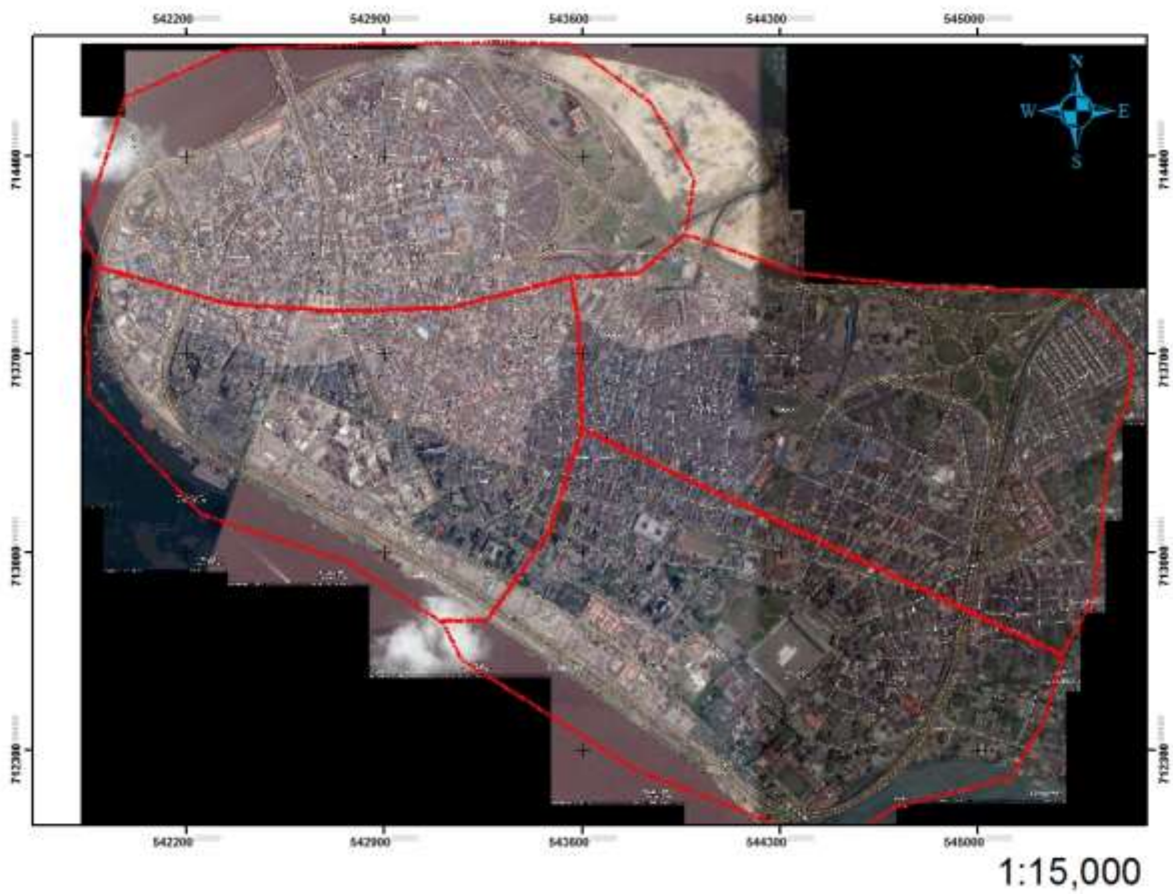
2.3.3: Sampling procedures and methodologies

Since few systematic counting and sampling methods are available or recommended to transport specialists interested in pedestrian systems, the process adopted by the researcher is of significance. The sample was carefully selected in order to draw valid scientific conclusions. The study population consisted of all residents, transients and operators of motorized vehicles.

Sampling criteria and determination of population threshold

Various assumptions were made to determine the ideal sample. The first was determining the sample size based on confidence level and precision rate (that is especially important when the size of the study population is unknown). Secondly, the pedestrians in the study area were divided into similar non-overlapping groups (i.e., strata) (see figure 6), developed by selecting an appropriate sample from each cluster and choosing a simple random sample in each stratum.

Figure 6: Designated area for the survey in the study area

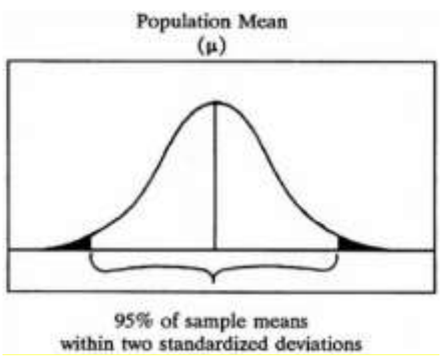


Source: Author's construction (2016) ©

In determining the sample size, respondents included in the sample were selected to meet specific criteria, including fractions of the pedestrians drawn from an extensive set in the study area, and inferences drawn from the sample were extended to the whole group. The most challenging part of any scientific research of this kind is possibly selecting an appropriate sample. Sampling error is also known as the level of the population value of estimate. The range in sampling error is expressed in percentage points (e.g., ±3 to ±5%). In any research, applying the confidence or risk level is necessary to obtain the central limit theorem.

The average value of the attribute obtained from those samples is equal to the level of the population value of estimate. In any regular distribution system, approximately 95% of the sample values are within two standard deviation levels of the population value of assessment. Random sampling is an acceptable scientific sampling method. It entails the selection of units from a population using random numbers or pseudo-random numbers generated by recursive mathematical equations (see Figure7). Each unit of the population has an equal probability of being selected.

Figure 7: Population sample mean



Source: Yamane's (1967)

Yamane's (1967) sampling technique was appropriate for this study. It provides a simple formula to calculate the sample size. A 97% confidence level was used and significant level =0.05 sampling error.

Equation

$$\boldsymbol{n} = \frac{\mathbf{N}}{\mathbf{1 + N(e)^2}}$$

Where:

N is the population sample; N = population sample (the universe); e = indicates sampling error, in this case 0.10, 0.05 and 0.01 acceptable error

Computing a sampling frame

The population threshold of the study area needs to be determined to calculate a sampling frame. According to the 2006 Nigerian national population census, Lagos Island was home to 859,849 people, using a 5% sampling error margin and 95% degree of confidence. These figures appear to be outdated and may not reflect the current status of the study area, thus the need to make a projection based on the existing population. The statistical population screening technique was used to calculate the population in the study area beyond 2006. This statistical prediction method uses previous population growth rates based on the existing population. The average annual population growth rate is calculated for each year. This technique is employed by demographers and planners to estimate a growing population. Mathematically, the representation of this prediction method is as follows; $\boldsymbol{PO = Pt(1+r)^t}$

Po = Required Population, Pt = Initial Population, 1= Constant, r= Growth rate, T = Time interval. Using this formula, the projection for 2006 through 2015 is indicated in Table 5 below.

Po=?

Pt = 859,845

R = 5%

Po= 859845 $(1+5/100)^{2006\text{-}2007}$

Po= 859845 $(1+0.05)^{1}$

Po= 859845 $(1.05)^{1}$

Po=859845 (1.05)

Po=902837

Table 4: Existing population and projected population for the study area

Year	Population @ 5% growth rate
2006	859845
2007	902837- Projected
2008	947979 Projected
2009	995378 Projected
2010	1,045,146 Projected
2011	1.097,404 Projected

2012	1,152,274 Projected
2013	1,209,888 Projected
2014	1,270,383 Projected
2020	1,333,901 Projected

Source: Author's construction (2016) ©Based on 2006 population census figures for Lagos Island local government.

Sampling Size

Certain scientific assumptions were made to ensure that the sample was representative and to determine the sample size and frame for the study. The researcher considered the estimated population threshold and geographical distribution and divided the survey area in the same ratio as the allocation of the entire population. The projected population for Lagos Island local government in 2020 is 1,333,901. Using a margin of error of 5% and 95% confidence level the required sample was 385 respondents. However, 770 questionnaires (double the required number) were administered. Table 6 provides information on the sample size.

Table 5: The tested size

Parameters	Determination of sample size
Population Size	1,333,901
Margin of Error	5%
95% confidence level	95%
Sample size required	385

Source: Author's construction (2016) ©

Sampling error:

This sample is technically sound and was deliberately adopted to reduce the likelihood of benchmark error that could have adversely affected the research results.

Participation and non-participation rate in the study area

The response rate was impressive with over 95% of the potential respondents agreeing to talk with the field workers and only 2.5% declining (see Table 7). The latter group expressed fear of possible change that they might not find acceptable or that any information they volunteered might be used against them.

Table 6: Survey participation and non-participation rates

QUESTIONNAIRES	NO.	%
No. questionnaires returned	751	97.5
No. questionnaires not returned	19	02.5
Total no. of questionnaires printed	770	100

Source: Author's construction (2016) ©

The impressive return rate suggests that many residents and transients want something to be done about the state of pedestrian infrastructure in the Lagos metropolitan area.

Sampling count, duration, day and time

Pedestrian counts were conducted on Mondays, Wednesdays and Saturdays over two consecutive weeks. The surveys were conducted from 8-9 am and 10-11am (morning peak period); 12.30-1.30pm and 1.30-2.30pm (afternoon peak period) and 3-4pm and 4-5pm (evening peak period) Data were recorded at 15-minute intervals. Preferred pedestrian lines, indicating the locations where pedestrians crossed the road most frequently, were recorded.

Sampling bias

The questionnaire and survey approach were designed to avoid study bias as much as possible. For example, the field workers were instructed to approach any person in the target population regardless of their outward appearance, gender, and age. In line with ethical principles, no one was coerced to take part in this study. Bias was also minimized by appointing knowledgeable field officers to administer the questionnaires. All respondents were approached in a friendly and supportive manner.

Data processing, organizing, analysis and interpretation

Once data is collected, it is logically organized and analyzed for scientific interpretation and judgment. This requires logical explanatory and exploratory conclusions. Quantitative and qualitative techniques were used to obtain in-depth understanding of the phenomenon as well as sound and useful results. Data analysis, irrespective of whether the data is qualitative or quantitative, explains and summarizes the data, reveals relationships between the variables and proactively compares variables. According to (Hitchcock and Hughes, 1995) and (Marshall and

Rossman, 1995), data analysis and interpretation are the holistic processes of bringing order, structure, and meaning to a mass of collected data. The data collection for this study offered ordinary individuals the opportunity to influence planning decisions. It thus promoted citizen input.

Statistical analytical methods and interpretation

Qualitative data analysis involves a scientific search for general statements about relationships among categories of the dataset. The results are presented in graphical or numerical form. In the scientific sense, data analysis is the process of developing answers to questions through examination of the primary dataset. Primary, raw data from the field is analyzed to discover useful information, suggest reasonable conclusions and support the decision-making process. It is generally accepted that results expressed in binary forms are more precise, less ambiguous and more comprehensible. For the purpose of this study, two main types of statistical methods were used to analyze the data, *descriptive statistics* and *inferential statistics*. These methods transform the initial dataset into credible evidence about an intervention and its performance.

Descriptive statistics

As the term implies, descriptive statistics merely describe what is or what the data shows. Descriptive statistics are also concerned with ordering the original dataset through summarization. The three major features of descriptive statistics are distribution, central tendency, and dispersion. Distribution shows the frequency of individual values or ranges of the values of a population group. The simplest distribution group lists every value of a variable and the number of participants that had each value. The central tendency of the population distribution is an estimate of the center of distribution. There are three types of estimates of central tendency, mean, median and mode. Dispersion refers to the spread of the population in relation to the central tendency. Standard deviation and the range of the population are two common measures of dispersion. The range is the highest value of the population sample minus the lowest value.

Inferential statistics:

Inferential statistics examine the relationship between or among variables. They allow a researcher to make inferences using the sample size. Inferential statistics are also able to explain and predict future situations based on trends in the data collected. Decisions are made based on relationships between samples that represent the study population and the whole population. Frequency distribution tables are constructed, and the data are presented in pie charts, histograms and bar graphs. Inferential statistics yield conclusions that extend beyond the immediate population sample. They also enable scientific judgments to be made based on observed probability. It is important to measure differences between groups and what is happening by chance. Thus, inferential statistics enable a researcher to draw logical inferences from data in order to make more general statements, while descriptive statistics describe what's going on. The Statistical Package for the Social Sciences (SPSS) was used for the analysis of closed-ended questions and construction of frequency tables. Microsoft Excel (MS Excel) was employed to construct spreadsheets

Data Presentation and Editing

Data presentation and editing involve presentations, preparation of reports and publication of results. Data editing is critical as poorly edited data can result in misrepresentation. Verification of data entry was ensured, and the report was edited by a professional editor.

2.3.4: Limitations of the Study

All research confronts barriers and challenges ranging from a lack of reliable data to challenges in acquiring data, time and financial constraints and ethical and management issues. The lack of reliable secondary statistical information was a major challenge. More specifically, the non-availability of appropriate surveillance and demographic data, as well as information on transportation characteristics and land-use was a severe hindrance. Furthermore, no information was available on the total number of accidents in Lagos Island, where they occurred, the breakdown of female/male /child victims and their ages, the number of deaths and injuries and the vehicles involved. Moreover, the dataset on planning in Lagos State is unsystematic and insufficient. Thus, intensive field work was required to source data for this study. Furthermore, there is no national databank and where data are available they not sufficient for planning purposes.

These deficiencies plagued previous transportation planning studies. Relevant maps and records of pedestrian activities are also not available. This study made extensive use of digital and electronic means to collect data. Heterogeneity, timeliness, complexity, and privacy problems in relation to data gathering impeded progress. Before undertaking this research project, the researcher familiarized himself with data collection methodologies. This ensured that a manageable sample was selected for the field survey and addressed some of the abovementioned challenges. While a study of this nature is expensive, despite the researcher's efforts, he was unable to source outside funding and had to commit private funds to ensure the quality of the research. Time constraints were a further challenge. To overcome this problem, the researcher and his supervisor drew up a schedule for the study. Despite these limitations, the researcher is confident that the study's aims, and objectives were achieved.

2.3.5: Ethical considerations:

Researcher received approval and ethical clearance from the UKZN Humanity and social science Research ethics committee before embarking on the field work (see appendix D). This Research ethics committee requires that participants are informed of their rights to voluntarily consent or decline to participate in a study. UKZN Humanity and social science Research ethics committee requires they should also be informed of their right to withdraw from participation at any time without any adverse consequences. Participants need to be informed of the purpose of the study, and the data collection procedures. Conducting research calls for expertise, diligence, honesty, and integrity. Respondents have the right to self-determination, anonymity, confidentiality and informed consent. To ensure confidentiality and privacy, the respondents were not asked to write their names on the questionnaires. The data collected remained confidential and the respondents' identities will not be revealed when reporting or publishing the research. Furthermore, the researcher assured the participants that the information they provided would not be misrepresented.

2.3.6: Reliability:

Reliability refers to the degree of consistency with which an instrument measures an attribute. Researcher ensures high reliability through consistent assessment of the dataset. So, for the purposes of this research, information gathering was treated with a high degree of reliability, accuracy, reproducibility and consistency. This study puts in place ways of evaluating the caliber of the measurement procedure used in data collection because for a research of this magnitude to be scientifically considered valid, the measurement procedure must first be honest.

2.3.7: Validity:

The validity of a research instrument is the degree to which it measures what it set out to measure. The questionnaires were submitted to the researcher's supervisor for approval before administration. The supervisor reviewed the questions and included more issues to enhance representativeness. The supervisor also rephrased some questions and suggested more appropriate response choices. Subsequently UKZN Humanity and social science Research ethics committee issued an ethical clearance before embarking on the field work.

2.3.8: Confidentiality:

Protecting individual privacy is essential in research and confidentiality is a means of doing so. The survey ensures the highest layer of confidentiality with respondent's information. The hallmark of a good information in this study was strict confidentiality of study participants. Researcher ensures that the data that identifies survey participants were withheld or masked to avoid revealing and disclosures of classified information. The use of number or letter codes to link the respondent to a questionnaire adapted. Ensuring confidentiality, the author ensures that these techniques were kept for participants confidentiality during the study.

2.3.9: Data storage and access to stored data:

Appropriate handling and transmission of raw data after analysis is an important ethical duty. The data will be secured and stored in a flash drive and external hard drive, while the questionnaires are stored in a safe or cabinet with the project supervisor. On expiration of the mandated period of five years, documents will be shredded, and incinerated, and electronic information will be deleted.

2.3.10: Research tools:

Research tools enable the researcher to typically make use of support equipment in capturing inferring mechanisms and formulating experimental results within the same framework. Research tool as the name suggests is technical support equipment that helps this study in unmeasurable ways to shed lighter emphasize on this subject. There are plenty of maps and websites which are available online that helps this study. The simplest form of research tool used in this study is Map and other cartographic information and researching supporting facts online.

2.4: The Chapter summary:

The research methodology details out the research design as well as the various tools and techniques that were used in this study. The study engaged the case study approach with a focus on Lagos Island and the central business district. While using both secondary and primary data sources, a wide range of research techniques and tools were used in a manner that converged into providing a holistic insight into the understanding of competing factors that impinge on the transport system and infrastructure in Lagos. Table 7 below provides concise summary of research intention and methodology and provide an in-depth summary of this Chapter 2. Interestingly, for clarity purposes Table 7 provides an overview of the research questions with appropriate targets and methods. This table attempts matching the research questions with the objectives and methods

Table 7:7Aims of the study and critical research questions.

AIMS	The main aim is to encourage increased pedestrian activity by suggesting practical measures that would result in substantial improvements to pedestrian safety. The goal is pleasant, secure, safe and attractive pedestrian linkages.			
OBJECTIVES	RESEARCH QUESTIONS	METHODS		
		Data collection		Data analysis
		Primary	Secondary	
To examine available transportation modes and their characteristics	*(i)* What are the travel origin, destination, reasons and the purposes of travel? *(ii)* How adequate and safe are these modes of transportation?	Questionnaire administration (see Appendix A), photographs and records. Inventories of existing infrastructure (see Appendix C)	Review relevant literature on pedestrian traffic in Lagos	Thematic and descriptive data analysis. Manual input of data input in the computer and descriptive statistical methods such as count (frequencies), percentage, mean, mode, median, range, standard deviation, variance, ranking
To identify the participants' socioeconomic characteristics To evaluate the economic contribution of activities in the study area	*(i)* What are the socio-economic features of the participants? *(ii)* What are the particular behavioral characteristics of the participants in the study area? *(iii)* What is the economic viability of the survey area?	Questionnaire administration (interviewing stakeholders such as residents, traders (using Appendix A), taking supporting photographs and recording activities	Review relevant literature on pedestrian traffic in Lagos	Thematic and descriptive data analysis. Manual data input in the computer and descriptive statistical methods such as count (frequencies), percentage, mean, mode, median, range, standard deviation, variance, ranking
To identify the impact of human and vehicular interaction in the study area	*(i)* Are there clashes between vehicles and the pedestrian system (what is the current status of pedestrian safety in the study area)? *(ii)* What are the purposes and reasons for the pedestrian system?	Questionnaire administration (see Appendix A), taking photographs and recording activities	Review relevant literature on pedestrian traffic in Lagos	Thematic and descriptive data analysis. Manual input in the computer and descriptive statistical methods such as count (frequencies), percentage, mean, mode, median,

AIMS	The main aim is to encourage increased pedestrian activity by suggesting practical measures that would result in substantial improvements to pedestrian safety. The goal is pleasant, secure, safe and attractive pedestrian linkages.			
	(iii) Are there physical barriers that prevent a convenient pedestrian system that enables access and allows people to cross the street? *(iv)* What is the intensity level of walkability? *(v)* What is the current status of pedestrian safety in the study area? *(vi)* What types of pedestrian and other NMT facilities exist in the study area?			range, standard deviation, variance, ranking
To address the issue of physical expansion and conversion of building use on the Island (the density of commercial buildings in the traditional/ancient parts of the CBD and the modern section)	*(i)* What are the land-use types (buildings use) and how do they impact travel patterns? *(ii)* How and to what extent is the built environment (land use characteristics) of Lagos Island attractive to buyers and sellers?	Questionnaire administration (see Appendix A), taking photographs and recording activities	Review relevant literature on pedestrian traffic in Lagos	Thematic and descriptive data analysis. Manual data input in the computer and descriptive statistical methods such as count (frequencies), percentage, mean, mode, median, range, standard deviation, variance, ranking
To identify the key challenges facing the pedestrian system on the Island among other NMT problems and evaluate the adequacy of the proposed measures (and their implementation) through conducting	*(i)* What have past, and present governments done to address pedestrian safety in Lagos? *(ii)* Is there any legislation that protects and promotes pedestrian safety? *(iii)* What are the best ways to improve pedestrian transportation to make Lagos State pedestrian friendly?	Questionnaire administration (See Appendix A), taking photographs and recording activities	Review relevant literature on vehicular and pedestrian interactions	Thematic and descriptive data analysis. Manual data input in the computer and descriptive statistical methods such as count (frequencies), percentage, mean, mode, median, range, standard deviation, variance, ranking

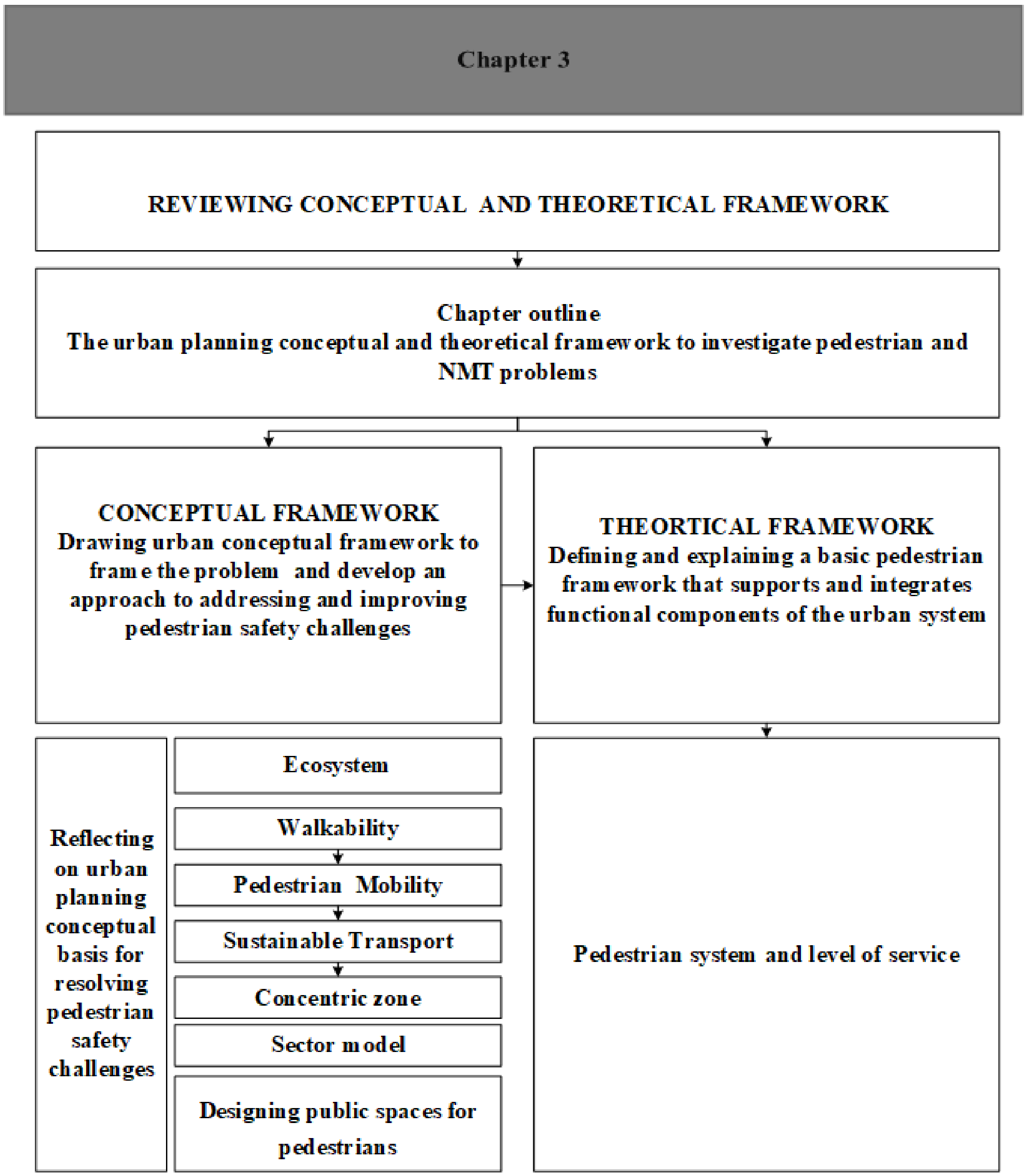
AIMS	The main aim is to encourage increased pedestrian activity by suggesting practical measures that would result in substantial improvements to pedestrian safety. The goal is pleasant, secure, safe and attractive pedestrian linkages.			
an inventory of pedestrian infrastructure and service facilities	*(iv)* What is the immediate and long-term recourse in the case of pedestrian and other traffic related accidents?			
To recommend measures to integrate marginalized pedestrians into urban planning and schemes in the Lagos metropolitan area (in this case, streets traders)	What are the policy implications of the study's findings in improving intra-urban pedestrian travel?	Questionnaire administration-Interviews (See Appendix A), taking photographs and recording activities	Review relevant local and international recommendations for effective intra-urban pedestrian travel	Manual data input in the computer and descriptive statistical methods such as count (frequencies), percentage, mean, mode, median, range, standard deviation, variance, ranking

Source: Author's construction (2016) ©

3. CHAPTER THREE: CONCEPTUAL AND THEORETICAL FRAMEWORKS

3.1: Chapter Outline

Figure 8: Overview of Chapter three.



Source: Author's construction (2016)

Conceptual and theoretical frameworks are employed as research tools to shine new light on existing problems. They enable intellectual representation of the reality of a given phenomenon. Theoretical and conceptual frameworks offer abstraction, and a logical structure to guide a study. This chapter presents the conceptual and theoretical frameworks that guided this urban planning investigation(Acharya et al., 2013). Figure 8 below presents the chapter outline.

3.2: Conceptual framework

This study employed six relevant conceptual frameworks, the ecosystem, the walkability index, the sustainable transportation, the concentric zone, the Sector Model and designing public spaces for pedestrians.

3.2.1: The ecosystem concept

To understand the dynamism of the ecosystem concept; there is a need to study how urban ecosystems work (Millennium Ecosystem Assessment, 2003, Boyle et al., 2003, Millennium Ecosystem Assessment, 2005)) and to establish the limits of performance of the metropolis as a living organism. The term ‘eco’ has become part of modern parlance. It refers to consciousness of the need for environmental sustainability. The Merriam-Webster Dictionary defines eco as ecology, economic or environmental. It depicts a natural habitat or not being harmful to the environment. In urban planning eco activities promote healthy ways of life and involve mixed development. The ecosystem prioritizes public-friendly transportation, especially non-motorized modes (Millennium Ecosystem Assessment (MA), 2005, Pickett et al., 1997, WIllis, 1997). There are several definitions of the term ‘system’. For the purposes of this study, that proposed by (Ratcliffe, 1974); (Marcotullio, 2008, Meyer and Gomez-Ibanez, 1981, Harper, 2014) and the (UK Systems Society (UKSS), 2003) cited in (Jeppesen, 2009) is appropriate. A system is a set of connected things or parts or a knowledge or belief considered as a whole, a method or an organization. The systems approach formalizes the method and components within the overall operation of the unit of study. A system is often defined in spatial terms, as a complex and single whole. Table 8 provides a synopsis of definitions of simple and complex systems.

Table 8: Definitions of straightforward and complex systems

Simple	Complex
A small number of elements	Large number of elements
Few interactions between elements	Many interactions between the elements
Attributes of the items are predetermined	Characteristics of the items are not predetermined
Communication between components is highly organized	Interaction between elements loosely organized
Well-defined laws govern behavior	They are probabilistic in their behavior
The 'system' does not evolve over time	The 'system' changes over time
Sub-systems do not pursue their goals	Sub-systems are purposeful and generate their goals
The 'system' is unaffected by behavioral influences	The 'system' is subject to behavioral influences
The 'system' is mostly not open to the environment	The 'system' is mostly open to the environment

(UK Systems Society (UKSS), 2003)

(Ratcliffe, 1974); (Robert, 1974); (Pickett et al., 1997, Bradshaw, 1993a) and (Wee et al., 2009) draw on systematic research to identify three kinds of systems, engineering, ecological and social. Table 9 presents the characteristics of these systems that reconcile society and overall biodiversity, promoting sustainability, economic viability, social justice, and political and cultural inclusiveness.

Table 9: Kinds of systems and Characteristics

Type of system	Characteristics
Engineering	Somewhat predictable as they are essentially (but not exclusively) deterministic. Guiding criteria are set externally either in the process of design or as part of operations
Ecological	Mostly probabilistic, counter-intuitive and difficult to predict due to feedback loop complexity
Social	The city is a socio-technical system

Source: Adapted from (Robert, 1974)

Applying the ecosystem concept to the study

The widely used term 'ecosystem concept' (a contraction of an ecological system) has a long history, with different views on its significance at different times (Millennium Ecosystem Assessment (MA), 2005, Millennium Ecosystem Assessment, 2003, WIllis, 1997, Nancy B. Grimm et al., 1999). (Pacala, 1994) notes, that, in the past 30 years, a lot more information has become available on ecosystems and that research on this subject is often imprecise. The ecosystem concept is a scientific milestone and an analytical tool to resolve social and urban phenomena such as transportation planning problems. This conceptual framework is highly relevant in relation to a typical transportation system in urban areas that can be regarded as an ecosystem. The (Millennium Ecosystem Assessment (MA), 2005, Millennium Ecosystem Assessment, 2003, WIllis, 1997, Nancy B. Grimm et al., 1999) attest to the viable and pragmatic nature of this methodology as do numerous other scholars (Haar, 2007, Millennium Ecosystem Assessment, 2005, Millennium Ecosystem Assessment (MA), 2005) (United Nations Environment Programme (UNEP-IETC), 2008, Saelens et al., 2003a, Wells and Yang, 2008, Paul M. Hess et al., 1999, Saelens et al., 2003b). Built environment professionals and international bodies (United Nations Environment Program (FAO/UNEP0, 1997; (United Nations Environment Programme (UNEP-IETC); Millennium Ecosystem Assessment (MA), 2005; United Nations Environment Program (UNEP-IETC), 2008) state, that, this concept is essential in creating better cities.

One of the first longitudinal studies of the ecosystem was conducted by Arthur George Tansley, an English plant ecologist, and social scientist. In a famous paper on vegetation concepts and terms published in 1935, Tansley rejected Clements and Phillips' proposition that small-scale studies should be conducted on 'super organisms'. He posited that animals and plants should be studied as part of their surroundings, or as 'systems'. Tansley added that it is not possible to separate living and non-living beings, especially from "the environmental perspective – the habitat factors in the fullest sense with which they make one physical system" (Tansley, 1935, Trudgill, 2007, WIllis, 1997, Ricklefs, 1990b). In his report, he described ecosystems as natural, whole systems. It is thus impossible to distinguish the environmental peculiarities within which physical systems exist. Tansley stated that these ecosystems (plants, animals, micro-organisms) (biotic facts) are basic units of nature of various kinds and sizes. This suggests that an ecosystem involves interactions between a community of living beings in an area and its non-living environment. This is useful in identifying the connections between the elements of urban transportation and provides a sound starting point in improving a pedestrian system. Tansley's approach is also helpful in integrating transportation elements with the natural environment for human use. (Tansley, 1935, Tansley, 1939, Ma and Wang, 1984, Midgley, 2003, Ricklefs, 1990a, Allen and Starr, 1982, Haar, 2007, City: and Metabolism, 2007, Falconer, 2008) (Meyer and E J Miller, 1984) extended Tansley's conceptual framework by posting that ecosystems consist of three subsystems, namely, social, economic and natural. However, their theory was criticized for providing insufficient evidence. (Lehrer, 2013) is probably the best-known contemporary originator and critic of a quantitative approach to the ecosystem concept.Lehrer argues that this is not a new scientific approach to urban planning but is an evolving concept. The author cites Geoffrey West's (1993) thesis and Kleiber's biology equation to affirm that, in the 21st-century, theoretical physicists are required to solve biological problems. Lehrer notes, that, regardless of whether one is speaking about the human skeletal system, the nervous system or the cardiovascular system, the inability of economic and governmental policies as well as urban studies to take these relationships into account has negatively impacted cities and indeed, global ecosystems.

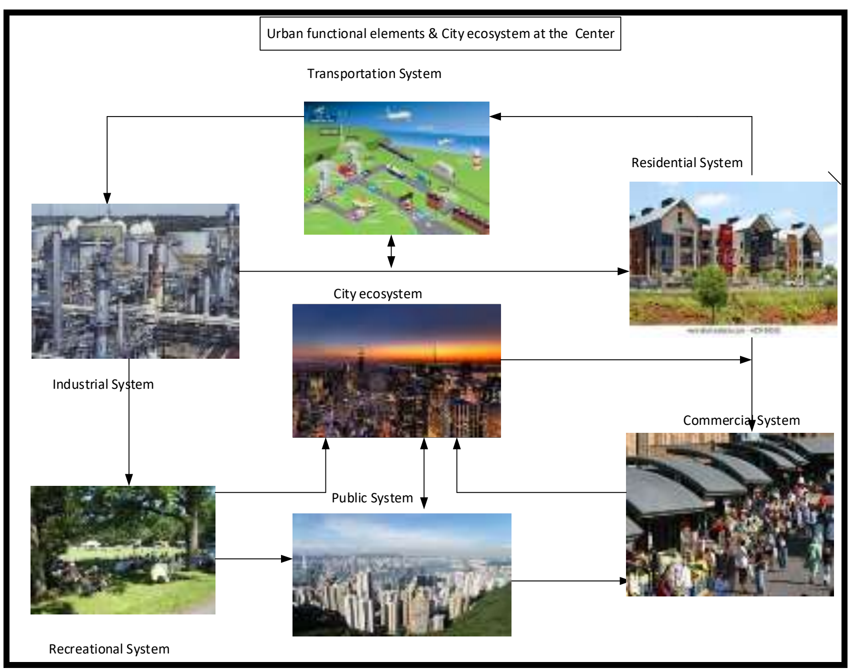
In the 1930s, little-known Swiss-American Max Kleiber measured the biochemical processes of different animals to explain their natural metabolism rate. Lehrer's equation defines this process in cows, humans, elephants and mice. Kleiber used an elephant and a mouse to test his experiment. The elephant is appropriate for this study. Kleiber argued that the elephant is much more metabolically efficient than a mouse; its metabolism is equal to the mass of the elephant raised to the 3/4. The equation below provides clarification of Kleiber's findings.

i.e., R ∝M3/4 ……………………………………………………………………………………………Equation 01(Lehrer, 2013)

The essential part of this equation is the exponent value, which is less than 1. Kleiber's equation has important implications for contemporary city planning. Lehrer argues that humans are more efficient than animals. Just as the biological mass of an elephant is equivalent to 0.75, using per capita consumption, for an urban metabolism this amounts to 0.8 for an exponential population figure in a typical city. The result is that every living creature has about a billion heartbeats worth of life; the city is a living organism. Per Lehrer, cities can double their population yet increase their resources. Likening cities to elephants implies that they will continue to experience development and steady socio-economic growth. No matter where a city is located in the world, each is simply a scaled version of the same city. Modes of transport in urban areas are viable in most cities of the world. Overall, sustainable mobility is an offshoot of the ecosystem concept.

Lehrer's paper on the living city or urban metabolism presents cities as living organisms (ecosystems). The city is a living place that obeys the metabolic law that governs every organism. Lehrer uses examples of many countries to show that there is an association between cities and common natural living organisms. Thus, understanding the city from a biological perspective is an innovative tool in 21st-century urban planning. Lehrer's thesis is useful in understanding the city transportation system as a living thing. Transportation invariably requires inputs such as land to sustain it. Like a living organism, transportation flows (both vehicular and pedestrian) into the city metabolize the city system to produce a sustainable ecological area. The city could be compared with both molecular and cellular organization in biological studies. A city is a unit of an organism that carries on the functions of urban life with different levels of organization. Cities take in materials from their surrounding environment and use them in a complex way. Urban residents can benefit immensely from this notion. As a living thing, a city transportation system exhibits the following principal universal characteristics: very organized, some unorganized, and uses energy to grow, develop and reproduce. All these traits determine what it means to be an ecosystem. Each city is unique in structure and has a hereditary ecosystem made up of urban functional elements (land uses such as commercial, residential, institutional, educational, recreational, public and transportation system). The Plate 1 illustrates the manifestation of the functional elements.

Plate 1: Urban functional elements and the city ecosystem at the center



Source: Author's construction (2016) © from google.com

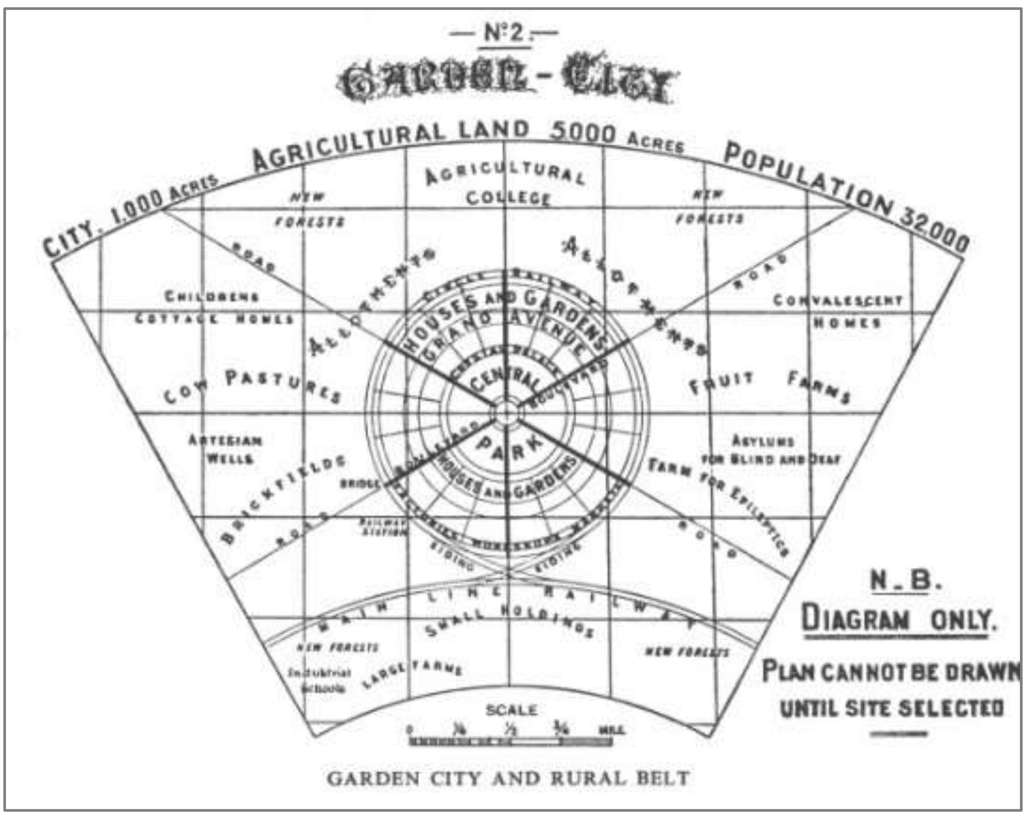
The urban metabolism quantifies the transportation flows (both vehicular and pedestrian) into towns and enables a better understanding of the utilization of the main streams. The concept of an ecosystem enables a more holistic approach to environmental matters. From the urban planning perspective, for city transportation to function as an ecosystem, there is a need for mixed, sophisticated and functional urban elements. It is thus argued that unlocking opportunities for positive social and economic development will require that all functional urban elements operate as an ecosystem. Lehrer's thesis is consistent with earlier studies (Starr et al., 1982 , Giuliano, 1989, Giuliano, 1986, Ricklefs, 1990a, Gehl and Gemzøe, 2000, Nancy B. Grimm et al., 1999, Boyle et al., 2003, Marcotullio and Boyle, 2003, Hillier, 2012, Pucher and Dijkstra, 2003a, Pucher and Dijkstra, 2003b, Gehl et al., 2006, Millennium Ecosystem Assessment, 2005, Millennium Ecosystem Assessment (MA), 2005, United Nations Environment Programme (UNEP-IETC), 2008, Girardet, 2008). Other consistent similar studies include,(Newman and Jennings, 2008) (Morlok, 1973, Ratcliffe, 1974, Robert, 1974, Moore and Pulidindi, 2003, Paddison et al., 2010) Boyle et al., 2003; Tugbobo, 2004; Jeppesen, 2009; Marcotullio and Boyle, 2010; Hillier 2012). However, despite the potential for the ecosystem conceptual framework to address urban planning problems, it has been strongly criticized (Boyle et al. 2003; Moore & Pulidindi, 2003; Marcotullio and Boyle, 2003, 2008).

For instance, West, cited in Lehrer (2013) observed that "cities are entirely different from biological organisms, which slow down with size; relative metabolism, growth rates, heart rates, and even rates of innovation – their evolutionary rates systematically and predictably decrease with organism size". Another criticism of the concept is the level of interaction among the several components of the system and the relationship between conception and achievement of objectives. Given this scenario, Morey (2008) and Lehrer (2013) contend that living things like cities' economic activity do not have any clear biological analog; thus, economically, cities break this rule. Furthermore, although not expressly mentioned in the literature reviewed, this concept is inconsistent in its predictions especially with regard to the extent of the city and various land use interaction that forms the core of the ecosystem. These conditions might be less likely to occur in most cities of the world. Nonetheless, it remains one of the best methodologies or tools to address transportation especially pedestrian challenges.

3.2.2: Walkability concept

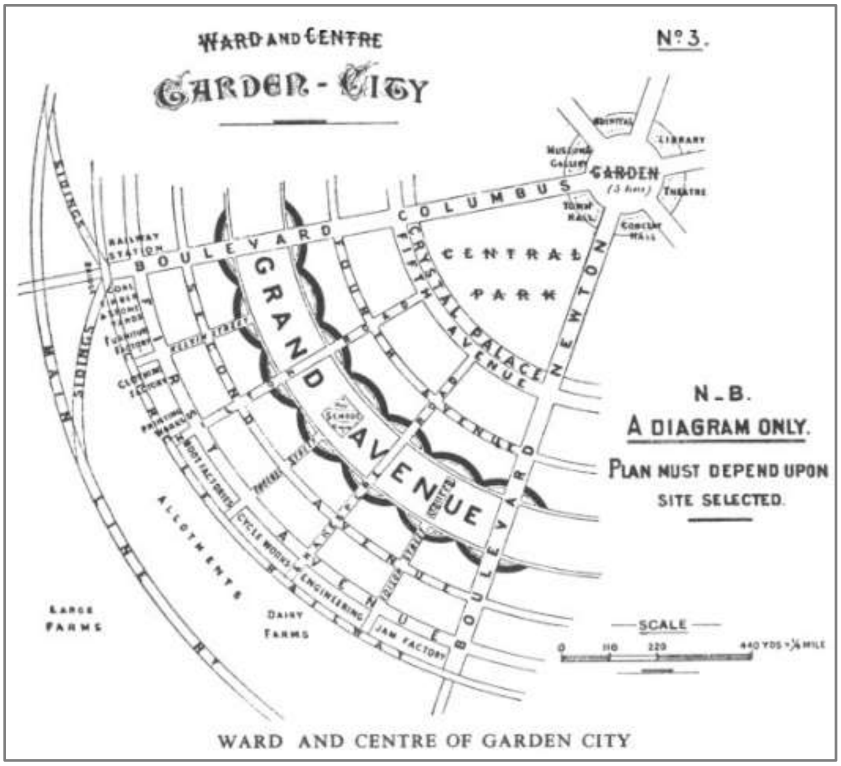
’Walkability’ has become a buzzword in the fields of urban planning, transport engineering, and public health as the social, health and economic benefits of walkable urban areas have become more apparent. What is the meaning of ‘walkable’, what is a useful index and what do pedestrians desire? Historically, Ebenezer Howard's Garden City concept marked the emergence of large-scale, comprehensively planned walkable communities. In 1898, Howard set out details of different stages of settlement in “Tomorrow: a peaceful path to real reform.” Howard's plan for garden cities was a response to the need to improve the quality of urban life. His work and that of the Garden City pioneers left Britain with an impressive legacy, from the world-renowned Letch, Worth and Welwyn Garden Cities to many places in the UK and throughout the world, including Garden Suburbs and the post-war New Towns program. The Figure 9 below shows the plan of the entire municipal area using Ebenezer Howard's Garden City concept while the Figure 10 shows the ground plan of the entire metropolitan area

Figure 9: A ground plan of Howard’s garden city indicating the town in the center



Source: https://www.google.com/

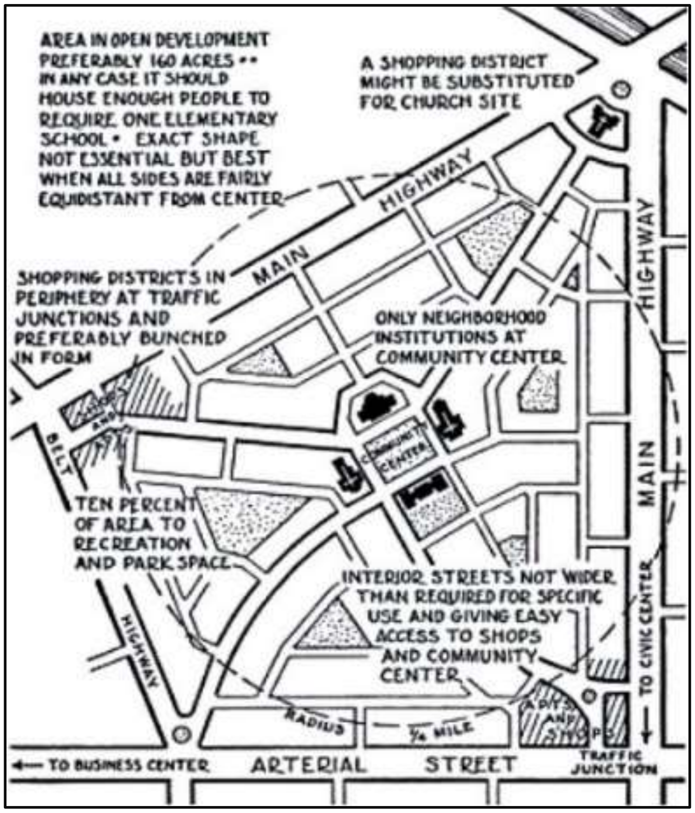
Figure 10:Representation of one section or ward of the town



Source: https://www.google.com/ accessed October 2015

Following on Howard's work, various disciplines developed the walkable neighborhood concept. While some urban planners and social scientists claim that the walkable neighborhood is an American 19th and early 20th century innovation, others disagree. Clarence Stein and Henry Wright's (1929) work on walkable neighborhoods and Clarence Perry's (1929) 'neighborhood unit' are examples of such work, with the latter most clearly depicted in their plan for Radburn in New Jersey, USA. At the core of the neighborhood unit is a primarily residential area that supports walkability. It is for this reason that this concept has been more popular than that of Stein and Wright (1929). The neighborhood unit is based on children and families; Perry aimed to ensure that children and families could walk safely from their homes to elementary schools and community centers. This conceptual framework had its origins in social reform in response to growing urban populations and borrowed from Howard's Garden City concept that was modeled on a typical British city of between 6,000 and 30,000 inhabitants living within walkable distance of amenities. Figure 11 illustrates the relationship between the residential components of a neighborhood and other uses.

Figure 11:Clarence Perry's "neighborhood unit" diagram, 1929



Source: https://www.google.com/ accessed October 2015

In modern times researchers, transportation establishment and supporters of the New Urbanism such as (Lo, 2009, Lo, 2011, Lopez, 2008, Mehta, 2006, Michigan Department of transportation MDOT, 2007, Mcintyre, 2014, Mazaza, 2002), have continued to advocate for walkable neighborhoods. It is characterized as Traditional Neighborhood Design (TND), Transit Oriented Development, Pedestrian Pockets, Transit Villages, and Urban Villages. The Figure 12 is an interpretation of Clarence Perry's neighborhood unit created and modeled by Farr Associates, Architecture, and Urban Design.

Figure 12: The neighborhood unit concept of Clarence Perry (1929)

Source: designed and shaped by four associates, architecture, and urban design https://www.google.com/

Illustration and application of walkable concepts to the study

The first serious contemporary discussions and analyses of walkability emerged during the 1990s with studies by Bradshaw (1993) and the Transportation Council Board & Cities (1997). More recently, some longitudinal studies have been conducted on a walkable index (FHWA, 2002; Salinas, Sallis, Black, & Chen, 2003). Southworth (2005); Frank et al. (2005); Leather et al. (2007); Leslie et al. (2007); Leslie, Cerin, DuToit, Owen, & Bauman (2007); UTTIPEC (2009); Ewing and Handy (2009); Charles, Zegeer, & Bushell (2010); Cost 358 (2010); A to Z Guide (2010); Cohen (2010); and Ozbil (2010) have also investigated walkability. Recent studies by Abley & Turner (2011); Walk Score.com (2011); Gota & Fabian (undated); Speck (2012); and Cambra

(2012) provide background information on the walkable index. There is a need to systematically understand what constitutes 'walkability' and a walkable index. Walkability extends beyond contemporary pedestrian concerns such as the ability to walk in a neighborhood; it is not simply a type of mobility and means of travel but is also a model of social interaction amongst neighbors. Southworth (2005) states that a built environment is walkable to the extent that it supports and encourages walking by providing for pedestrian comfort and safety, connecting people with different destinations with moderate time and effort, and offers visual interest on journeys throughout the network (Ng et al., 2012; Choi, 2012; Sanyal, 2013; Choi, 2012; Buehle, and Pucher 2012; Muhlbach, 2012; Ping et al., 2012).

The "A to Z Guide" (2010) states that walkability is a term given to a built environment or Green Cities that facilitate human-centered activities such as shopping, commuting, and socializing. Cohen (2010) notes, that, walkability is objective and measurable. The walkability of a community is the extent to which the built environment, and land use enables residents to walk for leisure. In simpler terms, walkability is described as the extent to which the built environment is walking-friendly. Furthermore, walkability is a sustainable supply and design option for a city to become green over time. A walkable community demonstrates a high level of streetscapes and livability. Streetscapes in this sense usually mean better-situated street roadways and public spaces to serve a range of users, including pedestrians, cyclists, transit riders, and automobiles. Figure 13 shows a snapshot of a typical livable city. This involves enlivening and activating existing spaces through good design and programming. On the other hand, an index is used to measure change or to adjust. It is a statistical measure of variations in a representative group of individual data points. In this context, it is a means of calculating walkability parameters using an algorithm based on walkability research.

Figure 13:Process of creating a livable city

Source:https://www.ura.gov.sg/uol/master-plan/view-master-plan/master-plan-2014/master-plan/Key-focuses/public-spaces/Public-space.aspx

Walkability Index Score (WIS)

A walkability index score (WIS) is the best way of judging the concise degree to which an area can extend opportunities to walk to various destinations. While it is not a one-size-fits-all approach, such indexes can rate the purpose of trips and residents' socioeconomic characteristics (Leslie et al., 2007; Ewing and Handy, 2009; Leo, 2009; Cambra, 2012; Ria 2011,). Hutabarat (Lo, 2009) and the (Victoria Transport Policy Institute (VTPI), 2014b) note, that, a walkability index score is a standard measure of the eco-friendliness of an area. It enables subjective or qualitative assessment against specific standards.

Scholars agree that measuring the walkability of a zone relies in part on its environmental attractiveness and pleasantness. Walkability thus has immediate environmental effects. Firstly, a WIS is a publicly available tool and possibly the most ubiquitous accessibility measure. Secondly, it is a methodological approach that assesses and determines an ideal pedestrian-friendly community that is not ordinarily walkable and makes (short and long) term improvements based on available parameters. Thirdly, a WIS is a deliberate and empirical method of assembling, and scrutinizing various data streams (street type, intersection complexity, points of interest, population density, environmental and physical data and so on) for assessment purposes using a set of evaluation parameters. These parameters are calculated using proprietary algorithms to determine the extent of walkability. The assessment utilization values could relate to comparison of neighborhoods or benchmarking. Despite its usefulness, studies criticize WIS for its limitations. Holly Krambeck and Jitendra (Jitu) Shah (2006) maintain that it is difficult to use indexes to explain walkability, paving the way for widespread misunderstanding. For instance, the index requires data gathering in the field, and the use of unsophisticated data collection techniques for practical reasons results in a less robust index(Krambeck, 1999, Krambeck, 2008, Leslie et al., 2007, Ozbil, 2010, O'Hare, 2006, Walk Score.com, 2011). While a WIS does address pedestrians' need for comfort, refuge, security, and climate protection and favors walking as a form of transportation, the method is also subjective and tends to produce biased observations and answers(Dover and Chael, 2004, Eunyoung, 2012b, Davidson, 2006). Nonetheless, it remains one of the best methodologies or tools to address pedestrian challenges. However, it should be borne in mind that other unconnected factors impact on the construction of a WIS. What makes a neighborhood walkable? Table 10 sets out the characterization of walkability and different criteria from various sources.

Table 10: WIS: Summary of Components and Variables

Parameter Component	Description Variable
Centrality Cost 358 (2010); Cambra (2012); Charles, Zegeer, & Bushell (2010); Choi (2012); FHWA (2002); Leather et al. (2007); Transportation Council Board & Cities (1997); UTTIPEC (2009)(Ewing, undated, Abley and Turner, 2011)	Walkable neighborhoods have substance, whether it is the main street or a public place
Coexistence Julie Campoli, Transportation Council Board & Cities (1997); Bradshaw (1993); Southworth (2005); UTTIPEC (2009); Cost 358 (2010); Cambra (2012): Charles, Zegeer, & Bushell (2010);	Streets designed for walkers, and transportation system

Parameter Component	Description Variable
Choi (2012); FHWA (2002); Leather et al (2007)(Southworth and Ben-Joseph, 2003, Acharya et al., 2013, Acharya, 2010)	
Commitment Southworth (2005)(Ewing, 1999b, Ewing, 1996, Southworth and Ben-Joseph, 2003, Amphlett, 2004, Newman and Kenworthy, 2006, Biddulph, 2012, Bloomberg et al., undated, Bradshaw, 1993b, Cambra, 2012b, Catherine et al., 2009, Buis, 2009)	Buildings are close to the road. Tight enough that most residents can walk from their households
Connectivity of walking path (Southworth and Ben-Joseph, 2003, Gallagher, 2012, Georgia Department of Transportation (DOT), 2003, Gokhale and Telang, 2013, Han, 2009)	The conflict between pedestrians and other modes on the road is necessary
Conservatism and contradistinction Bradshaw (1993)(Eunyoung, 2012a, Emily and Mehndiratta, 2011, Dover and Chael, 2004, Drennen, 2003, Ewing, 1999a, Federal Highway Administration (FHWA), 1994, Federal Highway Administration (FHA) and Federal Transit Administration (FTA), 2010, Federal Highway Administration(FHWA), 2002)	There is a need for enough people for businesses to flourish and for public transit to run frequently. Affordable lodgings located near businesses
Conspicuousness (Litman, 2002, Litman and Laube, 2002, Litman, 2003, Litman, 2011, Litman, 2012, John et al., 2010, Ke, 2011, Kost and Nohn, 2011, Kodukula, 2006)	The proportion of traffic accidents that resulted in pedestrian fatalities (most recent year available) Walking path model in conflict with crossing safety, perceptions of security from crime, quality of motorist behavior
Convenience and captivating (Minnesota Metropolitan Council, 2006, Davidson, 2006, Chapman, 2008)	Maintenance, cleanliness of walking paths, existence and quality of facilities
Convivial (Eunyoung, 2012b, D'Arcy, 2013, Clean Air Initiative -Asian Cities centre, 2011, Kost and Nohn, 2011, Clay, 2014, Nazelle, 2007, Pushkarev and Zupan, 1975, Putman, 1975, Richard Blomberg et al., 1998)	The negative behavior of drivers towards pedestrians indicates the sort of pedestrian environment
Custom (Dover and Chael, 2004, Davison, 2004, Buehle and Pucher, 2012, Allan and Donald, 2009, Cambra, 2012b, Cohen, 2010)	Funding and resources dedicated to pedestrian planning. Relevant urban design guidelines, existence and enforcement of applicable pedestrian safety laws and regulations. Degree of public outreach for pedestrian and driving safety and etiquette

Source: Author's construction (2016) ©

Having identified various checklists of walkability, the next phase is applying values to the checklists. This involves methods for data aggregation – that is, transforming the dataset into index rankings (criterion or rating points). Conventionally a WIS ranges from 0-10. Urban planners and survey participants assess preferences based on a 10- point Likert scale. Table 11 provides an example of 10-point Likert walkability measurements. Table 12 provides the score sheet of the walkability index.

Table 11: A 10- point Likert scale walkability measurement

Details	Recommendation by researcher	Category of Criterion or rating Points
0.0-0.0	Unsatisfactory	Looked at "poor" when responses are at extremely low ends of the scale
0.5-2.0	Unsatisfactory but acceptable	Thought "average" when responses are at below average extreme ends of the scale
2.5-4.0	Satisfactory	Thought "below mean" when responses are at average extreme ends of the scale
4.5-6.0	Acceptable	Considered "high" when responses are at moderately extreme ends of the scale
6.5-8.0	Reasonably satisfactory	Looked at "somewhat hard" when responses are at relatively extreme ends of the scale
8.5-10.0	Highly successful	Looked at "highly strung" when responses are at highly extreme ends of the scale

Source: Author’s construction (2016) ©

Table 12: Walkability Index Score Sheet

90–100	Walker’s Paradise- Daily errands do not require a car
70–89	Very Walkable- Most errands on foot
50–69	Somewhat Walkable- Some errands through walking
25–49	Car-Dependent- Most errands require a car
0–24	Auto-Dependent- Almost all errands require a car

Source: Author’s construction (2016) ©

Table 13 below provides a typical example of a walkability score sheet for three hypothetical geographical regions (A, B & C) using an ideological analysis of walkability.

Table 13: Typical WIS analysis score sheet

Characteristics	**Maximum Score**	**Minimum Score**		
		A	**B**	**C**
Centrality	10	7.5	5	4
Coexistence	10	8.5	3.5	4
Commitment	10	8.5	2.5	5
Connectivity of walking path	10	8	5.5	5
Conservatism and contradistinction	10	8	6.5	5
Conspicuousness in terms of safety and security from crime	10	8	7	6
Convenience and captivating grade crossings and safety	10	8	7	7
Convivial	10	9	6	5

Characteristics	Maximum Score	Minimum Score		
		A	B	C
Cozy nature of amenities and disability infrastructure and obstructions	10	9	5	5
Custom	10	7.5	4.5	8
Total	100	82	47.5	54

Source: Author's construction (2016) ©

Table 14 below presents the results of the analysis with regions A, C, and B having scores of 82%, 54%, and 48%, respectively. Region A is more walkable with little or no vehicular consequences. Region C is somewhat walkable with average high levels of car-dependence. Region B is car-dependent with a poor pedestrian system.

Table 14: Interpreting WIS score (summary of analysis)

Total	82%	47.5%	54%
Walkable index score	Very Walkable	Car-Dependent	Somewhat Walkable
Negative consequences	None	Car-Dependent ranking	

Source: Author's construction (2016) ©

3.2.3: Sustainable Transport

The concept of sustainable development, which emerged in the 1980s, is premised on the notion that present and future generations should equally benefit from the entitlements of nature (Acharya et al., 2013). The term 'sustainable transport' has been the subject of debate in recent years among individuals, corporate bodies and the international community (Bruton, 1970; Damian & Barbara, 2000; ECMA, 1996; Litman, 2014; Newman & Jeffery, 1999; United Nations Human Settlements Program, 2002; Victoria Transport Policy Institute, 2014a; Whitelegg, 1997). For instance, at the World Summit on Sustainable Development (WSSD) held in Johannesburg, South Africa in 2002, an agreement was adopted to ensure an integrated approach to national, regional and local transport services and systems. This includes promoting sustainable transportation development and plans for land use development, infrastructure development, and encouraging public transportation systems and goods delivery networks. These measures aim to provide an affordable, safe, and efficient transportation system, increase energy efficiency, and reduce pollution, congestion, and adverse health effects on human and plant life as well as eliminate urban sprawl. Such policies will need to take priorities and circumstances into account. Table 15 presents definitions of a sustainable transportation system adapted from the (United Nations Human Settlements Programme, 2014c, Victoria Transport Policy Institute (VTPI), 2014c, Victoria Transport Policy Institute (VTPI), 2014a, Richardson, 1999, World Health Organization (WHO), 1999)

Table 15: Definitions of sustainable transport

Extensions	Definitions
ECMT (2004)	A sustainable transport system is safe, affordable and eco-friendly.
Brundtland Commission (1987)	Sustainable transportation development implies meetings the needs of the present without compromising the ability of future generations to respond to their demands.
Richardson (1999)	A thoughtful pedestrian approach to discourage fuel consumption, reduce vehicle emissions, promote safety, reduce congestion reduction and enhance social and economic accessibility factor into the indefinite future without causing substantial or irreparable harm.
Transportation Research Board (TRB, 1997)	It refers to how economic, social and environmental systems interact to their common advantage or disadvantage at various spatial scales.
Litman (2011)	Sustainable transportation indicates decision-making processes, short, medium and long term, that are consistent with strategies in relation to regional and global destinations.
OECD	Sustainable transportation does not threaten public health or ecosystems. It satisfies the needs of the public and is consistent with renewable resources and non-renewable resources below the rates of development of renewable substitutes
European Union Council (EUC) of Ministers of Transport	Allows individuals and society to meet their needs in a safe, coherent, healthy and eco-friendly manner. Promotes equity within and between successive generations. It is affordable and offers an efficient pedestrian system that offers a choice of transport modes and promotes competitive regional economic growth. Limits emissions and waste and uses renewable resources at or below their rates of multiplication and non-renewable resources at or below the rates of development of renewable substitutes while reducing the impact on the use of land.

Source: (Victoria Transport Policy Institute, 2014a)

Thus, a sustainable transportation system is one that enables individuals and societies to equitably and safely meet their needs consistent with human and ecosystem well-being within and between generations. To researchers such as (Southworth and Ben-Joseph, 2003, Newman, 2003, Newman and Jeffery Kenworthy, 1989 , Newman and Jeffery 1999, Ping et al., 2012, Seattle Planning Department, 1993, Smith et al., 2010, Washington State Department of Transportation et al., 1997, Transportation Research Board (TRB), 1997, Tuan, 1977, Yang, 2009, United Nations Human Settlements Programme (UN-Habitat), 2013) a sustainable transportation system is affordable, operates efficiently, offers a choice of transport modes, and supports a vibrant economy. A sustainable transportation network limits emissions and consumption of non-renewable and renewable resources.

The most significant underlying assumptions in terms of sustainability are as follows:

1. Increased need for pedestrian mobility and less demand for motorized transport. The pedestrian system is the greatest individual source of greenhouse gas conservation.
2. Sustainable pedestrian transport is the most important means of improving and reducing health challenges as well as environmental pollution (noise and wind).
3. Sustainable pedestrian transport is a measurable and statistically meaningful relationship between the volume of vehicular and pedestrian traffic in urban areas.
4. Those who live in cities with unsustainable transport have a shorter life span and the possibility of increased incidence of terminal illness such as cancers and respiratory disease. This results in more frequent absences from work and school and more spells of hospitalization.
5. With sustainable pedestrian transport, the volume of motorized traffic will be drastically reduced in direct ratio to the total available road network and parking space.

Construction of new roads and bridges, and additional parking will increase. There will be improved access through careful land use planning for walking and public transport. Sustainable transport is a real planning solution for fulfilling the needs of all residents, irrespective of gender and income and protects, maintains and enhances the health of habitats. It represents an undamaging path for today's population and not compromising future conditions. Sustainable transport solutions are also economically efficient. They reduce dependency on imported oil, deliver substantial amounts of valuable foreign exchange; and promote local growth and local execution. They also maximize local input and local employment generation(Buehler and Puche, 2011, Blaquiere, 2009, Chapman, 2008).

Various transport planning objectives support sustainability goals:

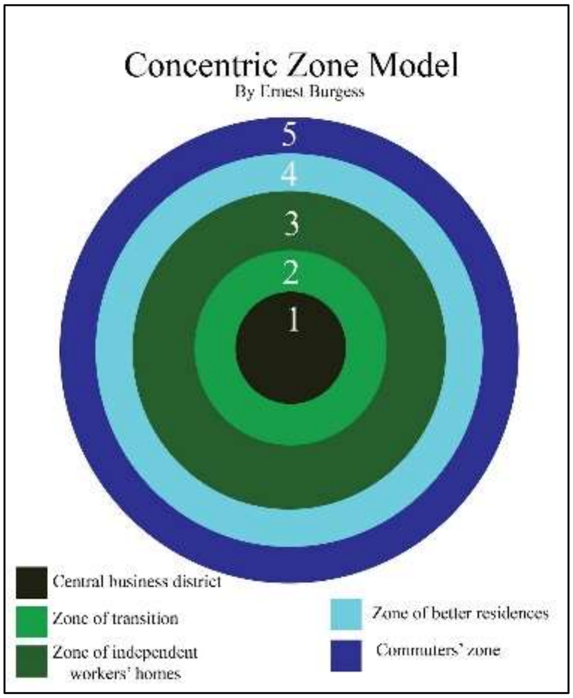
1. Transport system diversity: Travelers can select from different modes, position and pricing alternatives, particularly ones that are affordable, healthy, efficient, and accommodate non-drivers (Francois-Joseph & Ralf, 2014; Frank & Engelke, 2002b; Giuliano, 1995).
2. System integration: various transportation components are well incorporated, such as pedestrian and vehicular access to land use planning.
3. Affordability: Transport services offer low-cost choices.
4. Resource: (energy and land) efficiency. Policies encourage energy and land efficiency.
5. Operational effectiveness. Transport agencies, service providers, and facilities are managed efficiently to minimize costs and maximize service quality.
6. Comprehensive and inclusive planning: planning takes into consideration all significant objectives, impacts, and options.

Such a system integrates different transportation modes. In light of these factors, it can be concluded that most transportation systems are not sustainable. It is, therefore, important to trace the development of transportation, determine the extent of sustainability and, based on the findings, find way to ensure a healthy society (Bel & Pucher, 2012; Buehler et al., 2009; Burgess, 1925; (Nkurunziza, 2013).

3.2.4: Concentric zone model

The concentric area model was among the early urban development descriptions of form. Burgess developed this model in the 1920s and its first electronic spectroscopy was published in 1923. This model depicts the use of urban land as a set of concentric rings with each devoted to a different land use. It follows the general pattern illustrated in Figure 14 below, which reflects city expansion, namely, the disposition of each inner zone to expand by invading the next outer zone.

Figure 14: Concentric circles expanding from the downtown to the suburb



Source: https://www.google.com/

The model shows that cities expand in an outward direction from a central area in a typical ring pattern. While studies indicate that this ring varies, the process is universally uniform. The model suggests that the social and economic structure extends outside the commercial area. It implies that the lower-income classes live close to the city center, while the upper-income classes live farther from the center. Rent tends to increase the further away one goes from the CBD, and residents are more likely to rent near the center, specifically away from the CBD. Burgess used this model to explain the complexity of urban land use and urban growth in American cities in the early 20th century. He described the changing spatial patterns of residential areas as an invasion and succession process. The model shows that; the growth of an urban area will exert pressure on areas immediate surrounding the CBD zone (the area of transition).

Outward expansion of the CBD will invade nearby residential neighborhoods. The model further explains the conventional processes of the enlargement of the city. It shows successive zones of urban expansion and extension and the types of areas differentiated in this process. This aspect of development can be called succession which is part of the plant ecology process. The model represents cities in the United States and Canada during the height of industrialization. Based on the extant literature and human ecology theories, Burgess applied this model to Chicago to account for the distribution of social groups during the peak of the industrial revolution. An important feature is the positive correlation between households' socioeconomic status and distance from the CBD. Inner-city housing was occupied by immigrants and households with low socioeconomic status, while wealthier families lived at greater walking distances from the central city. Thus, the farther one lived from the CBD in Chicago, the better the quality of housing, but the longer the commuting time and the greater the cost of commuting. Burgess identified five distinctive rings (land use around the CBD). These are the (1) CBD, (2) zone of transition, (3) area with independent workers' homes, (4) zone of better residences and (5) zone of commuters. Today, this model remains one of the most vivid and useful models to explain concentric urban development throughout the world. Tables 16 and 17 provide functional classifications and alternate names used in reporting and explaining this model. It is important to be conversant with the variations and also necessary to bear in mind that this is a theoretical model; no city is perfectly laid out in even rings (Jean-Paul Rodrigue et al., 2006, Ke, 2011, Hao, undated, Rodrigue et al., 2006).

Table 16: Practical classification and alternate terms

Functional Classifications	Alternate Terms
1. Central Business District	1. CBD Downtown
2. Manufacturing and Wholesaling	2. Industrial Zone, Factory Zone
3. Lower-class Housing	3. Working-class, Blue Collar, Inner City
4. Middle-class Housing	4. Professional-Class, White Collar, Suburbs
5. Upper-class Housing	5. Country Estates, Exurbs

Source: Author's construction (2016) ©

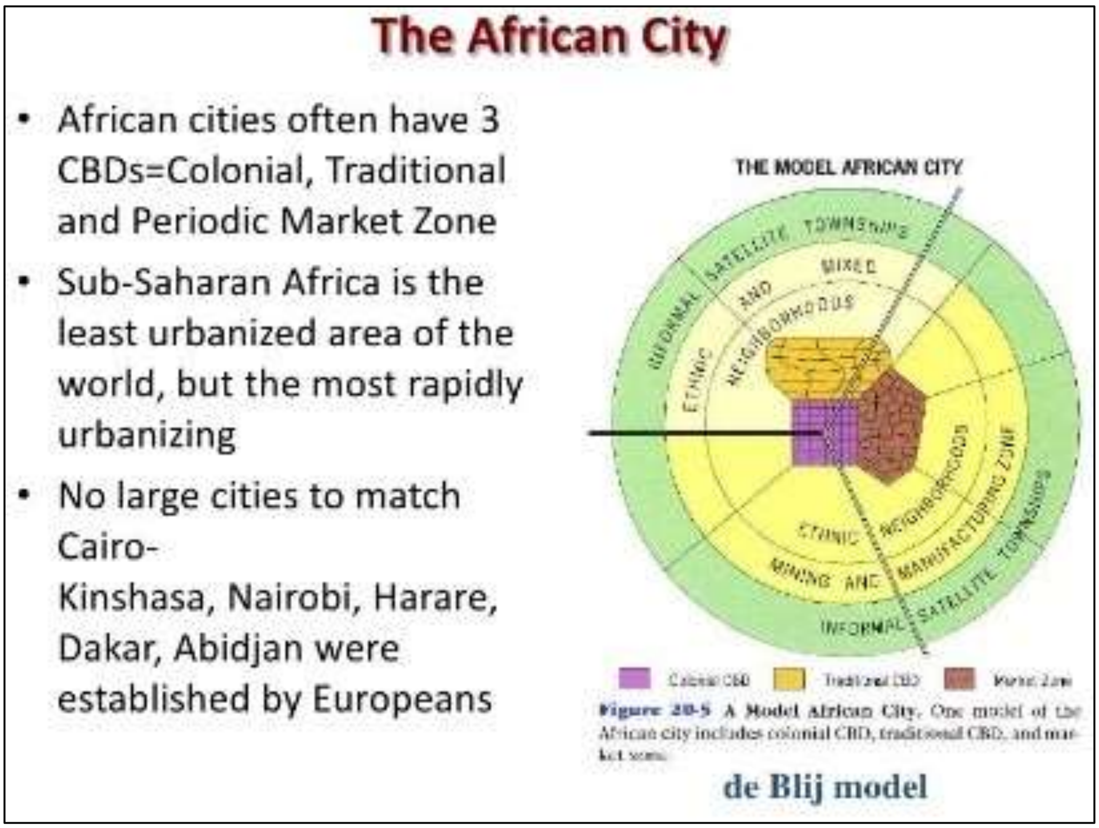
Table 17: Theoretical and Density classification

Theoretical Classifications	Density Classes
1. Central Business District	1. High-Density Commercial
2. Zone of Transition	2. Low-Density Commercial
3. Region of Independent Workers' Homes	3. High-Density Residential
4. District of Better Residences	4. Low-Density Residential
5. Commuters' Zone	5. Very Low-Density Residential

Source: Author's construction (2016) ©

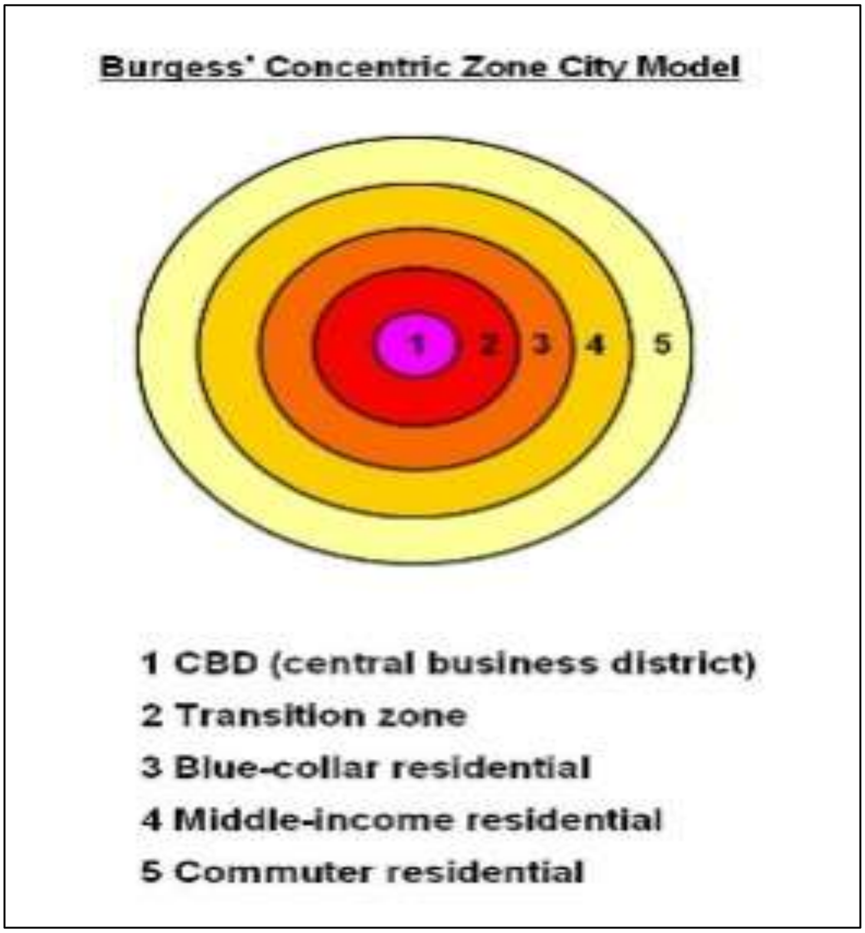
Typically, Figures 15 and 16 apply to African and Asian cities. Exurbs in many cities throughout the world retain the feel of large country estate homes on multi-acre lots as illustrated in Burgess' model. Many suburban and exurban areas in major cities have pushed well into traditional agricultural areas, further substantiating this model. However, the model promotes a series of expansions.

Figure 15: African example of the model



Source: https://www.google.com/ accessed in September 2015

Figure 16: Asian example of the model



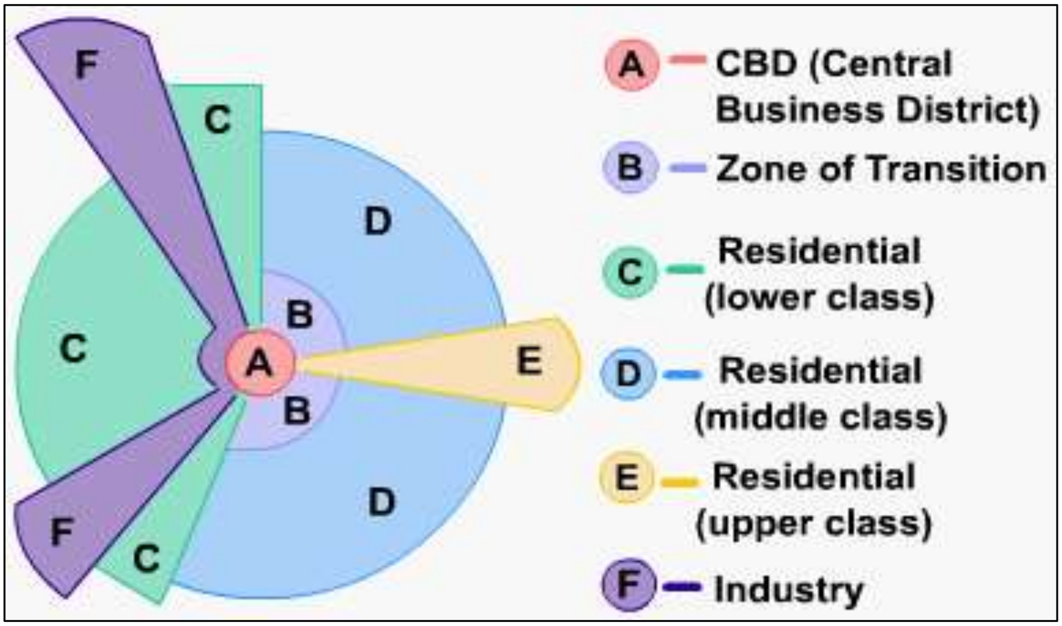
Source: https://www.google.com/ accessed in September 2015

Theoretically, Burgess' systematic model is understood in different dimensions using different terms depending on the researcher's position. While this is a straightforward and elegant model, it has attracted criticism. It is applicable only to the historical and cultural urban context prevailing up until the 1950s. The design revolutionized the growth of cities in America in demographic terms and encouraged motorization. It is also difficult to apply in most 20^{th} and 21^{st} century cities in developing countries as it was designed for American cities. Moreover, pre-industrial cities in Europe did not have a concentric design; the center was much larger than the periphery due to its social and economic status. Consequently, Burgess' concentric model is partially inverted. There are many spatial differences in terms of social and occupational status, as well as functional differences in land use patterns. Thus, the concentric model assumed the spatial separation of place of work and residence in the 20^{th} century.

3.2.5: Sector model

Economist Homer Hoyt's model of urban land usage modified the concentric zone model of city development postulated by Burgess. Hoyt claimed that a town springs up in a series of sectors, not circles. Within each of these areas are different activities, which are determined by environmental factors. Figure 17 presents a diagrammatical representation of the Hoyt Model (Angel et al., 2011, Silva, 2013).

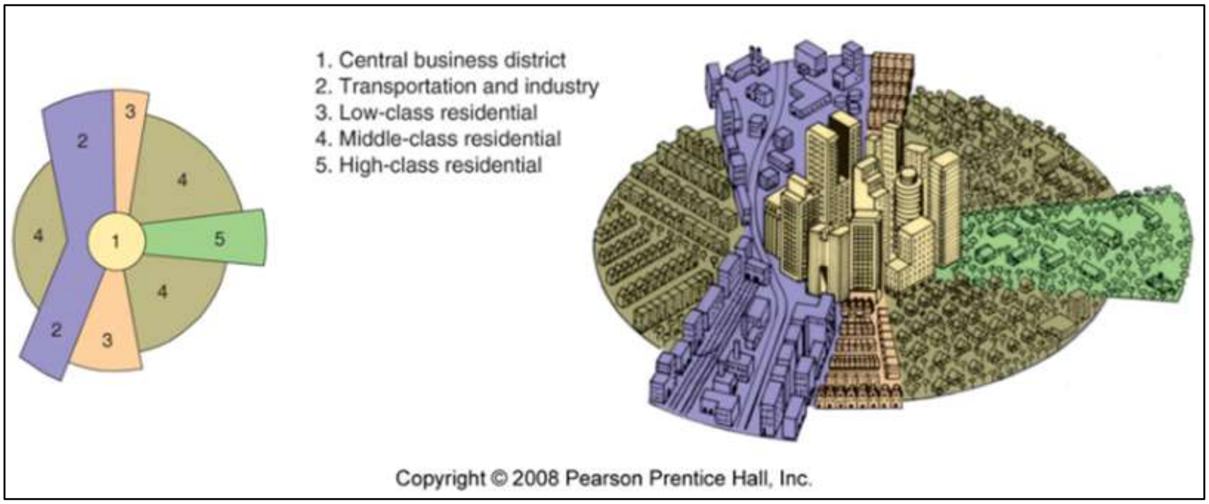
Figure 17: Hoyt Model



Source: https://www.google.com/

As illustrated in Figure 18 below, the Hoyt Sector Model is subdivided into five main categories: the CBD, high-income residential, middle-income residential, low-income residential, and transportation and industry. Hoyt believed that cities develop around several critical transportation facilities, such as railroad lines and harbors. As different sectors grow, these activities extend outwards. The advantages of this model include outward growth. While accepting the existence of a CBD, Hoyt suggested that there was a very high likelihood of various socioeconomic groups expanding outwards from the city center along railroads, highways, and other transportation arteries. The modern Hoyt Sector Model is presented in Figure 18.

Figure 18: Modern Hoyt Model



Source: https://www.google.com/ accessed in September 2015

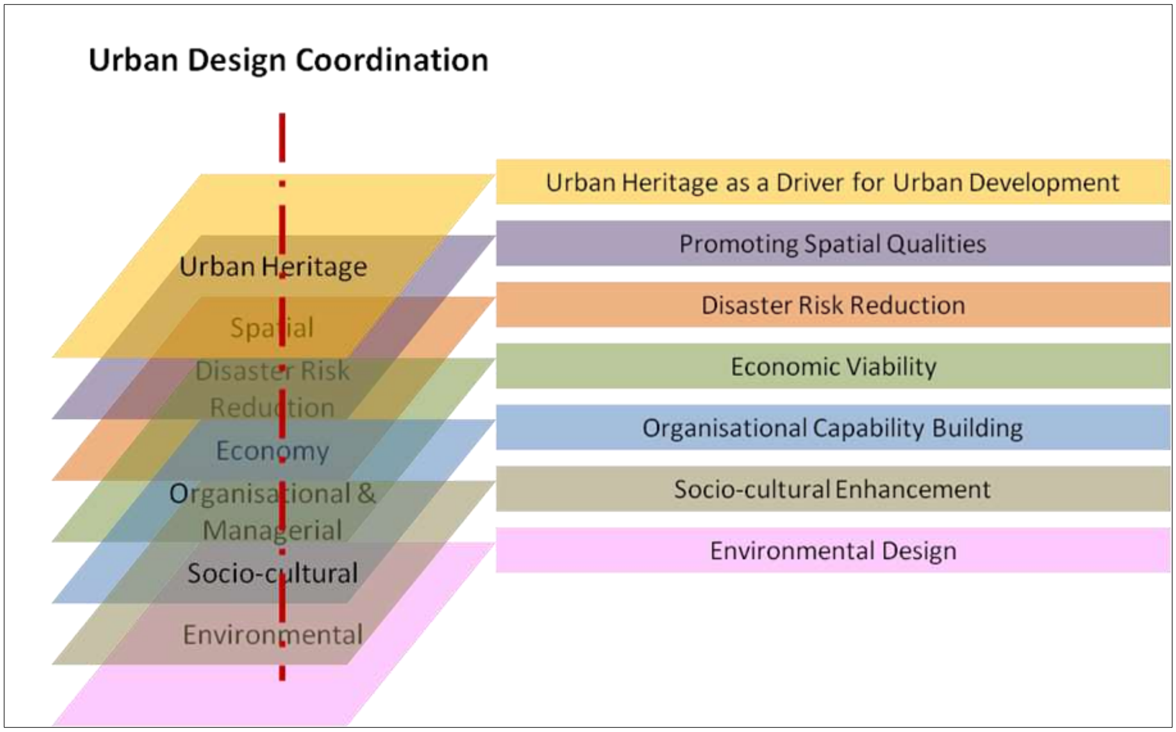
Urban households receive utility from land; Hoyt observed that it was common for low-income families to be near railway lines, and commercial establishments. His model considers the evolution of public transport and suggests that urban areas grow in sectors alongside primary transportation routes into and out of a city. Improved access results in higher land values.
Therefore, many commercial functions remain in the CBD, but manufacturing services would be concentrated in a wedge surrounding transportation routes. Residential services would grow in wedge-shaped designs with a low-income housing area bordering the manufacturing/industrial sectors (traffic, congestion and pollution make these areas the least desirable) while middle- and high-income families live furthest from these areas.

Hoyt's model states a principle of urban governance. Despite the importance of this design in contemporary urban planning, it has some disadvantages. The hypothesis is based on 19th century transport and does not allow for private cars that enable commuting from cheaper land outside the city limits. Physical features may limit or direct development along certain wedges. Nevertheless, the model remains a useful conceptual tool to explain concentric urban development and was a means of solving complex land use system and activities in American cities in the early-mid 20th century. (Nakoinz, 2012, Collarte, 2012, Srinivasan, 2000, Sisman, 2013)

3.2.6: Designing public spaces for pedestrian concept

Overall the essence of these conceptual framework is to practically, unleashing the full potential of public spaces or any commercial districts in cities depend solely on making a place pedestrian friendly. This human scaled approach to urban design invites a mix of different activities and has many diverse edges. Public spaces for pedestrian do not have to be large. In developed countries often opt for a singular, public space in cities exclusively design for pedestrian use. Cities do well through activating public spaces meandering for pedestrian design. Typically, this pedestaling urban design involves coordination. The urban design Coordination revolves around spatial planning, risk reduction, economy managerial coordination, socio-economic and environmental coordination. Improving pedestrian safety coordination implies that environmental areas are enhanced to make it aesthetically safe and easy to walk. Pedestrian activity is encouraged for all people. Figure 19 provides snapshot of example of urban design coordination for pedestrian space. This diagram provides a better understand of the extensive network of city efforts toward providing pedestrian friendly environment, the contextual elements of a successful urban safety and strategic urban design frameworks and spatial planning.

Figure 19:Pedestrian urban design coordination



Source: http://civitasphoenix.com/urban-design/

The purpose of the save spaces on roadways is to increase walking by calling for improved access to safe and convenient places to walk and creating a culture that supports these activities for people of all ages and abilities. Design and land use are critical components to increasing walkability but leaves it up to all of us to define what walkability means at home. Working in the delightfully walkable neighborhoods in and around Lagos Island CBD acknowledges three basic elements that create a walkable neighborhood: it must be entertaining, safety, and provide meaningful destinations. The overarching factor that makes these spaces so people-friendly is that they are comfortable, thus tend to inspire pedestrian to stay on their own volition. Perhaps, it essential to point out that commercial Streets have full potential of good pedestrian path by naturally attracting organized commerce activities instead of the loud noises and little space that cities mistakenly sacrificed for the sake of moving cars. Putting too much cars of public spaces will alienate people with grand or gargantuan, the resultant effects will be unpractical gestures. The figure 20 explains how individual cities can unleashing the full potential of public spaces. For example, the inner ring represents a place's key attributes, the middle ring its intangible qualities, and the outer ring its measurable data all these attributes ensure pedestrians are safe on the road.

Figure 20: What makes a great place

(Source: http://www.pps.org/reference/what_is_placemaking/) accessed in September 2017

3.3: Theoretical background

A sound conceptual framework gives research a strong scientific basis. The role of the theoretical framework is to identify the research problem and to frame a vision for a study. It shapes and specifies the focus and goal of the research problem.

3.3.1: Pedestrian level of service (PLOS)

Gokhale and Telang (2013) provided historical background on 'Pedestrian Level of Service Standards' (PLOS) in their research paper on existing sidewalks on roads in Indian cities. They note that, the origins of pedestrian assessment methods date back to this concept that was first introduced by John Fruin (1971). PLOS is an observation tool focusing on 'Sidewalk Capacity'. Kari Lautso and Pentti Murole (1974) used it to determine the influence of environmental factors on pedestrian facilities. Their ideas were incorporated in the US Highway Capacity Manual (HCM) in 1985 to quantify sidewalk capacity.

Walkability enhances comfort, convenience, safety, security, and attractiveness. In 1993, Sarkar proposed methods of computing PLOS based on six factors, safety, security, convenience and comfort, continuity, system coherence, and attractiveness. This theoretical approach is still used in many investigative studies. Interestingly, PLOS techniques are reversing the primary non-invasive methods used to determine pedestrian safety on roadways (Muraleetharan et al., 2005, HCM, 1965, HCM, 1985, Fapohunda, 1985, Transportation Research Board (TRB), 1994, HCM, 1992, Heinen, 2011, Rouphail et al., 1971, Transportation Research Board (TRB), 2000, Washington State Department of Transportation et al., 1997, Petritsch et al., 2006). There has been considerable debate on the PLOS approach and uncertainty remains as to its proactive and personal nature. While recent transportation engineering and urban planning studies acknowledge that it is important not to overemphasize or underestimate the strengths of PLOS in solving pedestrian accidents on roadways, the theoretical evidence on PLOS is compelling.

In transportation engineering and urban planning, PLOS describes current travel operations and offers a consistent, systematic evaluation of current conditions. It also presents the results in language that can be easily understood by transportation professionals and the public. PLOS provides an objective way to identify needs and prioritize improvements. It also offers a way to evaluate different growth types and cross sections. Estimation of PLOS is the most common approach to assess the quality of pedestrian facilities' operations. It is commonly used to measure the quality of services for vehicular capacity studies but is now being used for pedestrian facilities. In calculating PLOS, the vehicle is technically the same as pedestrians. Vehicular Level of Service (VLOS) is used to assess speed, travel time, and intersection delay. This general application has now been incorporated into pedestrian traffic. However, calculation of PLOS is more complex and represents the performance status of the pedestrian facility and level of comfort pedestrians experience in utilizing these services. This study argues that PLOS is one the best approaches to solve pedestrian problems. It aims to shed new light on these debates through an examination of PLOS and its application to resolve complex pedestrian safety issues. Historically, PLOS was used to determine the level of pedestrian comfort based on the degree of crowding on the street. It is a theoretical and classical model that was initially developed by Fruin in 1971 and further developed by Pushkarev & Zupan (1975) to explain urban spaces. At a later stage, it was developed into a policy document by the Transportation Research Board (TRB) in the US.

What is known today as the Highway Capacity Manual (HCM) was put together by the TRB in 1985 and metamorphosed into a standard engineering manual in 1992, 1994, 1995; and 2000. While there are a variety of definitions of the term PLOS, this study adopts that suggested by the HCM (1992, 1994, 1995; 2000) that expresses it using a simple scientific illustration. The HCM PLOS concepts are all point of service analysis of pedestrian flow on sidewalks, crosswalks, and street corners. They measure the pedestrian flow rate and sidewalk space. The HCM investigates the differential impact of conventional and non-formal PLOS in solving pedestrian transportation issues (1992, 1994, 1995; 2000, 2005). PLOS is described using scientific illustrations; as volume and density increase, pedestrian speed declines. In 2005 a new HCM was produced to explain that as density increases and pedestrian space decreases, the degree of travel of the individual pedestrian declines with the average speed of the pedestrian stream. The HCM uses the PLOS theory as a qualitative and technical approach to describe the operations and conditions of vehicular and pedestrian traffic using service measures such as speed of travel time, freedom to maneuver, comfort, and convenience. It thus involves the scientific measurement of pedestrian flow rate and available sidewalk space.

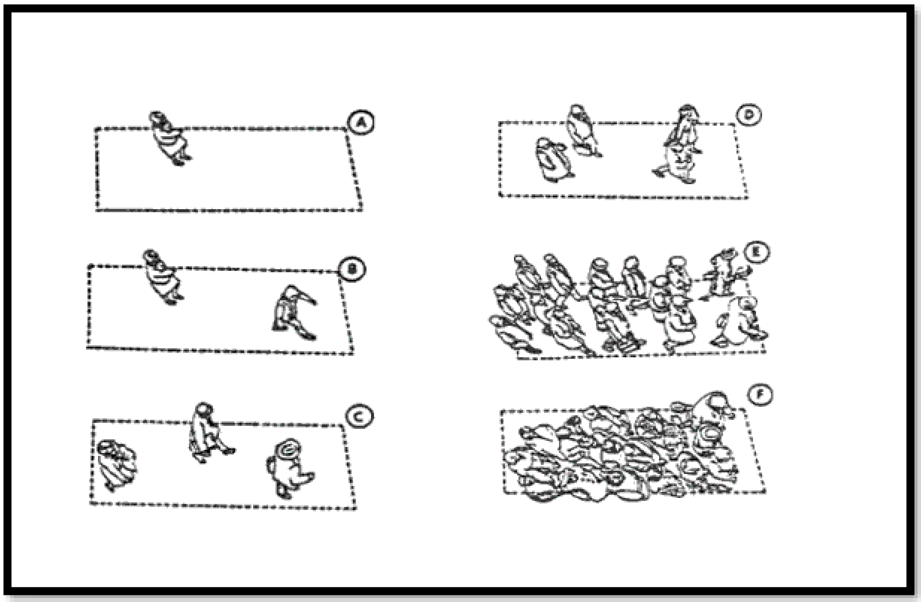
The pedestrian flow rate, which incorporates pedestrian speed, density, and volume, is equivalent to vehicular flow. At the sidewalk level, the midblock calculation of pedestrians per minute per foot (pedestrian /min/ft) is used as the basis for PLOS classification. MIT Press and Cambridge established six different services levels based on speed, flow rate, space available per pedestrian, and ability to maneuver without conflict and changes in walking speed. They agreed with the HCM on the official score. The rationale of the PLOS score is to provide a way of measuring the safety level and comfort of pedestrians walking along a roadway. It enables road and traffic values to be entered a model that provides a numerical PLOS. The numerical score translates into a pseudo-academic letter grade scaled from A to F using the stratification shown in Table 18 and Figure 21 below. Per the sensitivity of PLOS analysis, an average PLOS on a statistically calibrated scale ranges from A- (high) to F- (weak)

Table 18: Recommended pedestrian Level of Service (PLOS) thresholds.

PLOS designation	**Space**		**Flow Rate**		**Average Speed**		**v/c ratio**
	(m2/ped)	(ft2/ped)	(ped/min/m)	(ped/min/ft)	(m/s)	(ft/min)	
A	≥ 5.6	≥ 60	≤ 16	≤ 5	≥ 1.3	≥ 255	0.21
B	3.7–5.6	40–60	16–23	7–May	1.27–1.30	250–255	0.21–0.31
C	2.2–3.7	24–40	23–33	10–Jul	1.22–1.27	240–250	0.31–0.44
D	1.4–2.2	15–24	33–49	15–Oct	1.14–1.22	225–240	0.44–0.65
E	0.75–1.4	15–Aug	49–75	15–23	0.75–1.14	150–225	0.65–1.0
F	≤ 0.75	≤ 8	var.	var.	≤ 0.75	≤ 150	var

source: TRB, 1994; adapted from FRUIN, 1971

Figure 21: Graphical representation of recommended Pedestrian Level of Service (PLOS) thresholds.



Source: adapted from (Transportation Research Board (TRB), 1994); adapted from (Fruin, 1971, Nagui M. Rouphail et al., 1998, Rouphail et al., 1998, HCM, 1994)

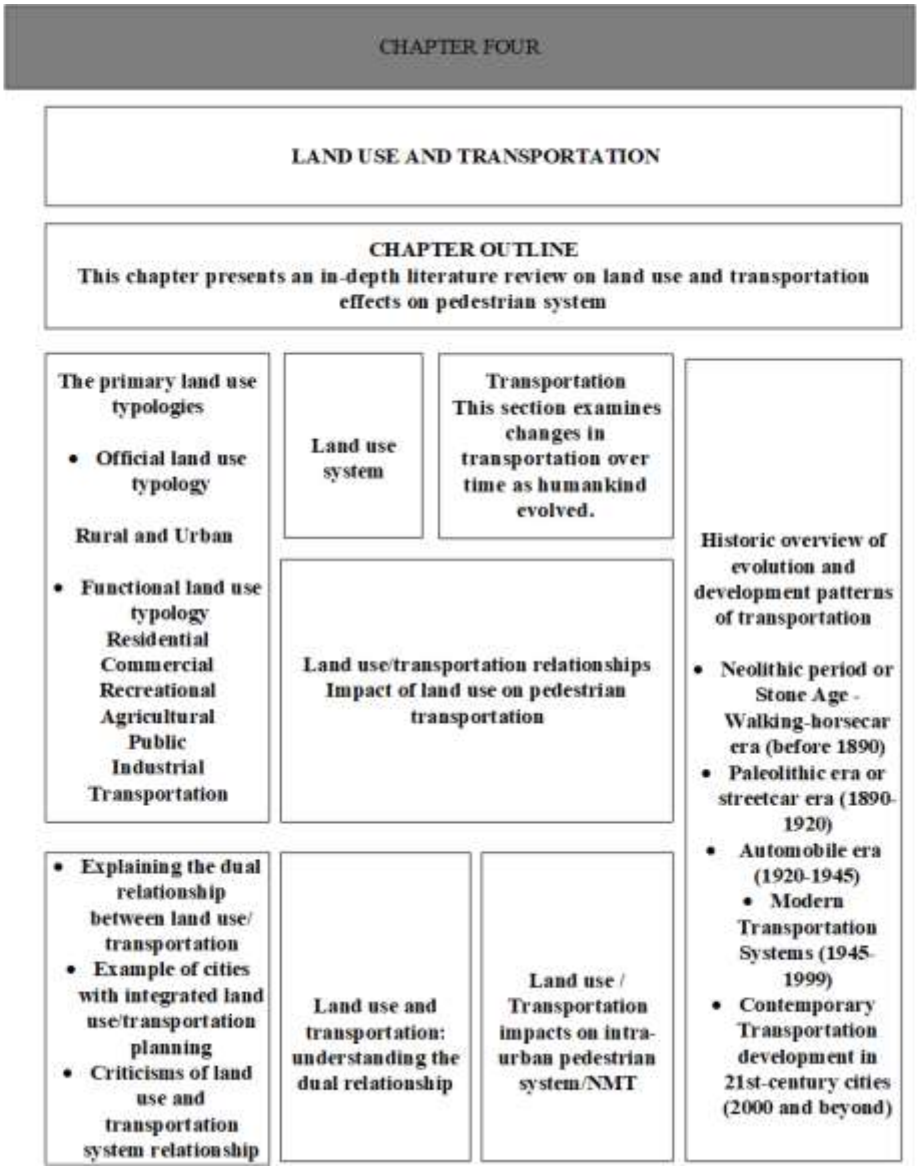
3.4: The Chapter Summary

This chapter presents the key concepts and theories that drive the study. A fair mix of concepts and theories are discussed in this Chapter with a focus on spatial development and transport planning. The conceptual and theoretical framework of the study is relatively clearly articulated in this chapter. More specifically, the Ecosystem concept, Walkability concept, Sustainable transportation, and Dynamic models of urban form

4. CHAPTER FOUR: LAND USE AND TRANSPORTATION

4.1: Chapter outline

Figure 22: Chapter four outline



Source: Author's construction (2016) ©

This chapter presents an in-depth relevant literature review. The figure 22 below provides this chapter outline. It is divided into seven sections, which move from the general to the specific. It begins by discussing an examination of land use system, followed by transportation system and the role of land use and transportation in improving and promoting pedestrian safety. It further examines global road traffic injuries and preventability, explain share of Africa regional traffic injuries, and precedent studies of intra-urban pedestrian safety. The overall aim is to build a case for improving the pedestrian system and pedestrian safety.

4.2: Land use system

Explanations and definitions of property vary in the literature per the context and the views of different individuals. Many scholars have proposed definitions of land (Suzuki et al., 2013, Jonsson, 2008, Jalasto et al., 2008, Gresch and Smith, 1985, Alessa et al., 2008, Frank and Engelke, 2002, Transportation and Growth Management (TGM), 2003, Chapin, 1963, Platt, 2004, Muller, 1995, Wegener and Fürst, 1999, Litman et al., 2014, Kaiser and Godschalk, 1995, Munbi, 1968, Tseu, 2006), as have international bodies. According to the widely accepted definition proposed by the (United Nations (UN), 1994), land is a delineable area of the earth's physical surface which typically encompassing all attributes of the biosphere immediately above or below this surface. Conversely, land includes the near-surface climate, soils, terrain forms, and the surface hydrology. In more general terms, it encompasses shallow lakes, rivers, marshes, and swamps, near-surface sedimentary layers and associated groundwater reserves, and plant and animal populations (United Nations (UN), 1994, European Union EU, 2013, European Union (EU), 2013, European Union (EU), 2011, Silva, 2011). Hamerlinck et al. (2013) note that characterizing land-use patterns across space and time can be challenging. From a broader perspective, these challenges are due to dynamic changes in definitions of land-use categories (for instance, urban versus rural), methods of measurement (for example, census versus mapping), and a lack of information on land quality or suitability (for example, prime versus nonprime cropland). Thus, there is no consensus on the definition and characterization of the term land use. For the purpose of this research, the characterization offered by the (FAO/UNEP, 1997, FAO/UNEP, 1999, Hamerlinck et al., 2013, Kaiser and Godschalk, 1995, Kaiser et al., 1995, Mathew, 2012, Lerman et al., 1978); European Union (2013); Fisher, Comber, & Wardsworth (2005); IPCC (2000); and Platt (2004) is adopted.

These international bodies and scholars note that, land use is characterized by the arrangements, activities, and human inputs to a certain land type to produce, change or maintain it. Land use also refers to the action taking place on a specific piece of property or aggregation of resources. In other words, land use is the observed physical and biological cover of the earth's land, as vegetation or human-made features. Land-use typically represents the development of space to accommodate a variety of human activities. Bruton's (1970) longitudinal study on transportation found that land use is a convenient way of classifying and measuring trip generation. Citing the examples of the UK and US and most developed countries, Bruton contends that land use indexes predict future travel trends. He noted that, these patterns are readily measurable and have a reasonable degree of accuracy. The author adds that that judicious use of land for different purposes is crucial for economic, social and environmental sustainability. Thus, land use is very germane in addressing contemporary planning issues.

4.2.1: The primary land use typologies

Land use categorization is an integrated means of synthesizing and identifying various comparative activities and achieving environmental sustainability and orderliness. The more we understand the typology of land and its uses in a natural environment, the better the planning result. Careful consideration of land use typology is thus a comprehensive planning approach to achieve efficient integrated planning (Tugbobo, 2004). Land use typologies are determined and influenced by a combination of fundamental drivers at international, national, regional, state and local levels. In other words, land use typologies reveal prevalent activity and pathways that are relevant to the identification of potential and challenges (Alessa et al., 2008; European Union, 2013; Gresch & Smith, 1985; Silva, 2011). Many urban and transportation planners (Black, 1968; European Union, 2013; Fisher et al., 2005; Fujita, 1984; Garrison, 2003; Kaiser & Godschalk, 1995; Kaiser et al., 1995; Rodrigues, 2013. Seattle Planning Department, 1993) have sought to identify land use typologies. In general, they fall under two categories, formal and functional (Huang, 2003; Pandya & Katti, 2012).

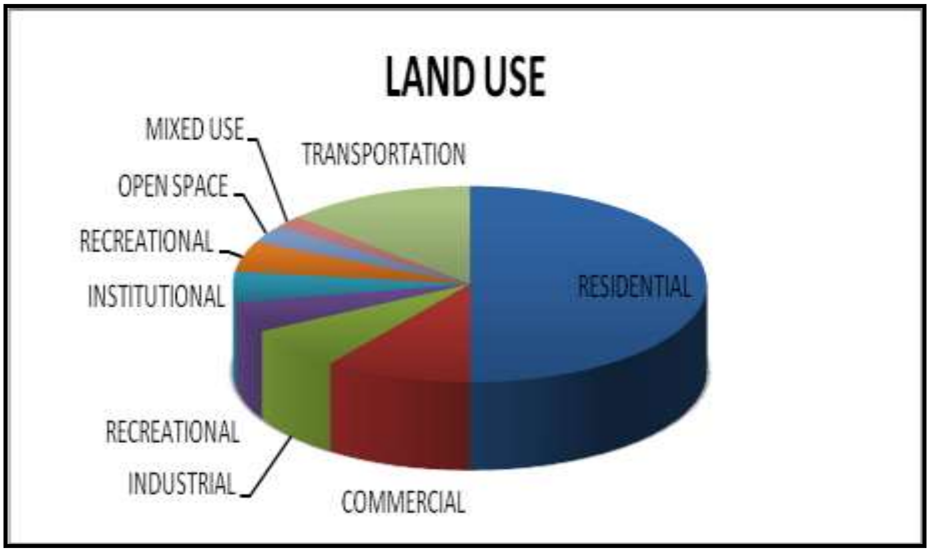
Official land use typology

Acharya et al. (2013) and Rodrigues (2013) focus on distinctive land use patterns and dimensions based on a geographical space and level of spatial intensity. In other words, regular land use refers to the qualitative attributes of space. It is primarily concerned with the qualitative attributes of space such as its form, pattern and geographical aspects and is descriptive in nature; this kind of land use typology explains natural geographic regions (urban and rural land uses). These types of land use typology reveal important interrelationships between human activities and the environment. Geographical studies show that formal land use covers different geographical spaces and involves both urban and rural land uses. However, in the modern world, urban land use can be sub-divided into two major elements, namely; the nature of land use, which relates to activities taking place, and the level of spatial accumulation, which indicates their intensity and concentration. Most urban planning experts note that, the intensity of different activities produces different characteristics. For instance, an acre of residential at high density would produce more movement of people than one acre of land developed for residential purposes at low density. On the other hand, the low-density residential area occupied by fewer and probably more expensive dwellings could well produce more private motor vehicle trips than the high-density residential area. These imprints enable a more detailed typology of land use structure in both rural and urban areas (Clay, 2014; European Union (EU), 2013; Hamerlinck et al., 2013; Jaffe, 2014; Litman et al., 2014; Mills, 2013; Victoria Transport Policy Institute, 2014a, 2014b).

Functional land use typology

While formal land uses are geographically-based, the functional land use typology is activity-based. In this case, the nature of activities on the land determines the method (Acharya et al., 2013; Litman et al., 2014; Rodrigues, 2013; UK Essays, 2013). This land use representation is concerned with the level of spatial accumulation of economic activities such as businesses, production, consumption, residence, and transport, and is mainly a socioeconomic description of events that have taken place in a space(Carlson and King, 1998, Bland, 1982). Land use operates at the scale of parcels of buildings and is often viewed in terms of types of activity. There are nine typical activity-based examples of land use, namely, commercial and industrial development; agricultural; residential; recreational; open spaces; mixed-use; transportation and utilities; public use, parks and recreation; and areas in transition (i.e., vacant). While the distribution of these activities varies per community, their typical distribution pattern in any settlement is shown in Figure 23.

Figure 23: Land use of a typical urban area



Source: Author's construction (2016) ©

In most cases, the distribution of these land uses follows the same pattern worldwide (Aderamo, 2012; Lynch, 2011a; Niedermeyer, 2011; Pandya & Katti, 2012; Silva, 2011; UNDESA, 2011). Hamerlinck et al.'s (2013) breakdown of the components of the definition of this land use activity is shown in Table 19. It indicates land use designations that are typically found in a geographical area.

Table 19: Typical activity-based land-use classifications

Land use	**Definition**
Agricultural use	Land use area for the development of plants, animals for food production
Residential	Areas where people live
Commercial	Land use area primarily for commercial development
Industrial	Land use areas for plant and manufacturing purposes
Mixed-Use	Combined residential and other land uses
Transportation	Sectors such as road, rail, and utility corridors and power plants
Recreation	Areas providing open space and recreational opportunities

Sources: Adapted (Hamerlinck et al., 2013) (Carlson and King, 1998, Ben-Joseph, undated)

4.3: Transportation system

Transportation simply refers to the movement of people, goods, and services from the point of origin to a destination. It is the act of conveying someone or something. Transportation systems are crucial to socioeconomic growth, and political and cultural development. The more contemporary literature (Acharya, Parumog-Persia, & Morici, 2013; Adamo, 2012; Dick & Rimmer, 2003; European Union, 2013; Jaffe, 2014; Jalasto, Kosonen, Moilanen, & Sihto, 2008; agrees that nothing would function within cities without transportation. There is barely a single human settlement that can relate harmoniously and efficiently without an adequate, dependable, reliable and affordable transit system. Transport is a central element in shaping most settlement patterns as it allows for easy mobility of people and goods. International non-profit organizations like UNDESA (2011); UN-Habitat, the United Nations Human Settlements Program (2014b) and others acknowledge that transportation is instrumental to a sustainable environment. Strings (2005) observes, that, this is based on maximization efficacies and effects on the environment at large. Strings (2005) cited in (Atubi, 2013) adds that a comprehensive transportation system is one of the safest ways of safeguarding the mobility of individuals and commodities.

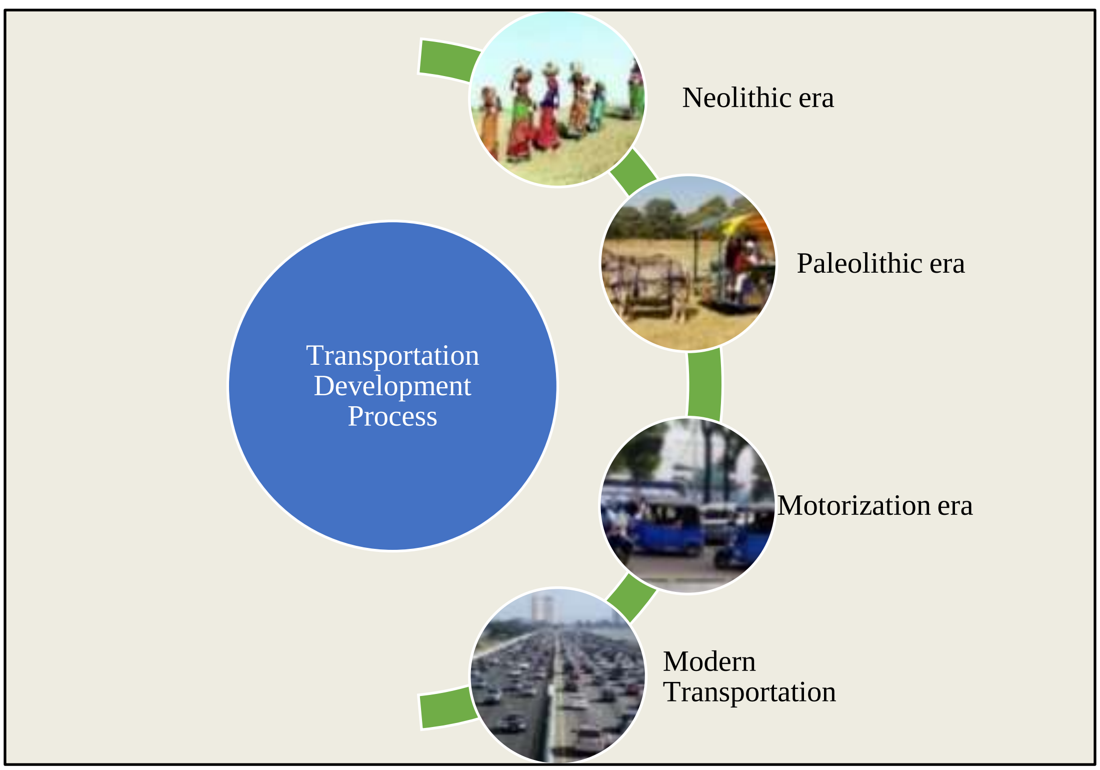
Urban planners and other built environment professionals are often called on to account for and explain the evolution of the transportation system or its basic operation (the morphological transportation process) (Hall, 1985; Hamerlinck, Lieske, & Gribb, 2013; Diameter (Diameter & Banjo, 1990). Symmetrical indices (time series characterization or generic evolution development patterns) are commonly used to explain this process. Commentators such as Black (1968); Bland (1982); Damian & Barbara (2000); Dunn (1978); Chapin (1963); Garrison (2003); Mills (2013); and TCRP (1997) are of the view that, transportation evolved as a result of traditional spatial attributes or symmetrical indices. Merriam-Webster and Wikipedia (2016?) state that symmetries are a biological science approach that represents certain natural philosophy properties or laws. The natural transformation process plays a key role in the development of physical phenomena. Fundamental theoretical assumptions and strategies are used to produce a sense of historical antecedents.

4.3.1: Historical overview of evolution and development patterns of transportation

Symmetrical indices imply using this biological approach to explain transportation development or the morphological transportation process. Using proportional indices, it postulates that a transportation system evolves over an extended period and subsequently undergoes some transformation (Pacheco-Raguz, 2009, Pacheco-Raguz, 2010, Pandya and Katti, 2012, Stopher and

Meyburg, 1975, Storchmann, 2005, Susskind and Elliott, 1983, Taiyab, 2008, Trans, 2005, UK Essays, 2013, Vance, 1990, Rosen, 2006, Roess et al., 2011, Roess et al., 2010). Furthermore, this evolution goes together with the development of humanity. Like human development, transportation experiences trials, transformation, tribulations and growth that span different time periods. Thus, the history of humanity would be incomplete without connecting it to the morphological transportation process (Suzuki et al., 2013, Christiansen, 2013). This is an overall development pattern that reveals the natural human growth process. Maturation includes four eras, the Neolithic, Paleolithic, Pre-classical and Classical periods. Overall, development patterns facilitate, accelerate, shape and determine transport patterns across the world. Tracing the transformation of transportation from pedestrianism to the current auto-dominated system is not possible without understanding this interrelated history (Bruton, 1970, Fujita, 1984, Meyer and E J Miller, 1984, Hall, 1985, John and Pharaoh, 1989). The Figure 24 provides the graphical representation of transportation evolution.

Figure 24: The evolution of transportation



Source: Author's construction (2016) ©

Neolithic period or Stone Age -Walking-horsecar era (before 1890)

Before the advent of the automobile, people traveled much shorter distances by walking from the point of origin to a destination. Garrison (2003); Joseph (2002); Litman (2002) and Rodrigues et al. (2006) concur that the transportation revolution transpired from simple walking to the sophisticated automobile. The first ancient transportation system was on human foot to transact business or socialize. Acharya et al. (2013); the European Union (2013); George (2013); and Suzuki, Cervero, & Iuchi (2013) note, that, from antiquity to date, people, goods, and services have always been transported from one place to another by walking. Indeed, researchers have found some correlation between walkability and the evolution of human settlements, especially during the Stone Age. Roadways were thus an integral part of even the earliest civilization. Advancements in road-building led to route networks to support walkability during this era.

During this epoch, settlement densities were not high, providing ample space for pedestrians. Many pedestrian streets were developed throughout the world. Most of the early settlements, especially in traditional cities in Greece and Rome, developed around farmland, rivers and natural harbors. In 332BC, the Greeks improved the grid network system exclusively for pedestrians, while the Romans elevated the science of pedestrian street design to shape what we today recognize as a pedestrianized system. Between 450BC and 600BC, Greek planner Hippodamus, who is considered the father of Greek town planning, built more straight and parallel streets for pedestrians and wagons. Other unique pedestrian cities emerged in the Minoan, Mesopotamian, Harappa and Egyptian civilizations of the early millennium (Dick & Rimmer, 2003; Drennen, 2003; Garrison, 2003; Grava, 2003; Huang, 2003; Platt, 2004; Pucher & Dijkstra, 2003b; Steg, 2004; TGM, 2003). Mazaza (2002) notes, that, traditional Romans cities elevated pedestrian sidewalks using stones and built on both sides of the street. The tracks occupied as much as half of a road's width and provided a safe, dry area for pedestrian traffic in Rome. He notes that, ancient cities were formed around virgin land with potential for transportation, embracing the walking city concept. Jackson (1985), cited in (Handy et al., 2003) confirms that the first pedestrian street design standard was established in 100BC. It set a road width of 15 feet, which could accommodate at least 20 pedestrians, the equivalent of two passing cars. Rodrigues (2013) notes, that from the 17^{th} century to date, European communities have benefited from a unique transportation structure which reflects the Roman and Greek cultures. He adds that, in Renaissance and Enlightenment

Europe many cities retained their transit-oriented form and to this day some city centers are shaped by the same roadways. Many European and American cities are characterized by walkability. Research on the Neolithic era in Africa and Asia reveals a similar scenario.

During the pre-colonial era, travel was purely on foot, with inhabitants covering around four to six kilometers in less than 45 minutes. In indigenous cities like Lagos, Ibadan, Accra and Kumasi (Africa), and Shanghai and Tokyo (Asia), walking was a common way of reaching the town center. At this time, activities were located in a central node alongside residential area, promoting pedestrianization. However, as the global population grew, and social and economic activities expanded, transportation also evolved.

Paleolithic era or streetcar era (1890-1920)

During the Paleolithic era, transport infrastructure consisted primarily of tracks for pedestrian and animal traffic, and navigable waterways. Between 2,000 and 4,000 BC, pedestrianized shopping streets and arcades emerged, and pathways and footbridges were built to accommodate chariots, camels, donkeys, and horses. This gave rise to waterway transportation (Buehler & Puche, 2011; Buehler, Pucher, & Kunert, 2009; Garrison, 2003; Jain, 2007; Jean-Paul Rodrigues, Comtois, & Slack, 2006; Lynott, 2010; Rodrigues, 2013; Rodrigues et al., 2006; UK Essays, 2013). This period witnessed the first phases of urban transit to improve accessibility. Emerging cities expanded along the main tramway (streetcar) lines, and transit corridors were constructed. Wikipedia notes, that, the Paleolithic period coincided with what is known as the Pleistocene era of geological advancement, which lasted from 2.6 million years ago, to around 12,000 years ago, Electric trolley cars were introduced that tripled the speed of urban transport. There were also important geographic and climatic changes during this time that affected human societies, especially in terms of transport. Urban road traffic mainly comprised horse-drawn vehicles, passenger cars, and buses. This resulted in the emergence of a specialized downtown area to cater for commercial and service activities. In Europe, tramway lines typically expanded towards neighboring long-established towns, which were integrated into the expanding metropolis. Public activities thus extended beyond city boundaries.

Urban transport systems at this time made extensive use of electric energy. This promoted urban sprawl and specialized economic activities, resulting in a wider separation between work activities and place of residence. Rapid growth of the urban population and technological advances led to the first public urban transport schemes. Roman and other major cities across the world were transformed during the Paleolithic era. Roads that had deteriorated during the Neolithic period were restored, long distance travel ceased, public spaces shrank, and walls were built to protect cities (Rodrigues, 2013).

The Paleolithic or streetcar era in cities in Europe and North America is widely associated with tracked transport. Railways and trams provided a wider range of transport. This resulted in expanded cities. Suburbanization gathered pace and commuting became the norm (Mazaza, 2002). It was during this period that the French central government built the Royal roads system spanning 24,000 km, with a public transport system of stagecoaches to carry passengers and mail. With an increasing proportion of the population having access to trams, commercial centers were established along transit corridors. Many inhabitants relocated outside the city boundaries, reinforcing social stratification and promoting the emergence of neighborhoods differentiated by socioeconomic position. Those less fortunate that experienced restricted mobility tended to remain in the central areas while the wealthier class relocated to the former intercity. The tram system was developed in the main urban centers of Europe from the late 19th-century (Hall, 1985). In response to increasing demand, larger cities such as London (1890), Liverpool (1893), Budapest (1895), Paris (1900), Berlin (1902), Hamburg (1912), and Glasgow (1896) also introduced underground metropolitan subway and rail systems.

Mainly through private efforts, Britain built a 32,000-km system of turnpikes. Ground transport technologies, including track and road transport, have significantly influenced the Western urban structure since the Paleolithic or streetcar era. In Africa, this period marked the beginning of colonial government. By the time the first European explorers arrived in Africa in the 1400s, Africans had domesticated some animals to carry goods and services over land. The colonial authorities sought to penetrate the African hinterland to exploit the continent's resources and ship them to their home countries. Innovations such as rafts and canoes emerged to facilitate water transportation. This period also witnessed industrial development, technical advances, and transportation development that significantly affected the development of metropolises in Africa. Rail became the principal means of transferring goods and services and also enabled colonial armies to defend the colonies. It was cheaper and more convenient to transport freight and cumbersome or bulk goods by rail than by road. Furthermore, the cost of developing rail transportation facilities was far less than those for road traffic.

(Automobile era (1920-1945)

Rapid increases in population during this period prompted municipalities across the world to seek innovative transportation solutions (Wilbur Smith Associates, 2000, Landis et al., 2001, Mascio and Corazza, 2001, Montero et al., 2001). The legacy of walkability in the late Neolithic era collapsed with the emergence of automobile. Development patterns became more dispersed and local communities served by neighborhood schools and other services that were accessible on foot or by means of cycling were no longer viable. The automobile introduced new levels of mobility and accessibility, breaking down the time and distance barriers to travel. During the pre-classical period, jobs and other activities were removed from the city core, supported by patterns of dispersed, lower density settlement encouraged by convenient public transport options. There was constant demand for more economically, socially and environmentally viable and faster modes of travel. Trade and commerce expanded, accompanied by transport developments associated with the development of villages. Road development also accelerated during this era (National Technical University of Athens, 2001, Sheehan, 2001, Wittink, 2001a). After World War 1, automobiles, which at that time were for the exclusive usage of the military and elites, slowly became accessible to the public. Many cars used during the war were sold and buses were introduced to public transport. Thus, this era witnessed the emergence of modern urban transport in the West (Wittink, 2001b, Joseph, 2002).Industrial development enabled mass production of affordable automobiles. The Model Ford was mass-produced in the USA from 1912, while the Volkswagen Beetle introduced in 1938 was dubbed the people's car in Europe (Grava, 2003). The sharp increase in the number of automobiles, buses, and trucks from after the war until the 1930s- placed tremendous pressure on road networks. The United Kingdom introduced a road development fund in 1909 and imposed taxes on gasoline to enable local government agencies to expand and improve the road network. However, this scheme collapsed in 1937 due to the fact that the revenue from the tax exceeded expenditure and that the subsidies received by trucks and buses threatened the viability of the railroad system, which was a potent lobby group (Dunn, 1978).

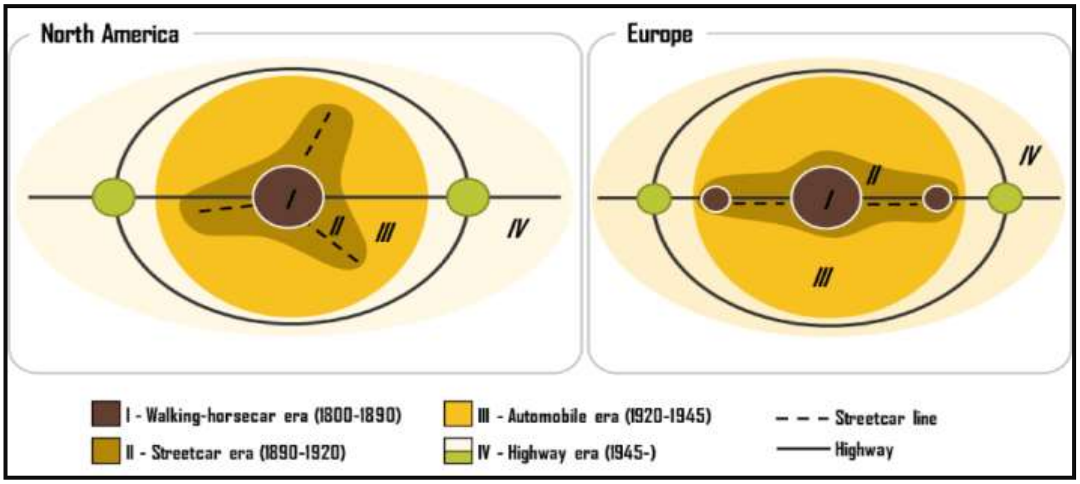
The 1920s witnessed the construction of the first all-weather transcontinental highway, the Lincoln Highway that spanned over 5,300 km between New York and San Francisco. Automobile development, mainly buses and cars, led to radical expansion of cities, with noticeable impacts on spatial patterns. Initially, only the wealthy could afford private vehicles. This enabled them to relocate to low-density suburban areas and resulted in increased ethnic and economic segregation. This was exacerbated by the decentralization of commercial and industrial activities. It was during this phase that European and North American urban development started to diverge. In 1938, General Motors and Standard Oil bought the Pacific Electric Railway of Los Angeles, disassembled it and replaced the trams with buses. Thus, while street cars became less important in urban development in North America, they remained influential in many European metropolises. This era also saw the consolidation of colonial rule across the world. The colonial rulers established major settlements in metropolises, which were the principal ports of main trading routes. Emerging cities across Asia and Africa followed this development trend. Since the colonial authorities sought to ease the movement of resources from regional areas to the cities, the primary thrust of infrastructure modernization in the late 19th and early 20th centuries were the growth of ports, harbors and interregional railways (Dick & Rimmer, 2003). The evidence suggests that some ancient empires and city-states in Africa had developed a system of well-aligned roads and streets, as opposed to meandering footpaths. Lagos and Kano states in Nigeria are pre-classical cities and Japan introduced a train service during this period. Excessive car usage has resulted in increased demand for travel over larger distances in Africa and Asia. The scattered nature of residential areas and human activities has made it difficult to offer a high-quality public transport service at reasonable cost.

Modern Transportation Systems (1945-1999)

Ongoing demand for increased mobility spurred further physical, social, economic, and political development and advances in transportation engineering. This epoch saw the emergence of a comprehensive urban transport system in response to developments in previous eras. Post-World War 11, cities across the world expanded further, prompting the need for all-weather urban roads and a more functional transport system. This period saw extensive development of the road network system, highways, and roads designed to meet the geographical and spatial needs of society.The era was also marked by increased automobile ownership and thus improved individual mobility. Most road design and highway development favored the extension of fully-fledged suburbs, particularly in America and Europe and in Africa and Asia. This involved higher densities on existing transportation corridors. Many important new urban transit technologies emerged during this epoch, and improvements in transport infrastructure significantly increased availability. Population, residential, and employment decentralization was accentuated. It ushered in the golden era of the railway transport system as rail networks expanded tremendously and became the dominant land transport mode for both passengers and cargo. The rail network was extended, and locomotives were able to travel at over 100 km/h. As the market expanded, rail services became more specialized with trains devoted to passengers or goods. Many nations particularly in Africa and Asia, were undergoing demographic transitions, with rapidly growing population and related urbanization and the extensive rail system enabled migration.

Underground metro systems were redesigned and reconstructed, with London being the first city to introduce such a system. In addition to locomotive development, various types of automobile propulsion systems were designed. The early 1800s until the beginning of the 20^{th} century, were marked by mobility through self-propelled vehicles. The mix of early automobile and slower transport modes caused conflict on the roads, resulting in the use of signaling systems and horns that are environmentally unsustainable. Faster automobile models resulted in significant modifications to the urban transport system and city growth. In the final 50 years of this epoch, there was a dramatic increase in automobile ownership, with concomitant effects on daily activities and land usage. Finally, sub-centers emerged to serve suburban areas with transportation connecting and linking different areas; this process favors the construction of ring roads around metropolitan regions. Figure 25 illustrates the historical process of transit development in America and Europe.

Figure 25: Historical process of transit development in America and Europe



Source: adapted from (Muller, 1995a)

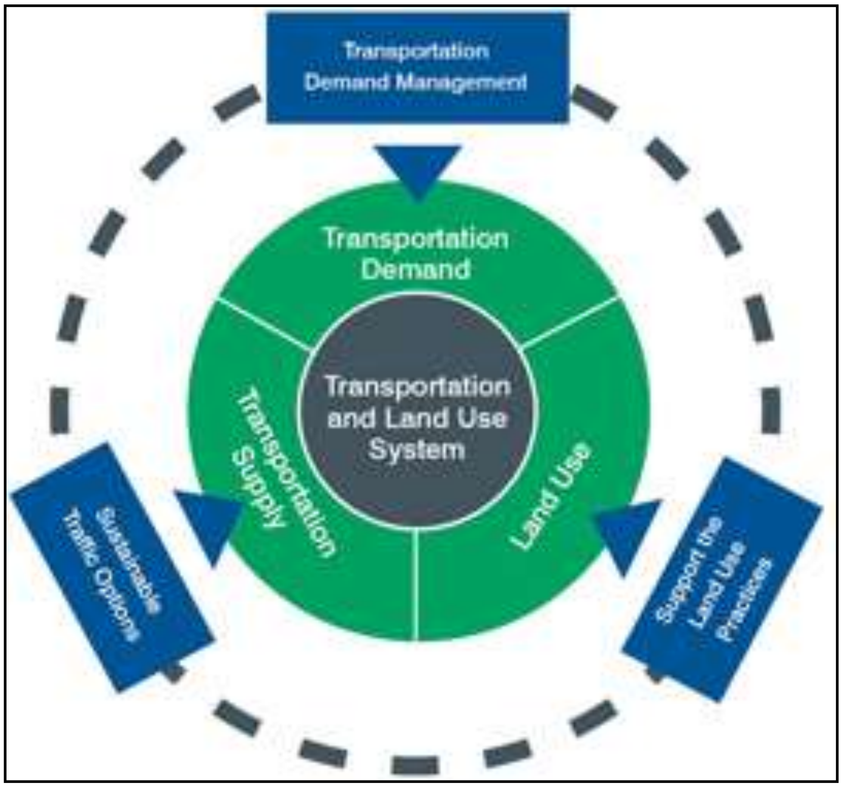
Contemporary Transportation development in 21st century cities (2000 and beyond)

Niedermeyer (2011); Rees (2010); and Smith et al. (2010) describe the comprehensive contemporary transportation system. This comprises of three primary modes, otherwise known as travel modes: land (road, rail, and pipelines), and air and water. Each mode has different sub-systems and unique features. Transportation determines the viability of most cities throughout the world. More than 50% of the global population now lives in towns and it is projected that this will rise to three-quarters in 2050. Growth is concentrated in the cities of the developing world. Urbanization in the advanced and developing countries creates several challenges, one of which is transportation and related energy consumption. Transportation accounts for between 70% and 80% of global energy consumption and 20% of green gas emissions. Transportation-related emissions are growing faster than those in any other sector. As vehicle volumes and congestion increase in intra-urban systems, pedestrians are less and less able to walk safely on roadways, particularly in rapidly motorizing developing countries of Asia and Africa. Intra-urban pedestrian safety is attracting increased interest as it is recognized that ensuring livable communities through walkability is the key to urban sustainability. However, the traditional pedestrian system is under threat due to the dominance of private vehicular transportation. While cities in developed countries have made efforts to promote access, safety and an enjoyable pedestrian experience, developing countries that were traditionally pedestrian societies are over-dependent on private vehicular transportation.

4.4: Land use and transportation: understanding the dual relationship

The literature (Meyer & Miller, 1984; Morris, 1979; Putman, 1975; Lerman, Datum, Lam, & Young, 1978; Srinivasan, 2000a) notes the mutual and the intimate relationship between land use and transportation and that this been an enduring theme in city planning, transportation engineering, and urban sociology. Figure 26 provides an overview of Land use/transportation relationship.

Figure 26: Transportation and land use relationship



Source: Eco Mobility Application Guide, Transport Canada, 2008

4.4.1: Explaining the dual relationship between land use/transportation

The relationship between land and transportation growth is an enduring topic in contemporary urban planning. Recent studies show that they are mutually dependent (Bland, 1982; ECMA, 1996; Giuliano, 1995; Hall, 1985; Kaiser & Godschalk, 1995; Kaiser et al., 1995; Mackett, 1985; Muller, 1985, 1995a; B. Robert & Rapkin, 1954; Lerman et al., 1978) Table 20 below provides more detail on the connection between land use and transportation.

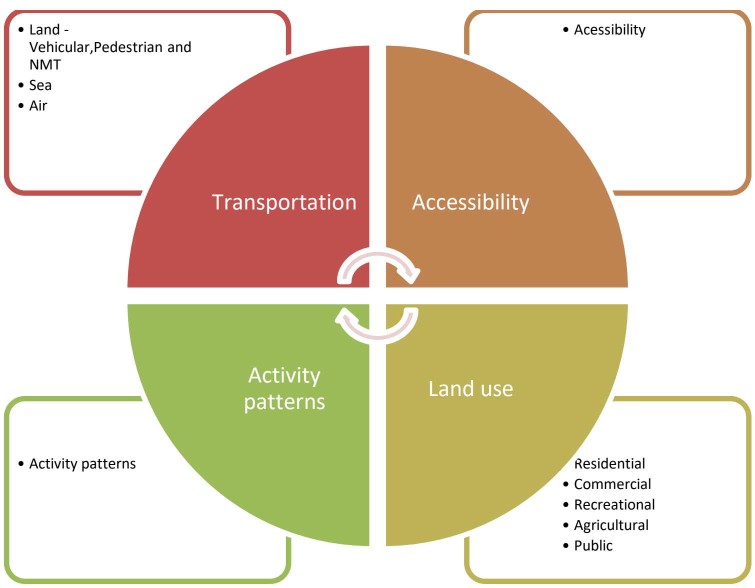
Table 20: Framework for the mutual connection between land use and transportation

	Forms	Functions
Land Use	Buildings and Physical Infrastructure	Activities (Residential, shopping, working, travel)
Transportation	Channels	Flows

Source: Adapted from (Mackett, 1985)

Figure 27 provides an empirical description of this mutual interaction. It explains the common characteristics of the transport system which determine the level of accessibility and in turn directly or indirectly affect the location of activities (land uses).

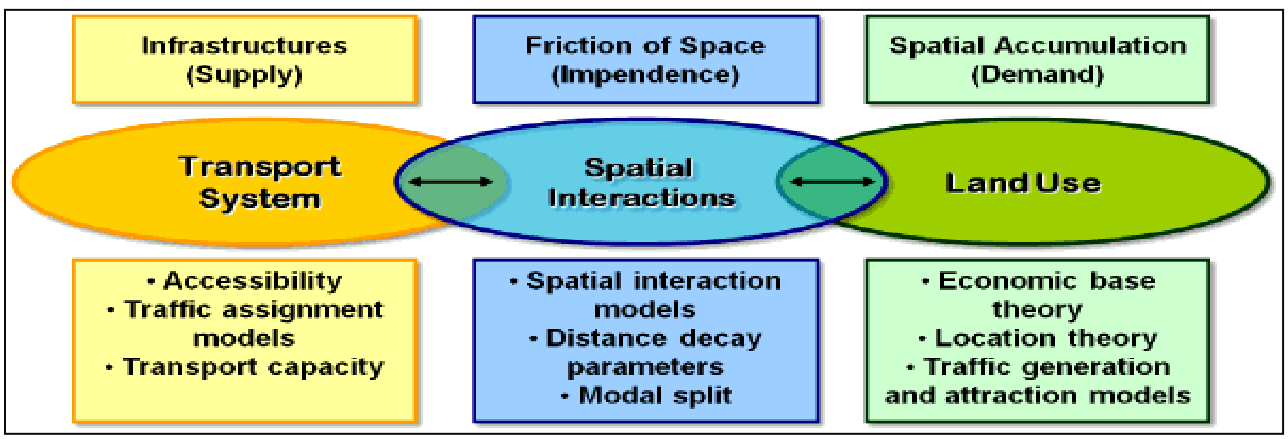
Figure 27: The transport-land use interaction



Source: Adapted from (Huang, 2003; Rodrigues, 2013)

A mutual relationship often raises the question of whether the ‘chicken or the egg’ came first. Is transportation the driving force behind land use development patterns and does land use influence transportation facilities? Many scholars (Aderamo 2012; Fujita, 1984; Grava, 2003; Hall, 1985; Hamerlinck et al., 2013; Kaiser & Godschalk, 1995; Kaiser et al., 1995; Mazaza, 2002; Meyer & Miller, 1984; Moore & Pulidindi, 2003; Stopher & Meyburg, 1975; Tseu, 2006; Vasconcellos, 2001) argue that for transportation and land use to be mutually exclusive, certain characteristics must exist. Hamerlinck et al. (2013) acknowledge that there is no real answer as to which came first and that transportation planners, and professionals in the built environment should keep their eye on the bigger picture of integrating transportation and land uses. It is clear that land use changes affect transportation patterns and vice versa. Adedamila (1977) observes that, “we cannot continue to let politics, bureaucracies, and additional rhetorical questions, get in the way of doing what right public planning process is”. Researchers (Dick & Rimmer, 2003; Fujita, 1984; Kraay, 1978; Meyer & Gomez-Ibanez, 1981(Johnson, 2006) and international groups such as the European Conference of Ministers of Transport (2003) concur. The relationship between transportation and land use is complex (Hamerlinck et al. 2013; European Commission, 2003; Frank & Engelke, 2002b; Handy, 2002; IPCC, 2000) and cumbersome. Nonetheless, social scientists agree that seeking ways to integrate land use and transportation into planning is the most practical option for sustainable development (Carlson & King, 1998; Rees, 2010; Thorsnes, 1994). Transportation and land use are connected, with land use having traffic implications, and transportation affecting land use. However, many built environment scholars (Rees, 2010; Suzuki et al., 2013) have noted that this is not necessarily always understood and is sometimes misunderstood. Figure 28 illustrates these complexities.

Figure 28: Transportation / Land Use complex relationships



Sources: Adapted from (Rodrigue, 2013)

Such complexity renders planning an arduous task. Coordinating (or integrating) multiple land use and transportation planning and development is regarded as one aspect of smart growth, sustainable development, and New Urbanism (Dick & Rimmer, 2003; Huang, 2003; Litman, 2014; Mackett, 1985; Muller, 1985; Srinivasan, 2000a). Understanding the complicated reciprocal relationship between transport and land use is a tool of urban planning (Black, 1995; Kaiser et al., 1995; Oduwaye et al., 2011; Pandya & Katti, 2012; Silva, 2011; Tseu, 2006). Contemporary researchers have identified two ways of explaining the relationship between land use and transportation: using environmental indexes and tracing the connection from biological perspectives.

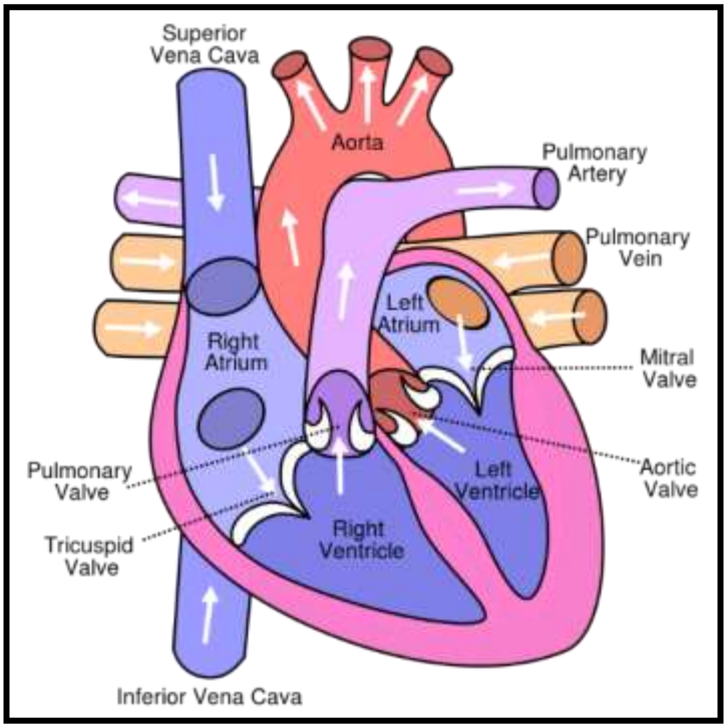
Environmental indexes

The transportation-land use relationship plays out in the many environmental decisions made by residents, businesses, and governments. It thus significantly impacts sustainability. Many built environment characteristics are believed to influence travel choices, including making travel by different modes more convenient by altering the distance, speed or qualitative experience of the journey. Land use and transportation policies can be used to reduce the use of automobiles and opt for walking, or transit instead of driving a vehicle occupied by one person. (Rodrigue, 2013) noted that traffic is negatively impacting the environment in several ways. The first is its direct impact, which includes the immediate effects of carriage/land use activities on the environment. Secondly, indirect impacts are the secondary (or tertiary) effects of transport activities on environmental systems. These often have more severe consequences than direct effects. Thirdly, the cumulative impacts which are the synergetic effects of transport activities have direct and indirect effects on an ecosystem and are often unpredictable.

Biological perspectives

Several studies such as (Carlson and King, 1998, Ford, 2011, Giuliano, 1995, Grava, 2003) affirm that Transport is the heart of every city's land use activity. The relationship between transportation and land-use can also be explained in biological terms. The human heart pumps blood throughout the circulatory system. It takes in deoxygenated blood through the veins and delivers it to the lungs for oxygenation. Thereafter, the heart supplies oxygen and necessary nutrients and removes carbon dioxide and other unnecessary waste from the body. Figure 29 shows that it is divided into four chambers, right atrium and right ventricle and the left atrium and left ventricle.

Figure 29: Functions of the human heart



Source: (Wikimedia, 2016)

Just as blood moves into the heart from the body, so transportation moves through a well-coordinated circulatory system to different land uses. Traffic is a conspicuous part of the heart of a public land-use system. In the same vein, the transport system pumps blood throughout complementary land uses. The transit system thus connects various land uses, including settlements, links streets, integrates urban and rural areas and the city and above all provides accessibility (see Figure 30 below) (Aderamo, 2012).

Figure 30: Transportation network connecting different points/uses to various settlements

Source: (Central Kowloon Route Highways Department, 2017)

Furthermore, just as the human heart rate is influenced by the nervous system, hormones, emotions, and substances, the transportation rate (the heart of the city) is affected by functional and non-functional land uses such as commercial, residential and industrial. Figure 31 shows this symbiotic relationship. Regardless of the mode of transportation-train, air, rail or roads (pedestrian, auto, bicycle or transit), a traveler will follow the roadway network. Biologically, when the human stress response is triggered, the sympathetic nervous system (a division of the autonomic nervous system) increases the heart rate and the volume of blood pumped through the heart (known as cardiac output). The parasympathetic nervous system restores the heart rate to normal. The same applies to a transportation system. When the stress response is triggered in a typical settlement because of lack of sound planning or poor coordination of land uses, this increases the traffic rate and volume and results in myriad problems that cumulatively affect the functionality of other systems. To restore traffic to a healthy situation, business as usual is not the best approach. Rather, there is a need to coordinate transportation and land use. The biological term, symbiotic, can also be used to explain this relationship. Harper (2014); Merriam-Webster (2014) and the Wikimedia Foundation (2014) note that symbiotic is a parasitological term.

It is a biological approach which indicates the association of two individuals or populations of different species. Symbiotic is also known as mutualism, commensalism, parasitism, and amensalism. In other words, it implies the cooperation or interdependence of two people, such as mother and infant, or husband and wife and is also sometimes used to denote an excessive or pathological relationship between two people. In the scientific world, symbiotic further implies a close and often long-term interaction between two or more different organisms. It also depicts living together in an intimate relationship and people cohabiting in a very interactive manner in the community. In all cases, the relationship is mutual and usually obligated. In obligated symbiotic relationships, the parties depend entirely on each other for survival. This is a perfect illustration of the relationship between transport and land use.

Transportation planning decisions affect land use development and vice-versa and this is a very close relationship. Both transportation and land use are relevant to everyday human activities. Transport is the non-threatening relationship that enables people, firms and other organizations to carry out activities on a separate but interrelated basis (Rodrigues et al., 2006; Meyer & Miller, 1984; Rodrigues, 2013). Land use is an important determinant of travel and is therefore partially determined by the performance of the transport system. For example, decisions about land utilization and infrastructure affect the efficiency of the various transportation modes. A compact community where amenities are close to residents is best able to meet community demand for walking. The relationship thus involves shared responsibility between land use and transportation. Traffic exerts a significant influence on urban form (the land use system). Land use and transportation are thus fundamental components an urban system (Pandya & Katti, 2012(Han and Fang, 2000, Handy, 2002, Handy, 2005, Huang, 2003, Litman, 2009).

4.4.2: Example of cities with integrated land use/transportation planning

Oduwaye et al. (2011), the United Nations Human Settlements Programme (2002) and other professionals provide examples of cities that have integrated land-use and transportation planning. Table 21 provides details in selected cities throughout the world.

Table 21: Successes of transportation/ land use policies in selected countries

Town and country	Transportation/ land use policies
Toronto, Canada	Toronto is a model for transport and land use planning policies. High rates of public transport usage are achieved through a combination of transportation and land use policies. Provinces and municipalities are responsible for urban transportation, planning and financing assistance for both capital projects and operations.

Town and country	Transportation/ land use policies
London England	As the largest city in Britain, London has been the subject of numerous planning analyses that centered on land use and transportation, especially in balancing transportation planning and land use.
Australia	Australia offers examples of exceptional designs and unlimited space for urban growth that focuses on a transportation-land use system. The main cities developed strong core centers while suburbs grew around the stations of railway transportation networks.
Sydney:	An integrated transportation-land use strategy for Greater Sydney was formulated to ensure urban containment. The emphasis is on providing a balance between transportation and land uses.
Sweden	Sweden has a long tradition of integrated land use and transport planning design. Moderate traffic-generating land uses are within an easy walking distance of public transportation. Parking is provided on the periphery of the city. The core city center offers extensive pedestrian areas with many attractions and is very people-oriented.
Asian cities	Asian cities exhibit different urban conditions from those found in Europe and North America. Transportation is affected by limited space, and this has led to the application of innovative methods to solve urban transportation problems.
Lagos, Nigeria	Lagos has little room for expansion due to its coastal nature (islets, creeks, swamps, lagoons and other physical barriers to spatial expansion) and the political boundaries of the state. Land use/ transportation improvements include the land use development plan of 1980-2000 and the more recent Eko Atlantic project, which aims to construct residential development using land reclaimed from the sea.

Sources: Adapted from Oduwaye et al., 2011; United Nations Human Settlements Programme, 2002;(Burgess, 1925, Hesse and Rodriguez, 2004)

Transportation is a land use and relates intimately to all other land uses. It is the most significant public investment activity in the physical development of any community, city and country.

4.4.3: Debate on the land use and transportation system relationship

As noted earlier, coordinating (or integrating) land use and transportation planning is currently regarded as an important facet of smart growth, sustainable development, and New Urbanism. Nonetheless, there is no consensus on the strength of this relationship and on the most appropriate strategy to achieve integrated transport and land use planning and environmental policy. Globalization has substantially blurred the relationships between transportation and land use. Rodrigues (2013) critiques the implied relationship between land use and transportation from a global perspective. He contends that the central paradigm is concerned with some factors that were once endogenous to a regional setting but have now become exogenous. The interaction between land use and transportation also produces different adverse effects. Black (1995) described this as a complex bundle of interrelated problems, with traffic congestion as the most visible manifestation. The distribution of land uses within settlements varies greatly and determines the extent of transport-related problems.

Furthermore, while it is generally agreed that there is a relationship between land use factors and transport activities, there is conflicting evidence on the causal nature of this relationship. This arises from the influence of different factors and the relative influence of non-land use factors, such as demographic and socio-economic factors, and the impact of changing travel patterns. For example, it is difficult to compare the environmental impact of trips when they vary on three dimensions, number, length, and mode. Investment in transportation also has a considerable impact on surrounding land uses, while land use patterns affect the utilization of transportation facilities. These interrelated effects will occur regardless of whether city officials consider land use in determining their investment in transportation. The relationship between land use and transportation has been over-theorized in many studies, which might explain the lack of consensus. Morris (1979) and Chapin and Edward (1979, cited in Tugbobo, 2004) note, that, transportation and land use are commonly regarded as a distinct issue in urban planning relating to vehicular and pedestrian systems. While acknowledging, the relationship enables an examination of the factors that determine policy choices, it does not offer guidance on how to think about land use activities as discrete choices or what attributes might be relevant to transportation options.

It has been widely accepted that, in most cases, the relationship between land use and transportation is largely technical and focuses on policy options, instruments or assessment methods, rather than on decision-making and implementation. Indeed, most studies are concerned with the definition of the phenomenon and the mechanisms of interaction, which are technically ambiguous due to the complexity, and polymorphous nature of the issue. Gakenheimer (1993) cited in Mazaza (2002) observes that, in most cases, institutional or legislative support for land use and transportation integration is lacking. Bridgestock (2000), Bruton (1970), Mills (2013) and Whitelegg (1997) concur with Rodrigue's (2013) analysis of the impact of transport and argue that one of the major externalities confronting the modern world today is poor land use-transportation coordination, resulting in a mobility crisis. They add that business as usual is not a viable option for future transport planning. Tugbobo (2004) identifies visual intrusion, congestion, galloping motorization in place of mixed uses resulting from an archaic zoning system still in place in the metropolis and pollution caused by traffic in town as the most important negative environmental impacts of urban land use and transportation. To these can be added aging infrastructure, parking difficulties; longer commuting times, and inadequate public transport. A further major problem that has been neglected is non-consideration for and the difficulties faced by non-motorized transport in navigating roadway.

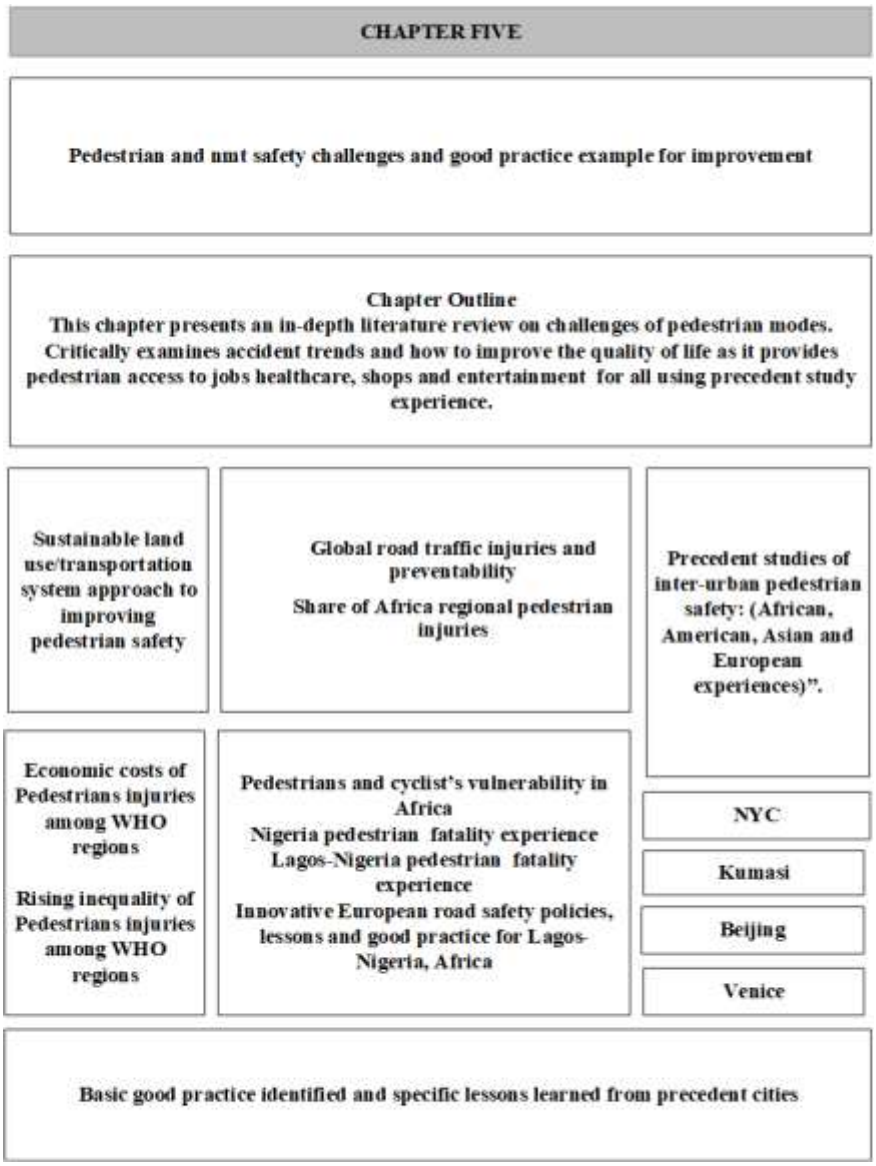
4.5: The chapter summary:

This is an extensive literature review where the researcher explores the linkages between land-use and transportation and how this impacts on pedestrian movement. This chapter gives a detailed perspective on historical evolution and development patterns of transportation systems. The literature review presented in this chapter was very robust and skilfully presented, providing good insights into land use and transport phenomenon in urban centres and dovetailing to road and pedestrian safety challenges and good practices across the globe.

5. CHAPTER FIVE: THE PEDESTRIAN SAFETY CHALLENGES AND GOOD PRACTICE EXAMPLES FOR IMPROVEMENTS

5.1: Chapter outline.

Figure 31: Chapter five outline



Source: Author's construction (2016) ©

Chapter five of this study reaffirms that over the past century, land use/transportation planning and development throughout the world focused on the automobile, frequently overlooking other modes of transportation such as walking and NMT transportation systems. Overall, governments provide approximately 80% of capital investment in transportation development that focuses on vehicular needs compared with 20% of support for other forms of transportation(Litman, 2009). Thus, there is a need for a well-integrated and sustainable land use/transport system that focuses on both vehicular and pedestrian or other NMT systems. This is essential to ensure equitable access without regard to age, gender, income level, physical ability, and location (Schiller et al., 2010).This land use/transportation approach to pedestrian safety is a groundbreaking model in several developed and developing countries. Thus, this is the focus of this chapter. Figure 31 provides chapter five outline

5.2: The sustainable land use/transportation system approach to improving pedestrian safety

The goal of a well-integrated and sustainable land use/transportation network is to improve the quality of life as it provides pedestrian access to jobs, schools, healthcare, shops, and entertainment for all (Partnership for Sustainable Communities, 2011) in a safe and environment-friendly manner. Safe walkability creates robust communities where people can easily get to know their neighbors and develop healthy relationships (Burden, 2001; Partnership for Sustainable Communities, 2011). Land use / transportation projects should consider both vehicular and pedestrian or other NMT systems. Enhancing equality and sustainability requires improvements to street design and building road networks with a higher tolerance for pedestrian or NMT systems.(Rahman, 2013). The experiences of various countries show that a well-integrated and sustainable land use/transportation system offers many benefits. Such systems create healthy communities through building exercise into daily transportation routines (Urban Design 4 Health, 2010).

Other benefits include safety, cohesiveness, economic vitality, and environmental friendliness. Pedestrian infrastructure enables those that are unable to operate vehicles, especially the disabled, the elderly and children, to become more mobile. Land use/transportation planning promotes lively neighborhoods, where residents discover that walking or other NMT can be an enjoyable and safe experience. It also reduces deaths and injuries from road accidents. However, there are also a number of barriers to sustainable land use/transport. Table 22 presents some of the obstacles to the pedestrian system and suggests solutions.

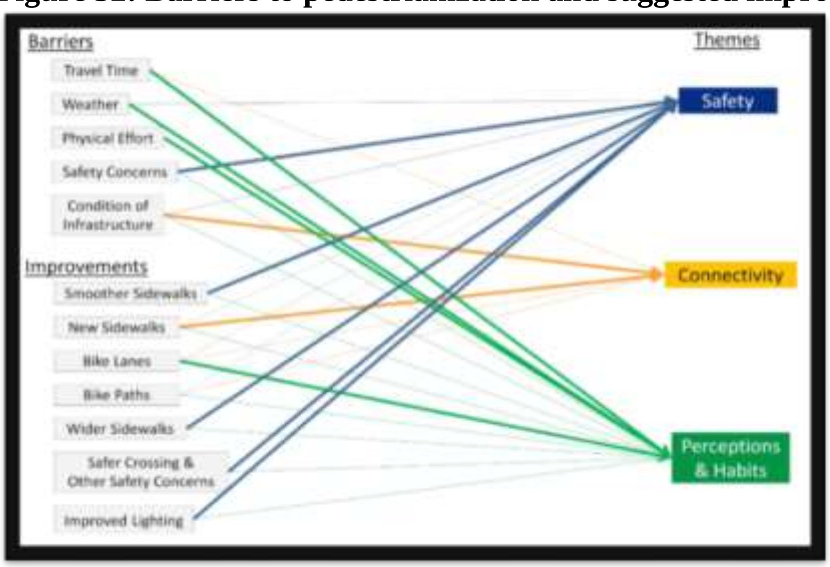
Table 22: Barriers to pedestrianization and suggested improvement measures

	Barrier to pedestrianization and proposed improvement measures	Theme
Barriers	Travel time	Perceptions and habits
	Weather	Perceptions and habits
	Physical effort	Perceptions and habits
	Safety concerns	Safety
	Condition of pedestrian infrastructure	Connectivity
Improvements	Smother sidewalks	Safety
	New sidewalks	Connectivity
	Bike lanes	Perceptions and habits
	Bike paths	Connectivity
	Wider sidewalks	Safety
	Safer crossings and bridge	Safety
	Improved street lighting	Safety

Source:(Kelly et al., 2012)

Figure 32 presents a diagrammatic representation of these barriers and suggested improvements.

Figure 32: Barriers to pedestrianization and suggested improvement measures

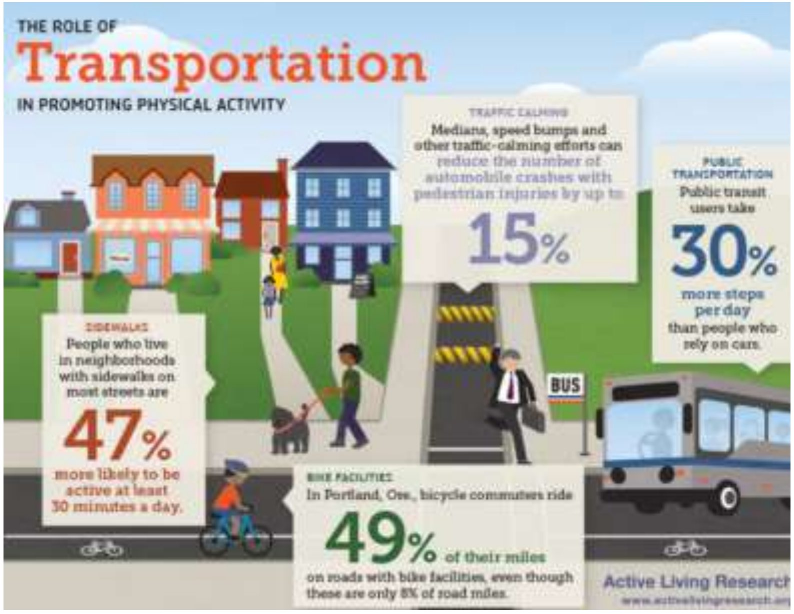


Source: (Kelly et al., 2012)

The question is: what options do urban planners have in addressing non-integrated and unsustainable land use/ transportation planning problems? Changing perceptions would go a long way in stimulating sustainable modes of land use/ transportation. Increased capital investment, especially in infrastructure improvements such as sidewalks, walkways, and dedicated pedestrian routes, would reinvigorate a pedestrian culture. Safe pedestrian and NMT infrastructure could be achieved by setting aside road space for the exclusive use of non-motorized users. Another solution is what transportation planners refer to as a 'road diet' or 'lane reduction' (roadways reconfiguration) strategy that slows down vehicular traffic and improves pedestrian safety. A fresh mindset is thus required to address intra-urban land use-transportation today, staring with city centers that are marked by intense pedestrian activities. Research shows that an efficient and effective pedestrian system enhances livability in CBDs and other residential areas. Planners and built environment practitioners are adopting this approach throughout the world.

The Living Streets-the Pedestrians' Association (2015) notes, that, cities should create pedestrian-friendly systems by removing barriers to active walking and promoting sustainability. Such city centers have convenient road crossings, and are inviting and aesthetically pleasant with smooth, uncluttered pavements (in developing countries) and well-positioned outdoor seating arrangements (in developed countries). A successful pedestrian system ensures that the city center is more than simply a shopping destination. It offers valuable public space, municipal facilities, and employment and leisure opportunities. Studies of traditional African community centers show that pedestrian paths provided people with an enjoyable public space to spend time with friends. Some European cities also offered such amenities. Pedestrianization also has positive impacts on a population's health and wellbeing, air quality, and safety levels (TfGM, 2013). Figure 33 provides a typical example of how pedestrian mode of transportation can promotes physical activity. For example, this study affirms that people who live in neighborhood with sidewalks on streets are 47% more likely to be active for 30 minutes per day.

Figure 33:How pedestrian mode of transportation can promote physical activity



Source: www.activelivingresearch.org

Traffic in city centers causes air and noise pollution. Living Streets-the Pedestrians' Association (2015) argues that drastic reduction of vehicle speeds to 20 mph will build environmentally friendly city centers. A multi-modal land use-transport network will promote mixed use development and community connectivity and create a pedestrian-friendly intra-urban environment by enhancing landscapes and streetscapes and supporting public infrastructure projects. Strategically placed, high-intensity mixed uses on comparatively less land in core corridors create a critical mass of activity, reducing the need for an automobile. People can use mass transit or walk to city centers. Land use and transport has a significant impact on the amount of land available for development and the spatial distribution of economic activity. Studies have thus found that there is a correlation between walking and business development.

A central principle of the pedestrian path is to design streets exclusively for pedestrian use. The beginning and end of every trip involves walking, regardless of the travel modes used in between. Good pedestrian access to a diversity of land uses, and transit services is crucial. When trips made on foot are pleasant and safe, neighborhoods flourish, more people walk, and the local economy thrives. This approach is more effective and less costly than expanding roadway capacity to address traffic congestion. A balanced transportation network eases congestion using other means of travel. A multimodal transport network consists of an interconnected network, continuous pedestrian walkways, and a comprehensive public transit system. It also includes the systems and infrastructure required to combine modes of travel and enable people to move quickly. Examples include clustering amenities and activities where many travel modes meet and providing safe pedestrian connections to public transit stops. Pedestrian access and direct routes through main streets offer a range of land use-transportation options to move people and goods. They also provide public space. Street paths are not only thoroughfares for cars but represent communities' outdoor living rooms; they are the setting for friendly chats, and children's games. Thus, designing streets for both pedestrian paths and vehicular movement can play an integral role in a community's identity. Land use-transportation planning for these multiple purposes requires street design that distributes the traffic load among many narrow streets rather than a few broad ones.

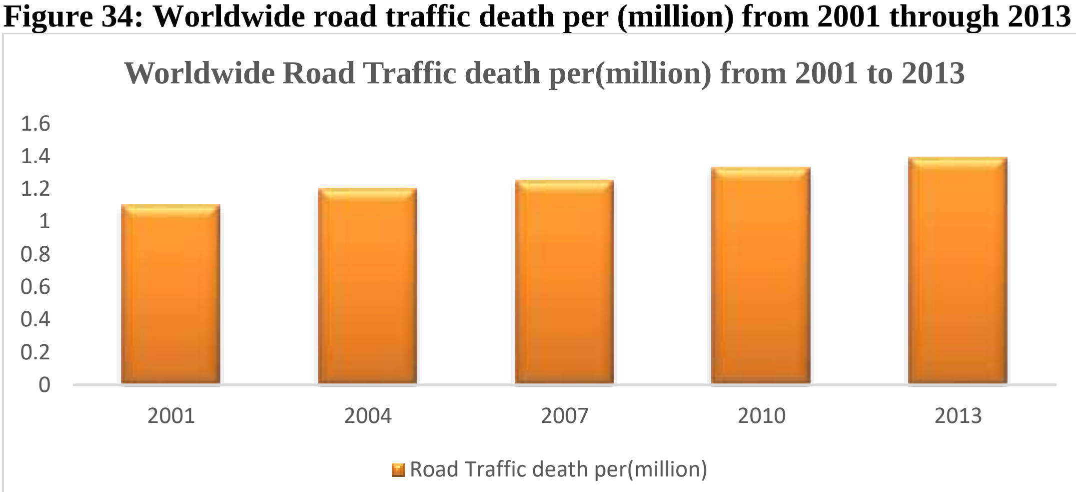
This enables traffic to be efficiently distributed over the entire network and provides space for community-oriented design elements, such as wide sidewalks, public spaces, landscaping, and trees. Adjacent land uses dictate street design and insight into the diverse walkable city and transit city is essential, as these can develop into urban zones. Recent experience has shown that the walking city and transit city can grow in popularity if systematically developed. It is believed that these two forms of cities will persist for the next 20 or even 50 years. Compact community structures reduce energy consumption and promote pedestrian and transit systems. Urban development that integrates the existing community will encourage people to walk. Motorization has been the core focus of most land use and transportation studies, with pedestrian travel neglected.

This reflects a research and cultural bias that conceptualizes travel as an automobile-dependent phenomenon. Much of the work on transportation and land use focuses on vehicular congestion and emissions reduction. Adedamila (1977); Dick & Rimmer (2003); Giuliano (1995); and UK Essays (2013) note, that, there is thus abundant data on automobile transportation and relatively little on pedestrian modes. In most urban design and classical planning, variables such as land use are difficult to disentangle from traffic, creating a vicious circle of problems and promoting the dominance of vehicular transportation. There is no universally accepted methodology in the scholarly literature to correct this situation. Thus, most scholars in the fields of Urban Planning and Engineering find it difficult to identify the effects of urban form variables (land use) on pedestrian travel which is part of transportation modes. This results in less focus on pedestrianization (Ying Ni, 2006; Buehler et al. 2009; Jain 2007) and thus high energy consumption, environmental pollution, increasing congestion and high accident rates. If these problems persist, current land use-transportation will fast become unsustainable.

5.3: Global road traffic injuries and effects on pedestrian's modes of transportation

Traffic deaths worldwide have been unprecedentedly increasing since the start of the millennium. Despite relentlessly and joint efforts of the World Health Organization and other (international and national governmental partners) to promote good practice, ameliorate, raise the profile of the preventability of road injuries traffic fatalities remain the primary cause of death for youngster between ages fifteen to thirty globally. It also remains the 8th leading cause of global mortality. (Urbanczyk, 2011, UN-HABITAT Sustainable Urban Development Network (SUD-Net), 2012, World Health Organization (WHO), 2015). Much appreciated World Health Organization(WHO) and United Nations Global Road Safety (UNGRS) initiatives to advancing the ten years of Action for Road Traffic Safety (between 2011 and 2020) and saving 5 million lives failing to yield positive and desired results. Increasingly, a global number of road traffic deaths appears trendy. For example, the road traffic deaths rate has been growing between 4% to 6% worldwide yearly since 2001 (see figure 34)

Figure 34: Worldwide road traffic death per (million) from 2001 through 2013



Source: Adapted from(World Health Organization (WHO), 2013a, World Health Organization (WHO), 2013b)

The similar longitudinal study by the U.S. National Highway Traffic Safety Administration affirms that one road user dies per every 2 hours and likely to be injured every 8 minutes in a road traffic accident. Further technical assessment of the global rate of death by World Health Organization (WHO) reveals that the current plateau in the road accident is responsible for over three thousand people deaths worldwide daily. This statistical revelation translates to an (average 3000 people killed in traffic accidents per day). Mathematically, 3000 deaths per day for the next three hundred and sixty-five days (365days) per year will be plateaued to (1095000) deaths on the road worldwide. This number is in addition to over tens of millions severely injured per year. This record is one of the worse road safety statistics in the modern history.

5.3.1: Economic costs of the pedestrian traffic injuries among WHO Region

Several studies of the relationship between economic status and Traffic injuries reported worldwide. Example, the 1997 epidemiological review undertaken by the United Kingdom-based TRL Ltd on the number of road identified road crash costs from twenty-one moderate or middle-income countries. An excerpt of the study found that on the average annual cost of road crashes stood at 1% of Gross Domestic Products (GNP) in moderate-income countries, 1.5% in middle-income countries and 2% in highly-motorized countries (see Table 23 below).

Table 23: 1997 Road accident costs by region

Region	GNP, 1997(US$ billion)	Estimated annual crash costs	
		As percentage of GNP	Prices (US$ billion)
Africa	370	1	3.7
Asia	2 454	1	24.5
Latin America and the Caribbean	1 890	1	18.9
Middle East	495	1.5	7.4
Central and Eastern Europe	659	1.5	9.9
Subtotal	5 615		64.5
Highly-motorized countries	22 665	2	453.3
Total			517.8

Source:(World Health Organization (WHO), 2015, World Health Organization(WHO), 2004, TFL, 2005)

Per this study, the annual burden of economic costs globally stood at around US$ 518 billion. On a country basis, the financial difficulties are expected to represent proportions of GNP ranging from 0.3% in Viet Nam to almost 5% in Malawi and KwaZulu-Natal, South Africa with a few countries registering even higher percentages. In most countries, though, the costs exceed 1% of

GNP. Less than 20 years after (1997 to 2013) the story is not the same. A considerable but more sophisticated study by the International Road Assessment Program (iRAP) found that on the average annual cost of road crashes stood at an estimated 3% of most small and middle-income countries (GDP) (see Table 24 below).

Table 24: Cost of fatal and severe road crashes.

Income Group	Fatalities	Economic Cost	% of GDP
low	130000	20	5%
Small- middle	495000	205	5%
Upper middle	510000	780	5%
High	95000	850	2%
Total	1240000	1855	3%

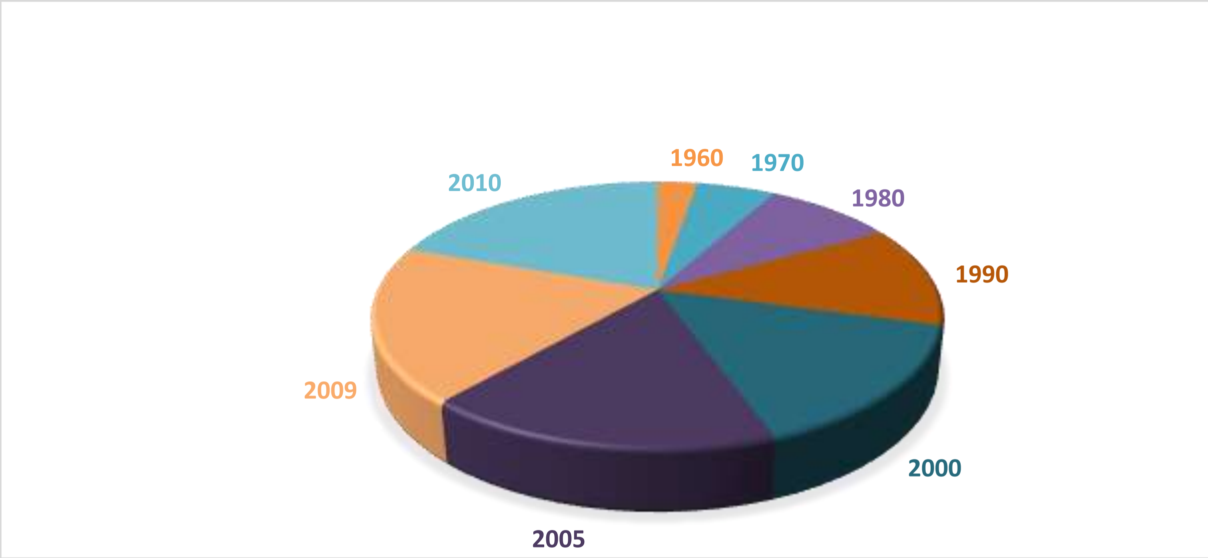
Sources: (World Health Organization, 2013)iRAP (2013)

In fact, 2014 reports of U.S., Federal Highway Authority and the U.K Department for Transport confirm this trend. Per these reports, Traffic accidents in the U.S and U.K cost $871 billion and £16,307 Million (over $21 billion a year in 2014 respectively). The truth is these economic loss is placing strain, very many potential effects and range of economic consequences on public health and international economic system.

5.3.2: Rising inequality of the pedestrian traffic injuries among WHO Region.

Studies confirm that the elevated risk of dying by pedestrian in a road crash remains staggering in small and middle-income countries. Growing traffic in urban areas linked with a growing number of accidents and fatalities, especially in moderate or middle-income countries. Historically, these nations plateau is against the backdrop of global arithmetic population increase of 4.5% and geometric motorization growth of 16% between 1960 and 2013. Figure 35 provides the example of historical motorization registration. More and more people continue to own and register the automobile without necessarily considering significant effects of such trend.

Figure 35: Historical trend of worldwide vehicle registrations1960-2010 (thousands)

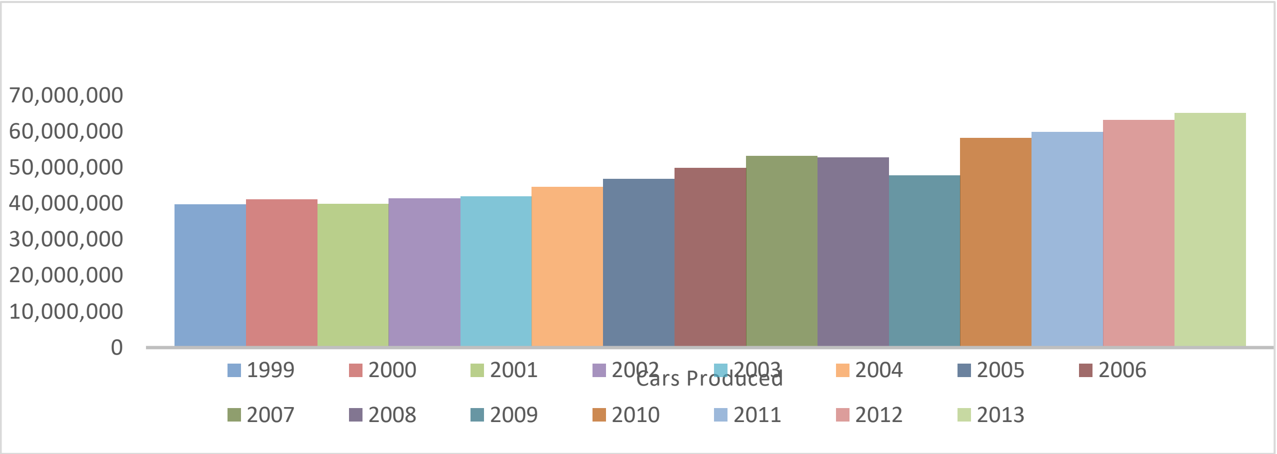


Source:(World Health Organization, 2013, World Health Organization (WHO), 2013a, World Health Organization (WHO), 2013b)

To some extent, the central cities of moderate or middle-income nations share of vehicle ownership are far behind the upper-income nations. Motorization trend has occurred so quickly that the existing road infrastructure systems in most cities of these central towns of moderate or middle-income countries have not been able to keep up. For example, Car ownership in Lagos and China grew a staggering 230 and 300 percent respectively from 2002 to 2008 (Silva, 2013). In the past ten years, Beijing has experienced a tenfold increase in private cars and so also the city of Shanghai a 25-fold increase. In Bangalore, India's new Silicon Valley, 900 new vehicles are registered every day ((Dijkstra, 2000, Pucher and Dijkstra, 2003a, World Health Organization (WHO), 2007). In addition to above statistical trend, the yearly car produced worldwide is growing geometrically.

The excessive growth of automobile throughout the world is a cause of concern to all and sundry. For example, in 1999, 39,759,847 cars were built and thirteen years after over 65,140,268 cars produced representing over 64% increase from 1999 to 2013(see the Figure 36)(Dargay et al., 2007). The consequential effects of mass production of the automobile are increasingly having devastating impacts on global accident trends mainly moderate or middle-income countries. The implications of these findings for study shows that something urgent must be done to address insurgence of private vehicular use on the cities of both developed and most importantly developing countries. Ensuring pedestrian safety is an important component of efforts to prevent road fatalities.

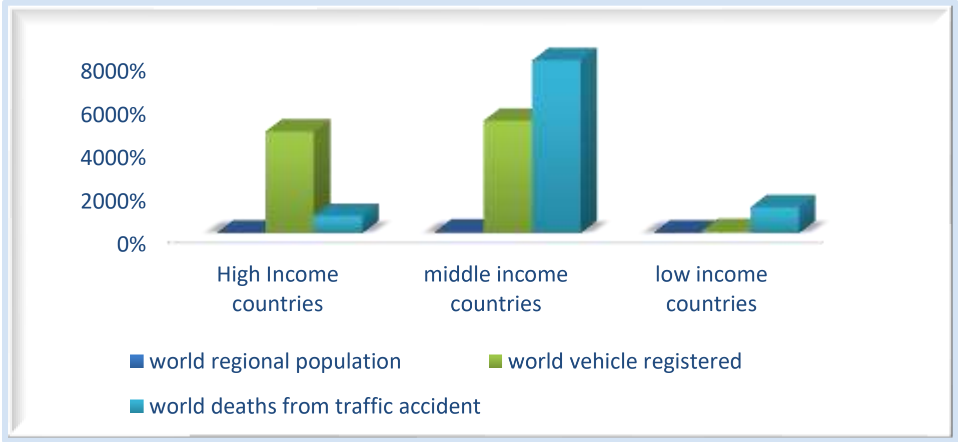
Figure 36: Total cars produced in the world



Source: Adapted by Author from (OICA, 2014)

Unsurprisingly, World Health Organization (WHO) correlates above submissions in 2013 that 80% of these road accidents occur in the main cities of moderate or middle-income nations which have only 52% of the world registered automobile. Figure 37 and 38 provide a snapshot of this analysis.

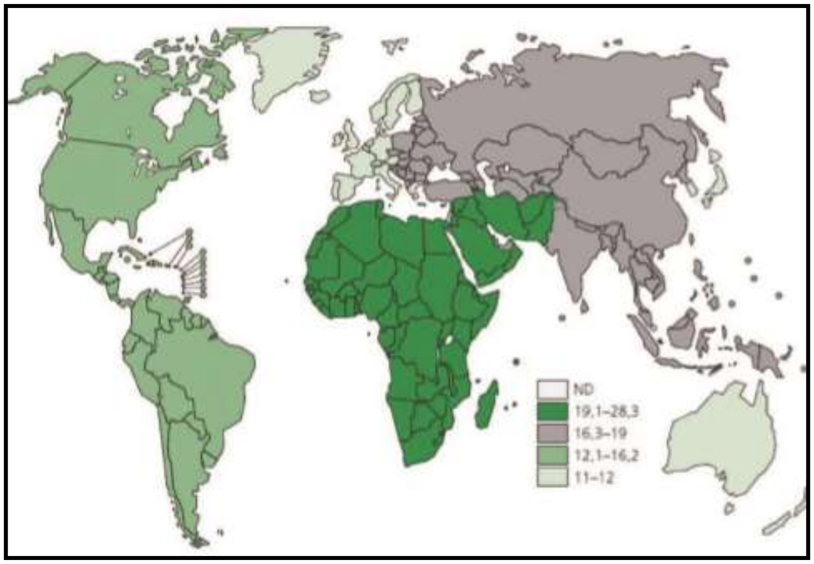
Figure 37: Road accident occurs more in moderate or middle-income nations



Source: Adapted from (World Health Organization (WHO), 2013a)

In 1999, WHO predicted that moderate or middle-income nations would have higher pedestrian road fatalities by the year 2020.

Figure 38: 2013 road traffic injury mortality rates (per 100 000 population)



Sources:(Riccardo Gallimbeni (FIAB), 2016)

Table 25 provides the snapshot of this predicted road traffic fatalities by region with exceeding negative impacts in moderate or middle-income countries. These testimonies suggest that while traffic accident reduction is practicable, nonetheless much more scrutiny, institutional will, aggressive professional inputs and academic resources needed for improving road safety for the vulnerable group of these moderate or middle-income nations.

Table 25: Predicted road traffic fatalities by region (in thousands), adjusted for underreporting.

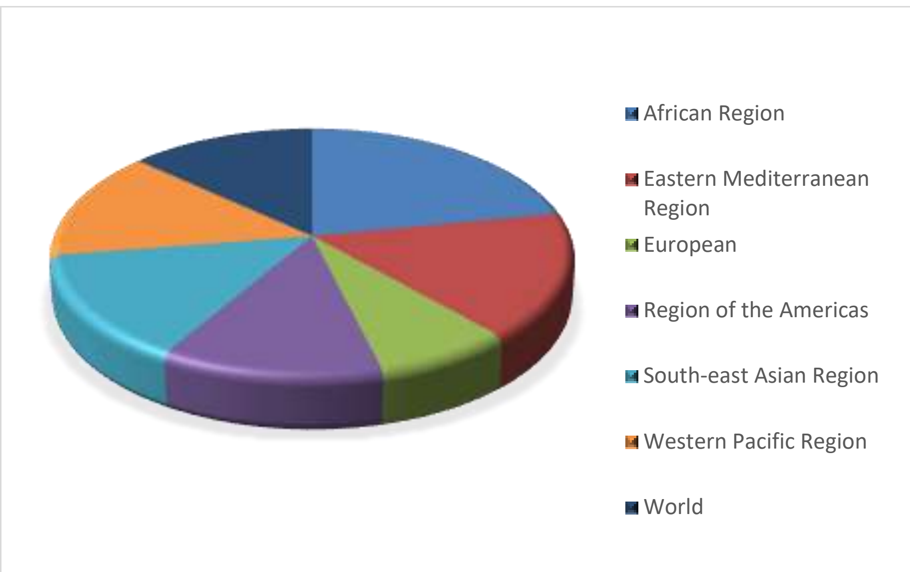
	No of countries	**1990**	**2000**	**2010**	**2020**	**Change (%) 2000–2020**	**Death rate (deaths/100 000 persons**	
							2000	2020
East Asia and Pacific	15	112	188	278	337	79	10.9	16.8
East Europe and Central Asia	9	30	32	36	38	19	19.0	
Latin America and the Caribbean	31	90	122	154	180	48	26.1	
The Middle East and North Africa	13	41	56	73	94	68	19.2	
South Asia	7	87	135	212	330	144	10.2	
Sub-Saharan Africa	46	59	80	109	144	80	12.3	

(World Health Organization(WHO), 2004)

5.4: Share of Africa regional pedestrian injuries

Concern as African countries facing looming and uncertainty road safety future mishaps(Oyesiku, 2002). Africa nations stand out as the world's most dangerous region for traffic fatalities. Despite enduring several burdens either by choice or absolute poverty in Africa nations, studies indicate that most prominent cities in Africa region now dealing with escalated road carnage. Road carnage is drastically increasing in recent years. International authorities (World Health Organization, 2013, United Nations Human Settlements Programme, 2014c) are showing and expressing serious concerns about this epidemic development. Also, some Africa urban analysts are already predicting that those road accidents will soon overtake HIV/AIDS, malaria, and tuberculosis thus overwhelming becoming the fifth leading cause of death in this regional area.(Africa Transport Policy Program, 2015, Wee et al., 2009, Dah, 2010). For example, the Figure 39 provides information about the road traffic fatality per 100000 population in the WHO regional areas.

Figure 39: The Road traffic fatality per 100 000 population in WHO region



Source:(World Health Organization (WHO), 2013b, World Health Organization (WHO), 2013a, World Health Organization, 2013)

The primary concern of various scholars and international communities is the emotional burden that comes with losing a precious one or dealing with an able-bodied that will forever confine to a wheelchair including incapacitated to fending for the family(World Bank, 2012). Indeed, this is the greatest cost victims of road crashes. A large Statistical analysis supplied by United Nations and World Health Organization indicate the traffic death rate in African is more than double European nations. Per 2013 (WHO) report, Africa countries usually have elevated road traffic fatality 26.6 rates per 100, 000 population. Compared to high-income countries with 9 per 100, 000 population. The scariest part of this statistical analysis lies in the fact that road crashes are making highway system intolerable for the vulnerable people across Africa. Table 26 below shows snapshot of selected countries' profiles and traffic safety information by WHO region. The Table 26 shows extracts and the further breakdown of the regional population, nation income category by WHO. This referenced Table provides additional information on Total registered vehicle, the number of reported the death from accidents fatalities and other pertinent traffic indicators. It is indeed disturbing taking into cognizance that these facts are not just rhetoric numbers but actual preventable human lives that have been lost or maimed on African roads. Given African countries traffic predicament, the onus is on decision-makers, practitioners, international organizations, professionals, and academic communities. These bodies need to brace-up for this looming road safety challenges.

Table 26: Selected countries profile and highway safety information

	NIGERIA	EGYPT	Burkina Faso	India	USA	UK
Population:	173 615 345	82 056 378	16 934 839	1 252 139 596	320 050 716	63 136 265
Income group:	Middle	Middle	Low	Middle	High	High
Gross national income per capita	US$ 2710	US$ 3 140	US$ 670	US$ 1 570	US$ 53470	US$ 41 680
Total registered vehicles for 2013	5 791 446	7 037 954	1 545 903	159 490 578	265043362	35 582 650
Cars and 4-wheeled light vehicles	3 267 139	3 851 916	197 702	38 338 015	245 669 103	32 978 351
Motorized 2- and 3-wheelers	2 524 307	1 054 175	1 282 706	115 419 175	8 437 502	1 252 102
Heavy trucks	—	104 013	24 139	4 056 885	10 270 693	483 000
Buses	—	139 710	9 615	1 676 503	666 064	172 132
Other	0		31 741	0	0	697 065
Reported road traffic fatalities (2013)	6 450b (75% M, 25%F)	6 700b (83% M, 17% F)	1 125b	137 572b (85% M, 15% F)	32 719b (71% M, 29% F)	1 770c (74% M, 26% F)
WHO estimated road traffic fatalities	35 641 (95%CI 27 949–43 332)	10 466	5 072 (95%CI 4 064–6 080)	207 551	34 064	1 827
WHO estimated rate per 100 000 population	20.5	12.8	30.0	16.6	10.6	2.9
Annual Estimated Gross Domestic Product (GDP) lost due to road traffic crashes is	3.0%c	-	-	3.0%c	1.9%c	1.0%d
Speed limit law					Yes	Yes
Max urban speed limit	50 km/h	60 km/h	50 km/h		32–105 km/h	48 km/h
Max rural speed limit	80 km/h	90 km/h	90 km/h		40–121 km/h	96 km/h
Max motorway speed limit	100 km/h	100 km/h	No		105–121 km/h	112 km/h
Local authorities can modify limits	NO	Yes	Yes		Yes	Yes
Enforcement	-					

Source: Adapted from(World Health Organization (WHO), 2015)

5.4.1: Pedestrians and cyclist's vulnerability in Africa

Road traffic fatality is becoming intolerably higher amongst Pedestrians and cyclists in sub-Sahara African. Several scientific traffic studies in recent times indicate that the crash involving pedestrian is most prevalent compared to other modes of transport. ½ of deaths on world roadways are among the vulnerable road users. The Table 27 below shows that the risk of a road traffic death varies significantly by region and different modal splits. Although there continues to be a significant disparity in rates within regions nevertheless, studies indicate that pedestrian in Africa is the most affected road traffic users.

Table 27: Road traffic deaths by type of road users (who region)

	Pedestrian	Cyclist	Car	Motorized 2-3 wheelers	Others	
Africa	39	4	40	7	10	100
Americas	22	3	35	20	20	100
Eastern Mediterranean	27	3	45	11	14	100
Europe	26	4	51	9	10	100
South-East Asia	13	3	16	34	34	100
Western Pacific	23	7	22	34	14	100
World	22	4	31	23	20	101

Source:(World Health Organization (WHO), 2015, World Health Organization (WHO), 2013a, World Health Organization (WHO), 2013b)

African today has presented highest rate of the possibility of dying on the roadways than any other continent in the world. Using dataset from WHO, World Bank, and other international pieces of literature, the African Region has the largest proportion of pedestrian and cyclist deaths amounting to 43% of all road traffic deaths. The African Region has the highest pedestrian traffic mortality rates, while European Region, notably among its high-income countries continue with a reduced fatalities rate. It is an uncontestable fact that the African Region possesses only 2% of the world's vehicles yet contributes 16% to the global deaths. Pedestrians and cyclists account for more than 38% of road traffic deaths in the African nation. An intuitive breakdown of this numbers show that Nigeria has the highest fatality rates of 33.7 per 100 000 population per year, follow by and South Africa with 31.9 deaths per 100 000 population per year. Studies indicate that More than one in four road fatality deaths in the African Region occurs on Nigeria's roads. Six other countries joined Nigeria to escalate this statistical traffic figure. The countries include Democratic Republic of Congo (DRC), Ethiopia, Kenya, South Africa, Tanzania, and Uganda thus responsible for 64% of all road fatalities in the continent. While Ethiopia, Kenya, and Tanzania have relatively small (for the region) road death rates. Nigeria, South Africa, and Uganda combine significant populations with very high mortality rates, resulting in scores of road fatalities. There is a growing International kind of literature suggesting that seven countries (Democratic Republic of Congo (DRC), Ethiopia, Kenya, Nigeria, South Africa, Tanzania, and Uganda) in Africa continent, must reduce high mortality considerably for the region to achieve a significant reduction in fatalities. Making pedestrian and cycling safer is critical to lessen the number of road traffic carnage in Africa and is essential for attaining the Decade of Action for Road Safety's aim to promote non-motorized forms of transport is the key. Many of dedicated efforts and preventive initiatives on road safety have been very successful at achieving and sustaining reductions in death rates in most European and America nations despite increasing motorization. This partly reflection of security consciousness and practical measures in place to protect different road users mainly pedestrian. It was disheartening nonetheless that similar global initiative to prevent accidents in Africa is currently unsustainable because Africa Nations not yet embraced these efforts. For example, only one African country signed up to the United Nations safety standard initiative protecting pedestrians in the event of a crash.

5.4.2: Nigeria Pedestrian fatality experience

No doubt about it Nigeria is the economic giant of sub-Sahara Africa with of 178.5million people and over 7.6million cars on its 204,000 kilometers' road network. Traffic accidents fatality patterns Nigeria has been very explosive and consistent since 1960. Per Table 28, The traffic fatalities in Nigeria have been twice the international average between 1960 to 2010. per (Ademiluyi, 2012, Ogwueleka and Ogwueleka, 2012, Filani and Gbadamosi, 1995). They concurred that the traffic fatalities records in Nigeria, have been consistent since 1960 till date (see the Table 28). Similar independent WHO (2013) reports, available for review indicates that there are 33.7 road fatalities deaths per 100,000 population in Nigeria every year. This road death statistics is making the Nigeria one of the countries with the highest number of deaths in Africa. Other independent resources from (World Health Organization(WHO), 2004, World Health Organization (WHO), 2013b, World Health Organization (WHO), 2013a, United Nations (UN), 2006, United Nations Human Settlements Programme, 2014c) attest to validity of this information

Table 28: Traffic accident in Nigeria 1960-2010

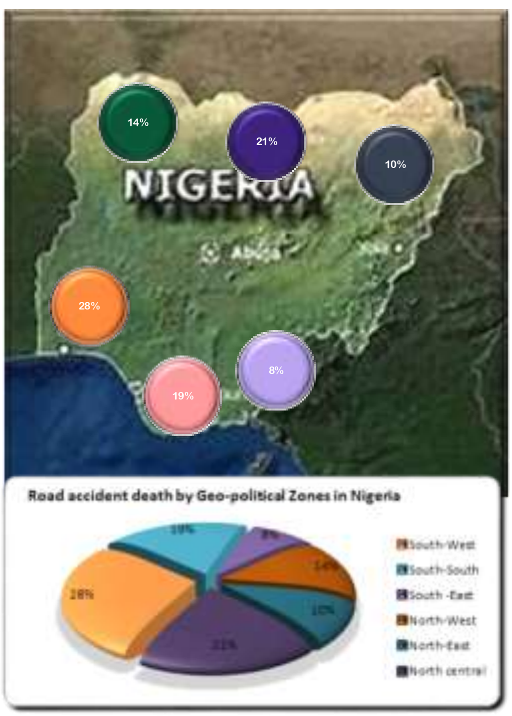
YEAR	NO OF CASES	NO KILLED	NO INJURED	NO OF CASUALTIES
1960	14130	108	10216	11299
1961	15963	1313	10328	11641
1962	16317	1578	10341	11919
1963	19835	1532	7771	9303
1964	15927	1769	12581	14350
1965	16904	1918	12024	13942
1966	14000	2000	13000	15000
1967	13000	2400	10000	12000
1968	12163	2808	9474	12282
1969	12998	2347	8804	11151
1970	16666	2893	13154	16047
1971	17745	3206	14592	17798
1972	23287	3921	16161	20082
1973	24844	4537	18154	22691
1974	2889	4992	18660	23652
1975	23651	5552	20132	25684
1976	40881	6761	28158	34916
1977	35354	8000	30023	38023
1978	36111	9252	28852	38104
1979	29271	8022	21203	29225
1980	32138	8736	25781	34720
1981	33777	10202	26337	36539
1982	37094	11382	28539	39921
1983	32109	10462	26866	37328
1984	28892	8830	23861	32691
1985	29978	9221	23853	33074
1986	25188	8154	22176	30330
1987	28215	7912	20804	28716
1988	25792	9077	25027	34104
1989	23987	8714	22117	30831
1990	21683	8154	19195	27349
1991	22498	9525	25443	34968
1992	22909	9620	25495	35115
1993	21419	9454	24397	33851
1994	18218	7440	18287	25727
1995	17000	6647	14668	21315
1996	16795	6364	14500	20864
1997	17500	6500	14500	21000
1998	16046	6538	17341	23879
1999	15873	6795	17471	24266
2000	16348	8473	19070	27543
2001	20530	9946	22309	32255
2002	14544	7407	22112	29519
2003	14363	6452	18116	24568
2004	14279	5361	16897	22258
2005	8962	4519	15779	20298
2006	9114	4944	17390	22334
2007	8477	4673	17794	22467

YEAR	NO OF CASES	NO KILLED	NO INJURED	NO OF CASUALTIES
2008	11341	6661	27980	34641
2009	10854	5693	27270	32963
2010	5217	4102	17744	21846
TOTAL	1,049,095	313,832	956,331	1,270,163

Sources: (Federal Road Safety Corps-Nigeria (FRSC), 2011, Federal Road Safety Corps-Nigeria (FRSC), 2012, Ogwueleka and Ogwueleka, 2012, Ademiluyi, 2012, Filani and Gbadamosi, 1995, Federal Road Safety Corps-Nigeria (FRSC), 2010)

More traffic analysis by Geopolitical and Regional distribution from Nigeria Federal Road safety commission report on Traffic accident reveals that Southwestern parts take 28% of the total traffic accident. This geographical area has the highest record of road accidents in Nigeria. North-Central Zone has (21%) of the total traffic accident in Nigeria. The total traffic accident for South-south and North-Western regions stood at 19 and 14 percent respectively. Graphical illustration of road accidents by geopolitical zones is in Figure 40 below.

Figure 40: Graphical illustration of road accidents by Nigeria geopolitical zones



Source: Adapted from (Federal Road Safety Corps-Nigeria (FRSC), 2010, Federal Road Safety Corps-Nigeria (FRSC), 2011, Federal Road Safety Corps-Nigeria (FRSC), 2012, Lagos State Government (LASG), 2011, Lagos State Government (LASG), 2012)

These statistic facts show an undaunted and high pressure on the road network across nooks and canines of Nigeria thus the prevalence of traffic accident. The repercussions of road traffic accidents in Nigeran has been colossal. The highway safety morbidity and mortality burden in Nigeria is a reality arising as results of the combination of salient factors. These factors include population, rapid motorization, poor land use/transportation, poor road and traffic infrastructure as well as the behavior of road users. Other causes of traffic accident crisis in Nigeria includes poor driving capabilities of drivers, environmental condition and lack of maintenance of the roads

5.4.3: Lagos-Nigeria pedestrian fatality experience

The main cities in Nigeria have the fair share of Road traffic death per population. An important data set from Nigeria Federal Road safety commission indicates that between 2006 and 2014 Lagos state has the predominant population of 8029200 with over 1579 death within eight years. Lagos figure was matched with Figure from Kano State with 3248700 with 373 accident rates within same time frame. (see Table29 below)

Table 29: Snapshot of Population and no of death reported 2006-2014

State	Population	Number of death reported 2006-2014
Lagos	80209200	1579
Kano	32487000	373
Ibadan	30784000	718
Kaduna	14589000	446
Porta-court	1053900	476

Sources:(Federal Road Safety Corps-Nigeria (FRSC), 2012, Abiodun, 1997a, Abiodun, 1997b, Filani, 2012) (Ogwueleka and Ogwueleka, 2012)

On the national scene, Lagos recorded the highest number of road traffic fatalities of 1,579 deaths from 620 events, while Kano has the relative number of road fatalities of 0.6 deaths per 100,000 population(Atubi, 2012b, Atubi, 2013, Eduardo A.Vasconcellos, 2001). A closer look at traffic data set in Table 30 below indicates variations in the fatality rates among local government area in Lagos State. The deaths rates are very consistent and uniform among the main local government areas across the state. Each of these Local public spaces (Ikeja, Lagos Island, Ajeromi, Lagos Mainland and Mushin local public spaces) sharing same fatality rate per capita. Lagos Island (the study area) is one of the major sub-urban area with high rate of accident fatality (see Table 30)

Table 30: Reported deaths from road traffic accident in different local government areas in Lagos

L.G.A.	No
Ikeja	32
Lagos Island	32
Ajeromi/Ifelodun	32
Lagos Mainland	32
Mushin	32
Apapa	16
Oshodi/Isolo	16
Surulere	16
Ojo	13
Agege	13
Shomolu	16
Badagry	32
Ifako-Ijaye	13
Ikorodu	32
Alimosho	13
Epe	32
Ibeju-Lekki	13
Kofofe	13
Eti-Osa	13
Amuwo-Odofin	13

Source:(Atubi, 2012a, Lagos State Government (LASG), 2010a, Lagos State Government (LASG), 2010b)

Table 31 provides additional information about reported number of injured since 1970 using local government area with same fatality rates. The questions to ask is very simple; what is the way out of these unimpressive number of death rate per capita in Lagos. Essentially, a critical analysis of the success stories of countries with very impressive and incredible records on road safety is the key. Thus, this study attempts an evaluation of European countries road safety experience as a lesson for practice in Lagos-Nigeria, Africa.

Table 31: Reported number of injured from road traffic accident in selected LGA.'s in Lagos state from 1970-2001

Year	Lagos Island	Ajeromi/ Ifelodun	Ikeja	Lagos Mainland
1970	40	32	56	40
1971	45	30	60	40
1972	33	35	33	35

Year	Lagos Island	Ajeromi/ Ifelodun	Ikeja	Lagos Mainland
1973	30	78	102	90
1974	50	60	70	60
1975	70	62	90	70
1976	90	72	90	90
1977	60	60	63	70
1978	98	70	99	90
1979	80	80	86	90
1980	100	92	105	98
1981	100	76	90	90
1982	60	50	64	70
1983	70	50	30	72
1984	65	50	70	66
1985	102	100	102	100
1986	82	76	85	35
1987	56	53	60	60
1988	100	79	100	101
1989	70	60	So	73
1990	71	50	73	71
1991	40	30	50	50
1992	35	35	40	4C
1993	40	29	50	45
1994	49	30	60	50
1995	20	32	40	30
1996	30	30	40	31
1997	30	40	45	30
1998	42	41	48	40
1999	40	30	50	41
2000	40	30	60	41
	42	33	53	44
Total	1930	1694	2234	2005
%	10.9	19.56	12.61	11.32

Source: Lagos State Police Command, Ikeja 2004

5.4.4: **Report of Innovative European road safety policies, lessons and good practice for Lagos-Nigeria, Africa**.

Several national and International studies attest to the veracity of European pedestrian traffic safety nature. For instance, the longitudinal scientific Survey data from a selection of seven European countries projects show that 20-40% of all trips in Europe are made by walking. The distance of walking trips varies but under 1km to 2.8km in most European larger cities. More scientific statistical evaluation on European traffic performance compare with United states indicates incredible revelation as the average walking share almost three times higher than in the U.S. (17% versus 6%) respectively. Studies also illustrate that the number of daily walking trips is greater for women than for men (Promising, 2001; Wittink, 2001; Lynott, 2010; Barnett, 2014). As with walking, even though the European cities and United states display many similarities. The transportation system is more sustainable in European nations (for example-Germany) compared with the United States, using a range of environmental, social, and economic indicators (see Table 32). Much of the difference is due to different travel behavior, which is partly the result of different policies.

Table 32: A range of environmental, social, and economic indicators of passenger travel and sustainability

Major parameters	The United States of America	The European (Germany)
The Car CO2 emissions per capita in pounds (2005)	8,600	2,900
The miles per gallon -vehicle fleet (2005)	20	30
Per passenger per year energy use, in million British thermal units (BTU), 2004-2005	55	17
Percent of household budget for transportation, 2003	19	14
Traffic fatalities per 100,000 population, 2002-2005	14.7	6.5
Cyclist deaths per 100 million miles of cycling, 2002-2005	18.0	4.0
The Pedestrian deaths per 100,00,0000 miles of walking between 2002 and 2005	8.0	4.0
The Car road fatalities per billion miles of car travel between 2002 and 2005	14.4	12.5
The Government transit subsidy as share of public transportation operating expenses in percent of levels of governmental authorities in the year 2006	62	26

***Sources:* Calculations based on the following sources (not cited elsewhere in the text): (Association of German Transit Agencies (VDV), 2002, German Federal Environmental Protection Agency (UBA), 2005, Oak Ridge National Laboratories, 2007)**

Per Table above, from an environmental perspective, transportation related energy use and CO_2 emissions per capita in Europe (Germany) are only about a third of the U.S. rate. There is technically more automobile utilization in the United States. Also, the car and light truck fleet in the United States of America is 50% less energy efficient as in Europe (Germany). The public transportation sector, Europe (German buses) are four times as fuel-efficient as American coaches.

The reason Mainly because of moderate energy use per passenger kilometer, more passengers per vehicle and more modern buses and trains. The truth is that just like any European countries the transportation network is also safer in Germany when compared to the USA. The total traffic fatalities per capita in the United States are 2.3 times higher than Germany.

The differences in road safety are especially striking for U.S. cyclists, whose fatality rate per mile cycled over four times greater. In addition to these broad characteristics, car travel is safer in Germany, with slightly lower fatality rates per mile driven. The better traffic safety in Europe (Germany) is due to better and extensive cycling and walking infrastructure. Other reasons include better motorist training, traffic calming of most residential neighborhoods, and traffic priority for non-motorized transportation. Nonetheless, Europe (Germany) better alternatives to the automobile and less car dependence encourage greater economic sustainability of transport. At the household level, Americans spend five percent more of their budgets on transportation, mainly related to ownership costs of multiple cars. Americans spend more than Germans although Americans drive with gas sold at half the price. Moreover, the public sector in Europe (Germany) spends less on transportation than the United States per capita. Mostly due to the provision of less expensive walking, cycling, and public transit facilities instead of the massive roadway and parking supply, as in the United States.

The question that readily comes to mind is how European nations got to this enviable road traffic status. The reasons among other include unique traffic culture, historical antecedents, government commitments, investment in research. Others are engineering and technological breakthrough. The ideology that standard space requirement for walking is far less than another modal split is a contributory factor. Table 33 provides space requirements for walking and other modal splits. For example, space area requirements for a car is ($11.52m^2$) on roadways and space area for the pedestrian is ($0.31\ m^2$). A car on the road will take approximately 38 pedestrians on the same space. 100 cars on the roadways can accommodate over 38000 pedestrian traffic. This assumption is one of the premises for flourishing pedestrian European in a friendly roads Environment. The key is pedestrian friendly streets environment require ample of land use consideration for pedestrian traffic than automobile traffic.

Table 33: Space occupied by each mode of transportation (the standing space needed for the pedestrian and other splits)

Mode	Illustration	Area required for the mode (m2)	Area ratio of mode/person*
Pedestrian		0.5 x 0.6= 0.31	1
Bicycle	 = 	0.6 x 2.0 = 1.22	4
Car	= 	2.4 x 4.8 = 11.523	38

Source: Author's construction (2016)

5.6: **Summaries of good practice example of European pedestrian friendly environment lesson not only for Lagos State**

Table 34 below provides summaries of good practice example of European pedestrian friendly environment as lesson not only for Lagos State, Nigeria but sub-Sahara Africa nations in particular

Table 34: Good practice example of European pedestrian friendly environment

Countries	**Design parameter**	**Pedestrianization policies**
Switzerland	Design Philosophy and Methodology: Land use policy and bicycle system Strategy	Most land use policies in Switzerland favored pedestrian, transit and bicycle use.
	Strategies: Development of Transport systems by Creating environmental friendly transportation goals	The Zurich City Council in 1987 set five primary transportation policy goals: promoting public transit, reducing motor vehicle traffic, channeling and restraining traffic in residential areas. Others include decreasing the number of parking spaces and guarantee the availability of dedicated bicycling and walking thus creating environment-friendly means of intra-urban movements. For more than 30 years, Zurich followed a policy of transit priority over private cars. This system implemented it through changes to infrastructure and traffic signals.
	System: Legislation and Constitutional back up for pedestrian transport & citizen participation.	City government and the public have consistently supported walking and bicycling, even at the ballot box. For example, dated back to 1955, motor vehicle traffic was restricted by law from the main street (Untertor/Marktgasse) through the historic city center. In 1973, by popular vote, motor vehicle traffic was prohibited from the entire historic city center. In 1983, popular vote approved the "Netzkonzept 100km," a 100-kilometer (km) (62.1-mile (mi)) bicycle route network. The late 1980s and 1990s saw several more iterations of bike route plans and pedestrian improvements. Most recently, in May 2009, an overwhelming majority of Winterthur voters (67 percent) approved an extensive streetscape project (with numerous pedestrian and bicyclist elements) near the city's central

Countries	Design parameter	Pedestrianization policies
		train station worth 84 million Swiss francs, or about US$78 million.
Copenhagen Denmark	Policies: Policies limiting automobile parking at the CBD Strategies	In Copenhagen, the city government has adopted several different policies that contribute to higher levels of walkability and bicycling, for example, Copenhagen has policies that limit automobile parking (through prices and availability) in the CBD and surrounding areas.
	Design Philosophy and Methodology: Land use Zoning policy that encouraged proximity of activities.	The city government has encouraged public workplaces, and the other main events located close to major public transit stations. A low emissions zone established in Copenhagen in which new policies seek to reduce particulate matter by 80 percent.
	Policies: A policy that discouraged car at the major centers through congestion charging.	The city and national governments considered a congestion charging zone proposal. Alternatively, Copenhagen that would charge motorized vehicles 3 Euros (about US$4.25) for passage during peak times (the charge would be 1.5 Euros, or about US$2.13, for daytime hours with free passage at night)
	Policies: Development of national Traffic Plan	The plan gave the exclusive right to pedestrian, for example, the Danish National Traffic Plan states that 4% of total car traffic should be converted into cycling and walk and one third car traffic under 3 km into non-motorized travel. In fact, with the advent of the plan several countries including the Denmark and Netherlands and ―report a Non-motorized travel rate of over 40 percent in urban areas. In addition to achieving considerable increases in the use of healthier and more environmentally friendly means of transport and still reduce the numbers of deaths and injuries among pedestrians and cyclists.
Sweden	Policies: The Urban User hierarchy strategy	Established an urban street user hierarchy that gave the highest priority to walking, biking, and public transit. The road user hierarchy developed to support a range of public policy goals. The Technical goals include climate change, congestion management livability, public health, and sustainability. This authority plan is a technical document that guides transportation decisions such as design, construction, maintenance, policy, planning, and operations. In this scheme, typical street design begins by considering the space needs of pedestrians and bicyclists first,

Countries	Design parameter	Pedestrianization policies
		rather than designating the motor vehicle area and then giving pedestrians and bicyclists the leftover space (if there is any).
Vauxhall London	Policies: concept of traffic evaporation	Initially, computer modeling indicated that excessive congestion would occur if traffic volumes across critical stop lines at the junction. However, eventually reduced by 20 %, the reduction considered necessary to provide the space and capacity. These areas needed for the proposed interchange thus emergency of the Transport planners have used the concept of traffic evaporation to win support for London's first fully integrated public transport hub at the Vauxhall Cross interchange in the south London Borough of Lambeth.
	Policies: priority order for road users such as pedestrians, bicyclists, transit users,	Also, the British system established this priority order for road users such as pedestrians, bicyclists, transit users.
	Policies: Design of Automated system for monitoring the activities of pedestrian	Transport for London, the regional transportation authority for London, put some measures in place to control pedestrian and bicyclist levels for several years, using both manual and automated counting systems. Manual bicycle counts performed at numerous locations at varying frequencies since 1972 till date.
Netherlands	Policies: The organic traffic clamming strategy is known as the woonerven Strategy	The Netherlands holds the world's road safety record, and all countries benefit from a closer look. The woonerven concept. A more organic traffic- calming approach, which has yet to take hold in most cities of the world, is the concept of "shared space" or woonerven in Dutch, translated roughly as living yard. Woonerven policy supports traditional segregation of motor vehicles, pedestrians, and other road users. Cars are treated as guests and expected to move at speeds compatible with walking. The speed is (roughly 8–16 kilometers/hour or 5–10 miles/hour).
	Policies: sustainable safety A strategy	A strategy for sustainable protection plan published in 2000 emphasizes classifying roads as areas for mixed land use. This policy is an extensive traffic calming measures, or as transportation corridors speed limits regulations and enforcement ranging 50 to 70 km/h (30 to 45 mi/h), depending on circumstances.

Countries	Design parameter	Pedestrianization policies
Rathausplatz/Theresienstrasse Square Germany	Policies: Preservation of historic city by pedestrianization process and address air quality problems	Since the early 1970s, the historic city center has been gradually pedestrianized to deal with the issue of worsening air quality. Despite many warnings from transport planners that this policy will fail and resulted in a chaotic traffic situation on the surrounding roads, the fact of the matter is that the chaos did not occur as projected. For example, forecasts predicted that the pedestrianization of Rathausplatz/Theresienstrasse Square (thereby closing a road which carried on average 25 000 cars/16 hours) resulted in traffic chaos in surrounding streets. This chaos did not materialize. At the same time, the decline in visitors predicted by retailers did not occur, in fact rather the opposite happened in the newly Pedestrianized streets.
	Policies: Urban walkability and sustainability policy	In the related development, the 1970s, widespread support for the pedestrianization scheme. The city authorities adopted a progressive strategy to give priority to more sustainable, less polluting modes of transport, to provide better access to shopping and offices within the area, and to improve parking space management.
	Policies: Traffic safety measures: Removal of cars from city center	The removal of vehicle traffic from the city Centre was carried out in phases, culminating in the closure of the last major transportation corridor through the city Centre between 1988 and 1989. Access to public transport permitted. Proposals to reopen the Rathausplatz/Theresienstrasse through road to car traffic following a change in political leadership of the city in 1996 realized due to public objection
	Policies: Urban Transformation strategy Of most areas in six phases into an attractive, pedestrian precinct, buildings renovated, and street furniture upgraded, and art works introduced	In 1989, following wide ranging consultation and a close vote by the city, the pedestrianization was made permanent. Over the next ten years, the area transformed in six phases into an attractive, pedestrian precinct, buildings renovated, and street furniture upgraded, and art works introduced. The area has become a pleasant place in which to stroll and enjoy street cafés free from pollution and congestion.

Countries	Design parameter	Pedestrianization policies
	Policies: The Urban development strategy supports pedestrian-only shopping streets (POSS)	Pedestrian-only shopping streets (POSS) have been trendy for many years in many European cities, especially in Germany. Pedestrian-only shopping streets (POSS) well designed, managed and strategically connected to networks of public transit, pedestrian paths, and bike routes. The Pedestrian-only shopping streets (POSS), dedicated cycling routes, and livable streets-making a significant contribution towards making communities more Livable. POSS design consists of one single street, two or more streets interconnecting with each other. Often through a square, to form a continuous and longer linear road. The central part of a POSS plan is a street-wide free landscaped zone for pedestrians. Streets designed and managed to achieve a desired environmental character and socioeconomic outcome. The project involved arrangement of the streets to accommodate pedestrian area at both sides. The plan also provides a variety of establishments that sell goods and services to the public along building line, such as souvenir shops, boutiques, restaurants, bars, coffee shops, grocery stores. Other includes but unlimited to bakeries, lifestyle and fashion stores, banks and department stores. Establishments such as churches, historic buildings, museums, weekly market, days fresh produce market, seasonal attractions and other special events accommodated in this plan.
France	Design Philosophy and Methodology: Development of the urban mobility plan.	The main aim of the project was to reduce the dominance of the private car and increase the use of more sustainable forms of transport such as public transport, cycling, and walking, in the city Centre. The first step was taken in 1992 and involved the extension of the traffic free precinct in central Strasbourg for a trial period. This trade free zone was subsequently made permanent and extended with the construction of Tramline
	Design Philosophy and Methodology: Traffic design and safety strategy	Also, through traffic access to the city Centre, which represented almost 40 % of general traffic flows, was removed. Access to districts of the city Centre and parking facilities has been made possible via several 'loops,' however, it is not possible to pass from one community to another. Through traffic is directed towards large boulevards on the outer circle or bypasses. Provision

Countries	Design parameter	Pedestrianization policies
		restricted local and delivery access in the heart of the city Centre. Parking charges introduced. The plan involved extending the traffic-free precinct in the city Centre and banning private car through-traffic; access restricted to tram, bus, taxi, bicycle, and pedestrians.
	Design Philosophy and Methodology: Traffic Evaporation policy	Strasbourg's policy of removing cars from its city Centre to make way for public transport, buses, new tram lines, cyclists, and pedestrians began in 1992. With the implementation of the 'plan de circulation. It is impossible to quantify the level of the traffic 'evaporation' in Strasbourg due to the nature of the data. Some of the traffic displaced to orbital routes, but a significant volume of traffic has disappeared. Also, the strategy has increased cycling, public transport patronage, and park-and-ride use. Over all, a significant reduction in the number of vehicles entering the city Centre reported. In 1990 before the implementation of the strategy, the number of vehicles in the city Centre was approximately 240 000 vehicles/day. By 2000 this had fallen by more than 16 % to 200 000 vehicles day. Forecasts suggest that had the strategy not been adopted, 300 000 vehicles anticipated in the City Centre in 2000, i.e. an increase of 25 %. This success achieved during a period of overall growth in the weight of traffic in the Strasbourg agglomeration as a whole

Sources: Adapted from (European Union (EU), 2011, European Union EU, 2013, Breen, Undated, Heydecker and Robertson, 2009, Renne and Wells, 2004, European conference of ministers of transport, 2003, European Commission, 2003, Wittink, 2001b, European Commission, 2000, Beatley, 2000, ECMA, 1996, Sarka, 1993, John and Pharaoh, 1989, Fischer et al., 2010, Buehler et al., 2016a, Pucher and Dijkstra, 2003a, Rodriguez, 2011, Lynott, 2010, Charles et al., 2010, Living Streets (The Pedestrians Association), 2016, Breines and Dean, 1974, World Health Organization (WHO), 2013b, TEEB, 2008, TEEB, 2011, Muller, 1985, Muhlrad, 2004, kraay, 1978)

5.5: Precedent studies of inter-urban pedestrian safety (African, American, Asian and European experiences)

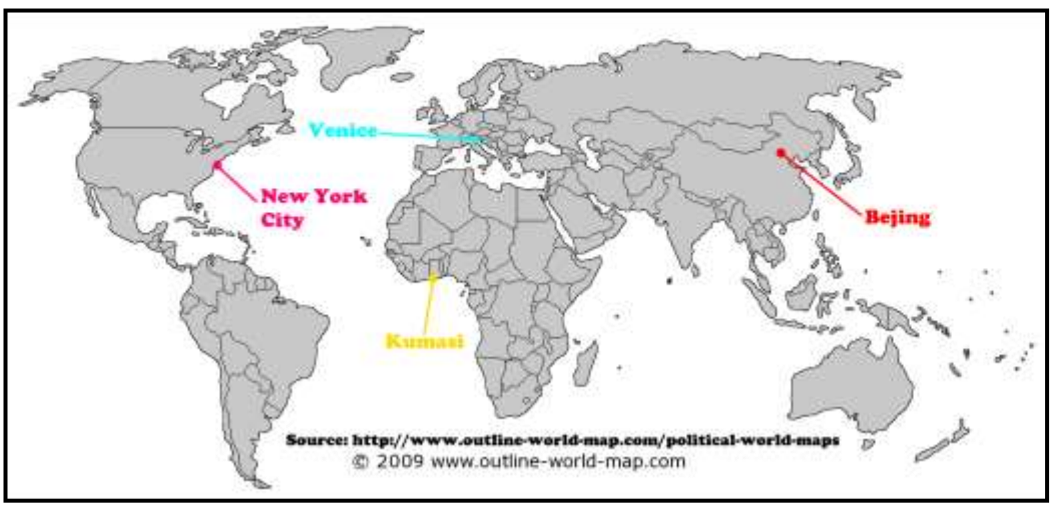
Precedent studies are a research tool to analyze and understand past experiences to improve existing and protect future situations. The lessons learnt enable recommendations to be made for solutions to local problems. This section identifies intra-urban pedestrian challenges and the practical measures adopted to resolve them in several metropolises. The lessons learnt from Beijing (China), Kumasi (Ghana), New York City (USA), and Venice (Italy) are used to propose pedestrian-safe solutions for the Lagos metropolitan area. Four parameters are used to measure the public pedestrian system in these selected cities:

1. A general overview of the choices made;
2. Transportation characteristics;
3. Significant challenges;
4. The safety design approach, traffic legislations and specific lessons learned from these cities in terms of a seamless pedestrian system;

This is followed by a summary of the lessons learnt.

General overview of precedent metropolises: why are these cities worth emulating?

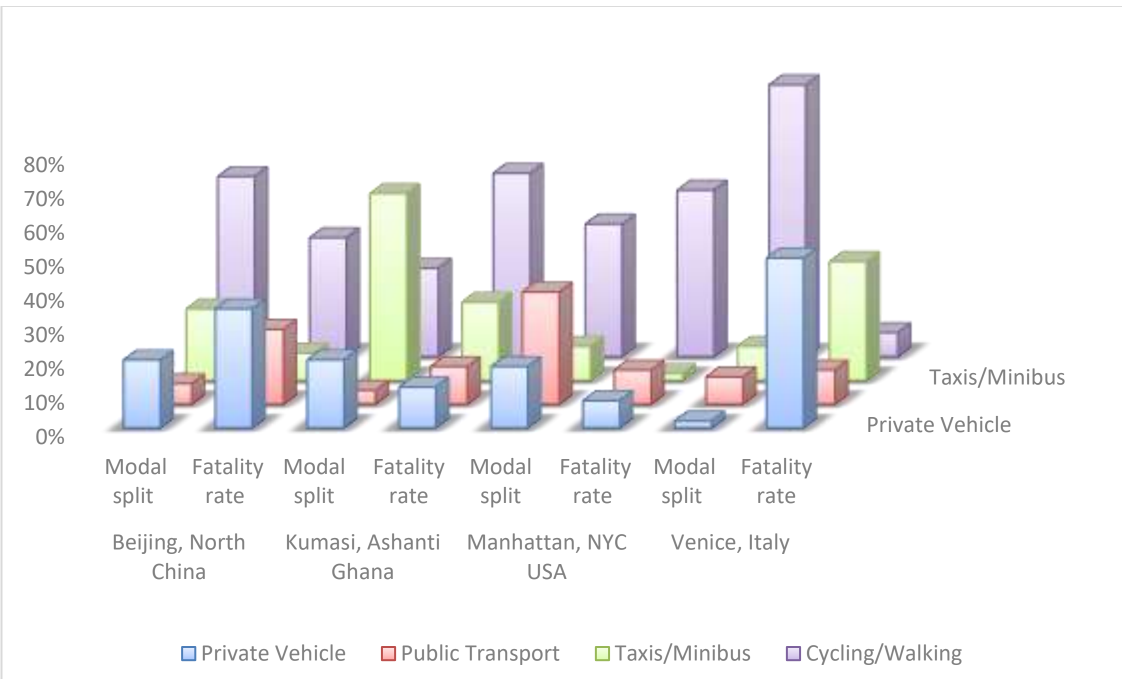
Figure 41: World map showing the location of the cities



Source: Adapted from Google Earth Map, 2016

As noted above, the cities selected include Beijing (China), Kumasi (Ghana), New York City (USA), and Venice (Italy) (see Figure 41 above). They thus span the continents of Africa, Asia, America, and Europe and are the primary centers and core cities for light industry, business and foreign trade in their respective countries. They are also characterized by high land costs and experience a massive pedestrian influx daily, as well as significant vehicular activity. The analysis examines intra-urban travel and road safety in these cities over two decades (1996-2016). The Figure 42 shows these precedent cities on a world map. It is important to note that these precedent cities are not necessarily the best models for intra-urban pedestrian safety but offer strategies that could be adapted by developing nations. Furthermore, they exhibit unique and common transport models and characteristics.

Figure 42: Transport modal share of the case cities



Source: Adapted from (Service, 2010, May, 2010, Gyamera, 2012, Obeng, 2013, New York City Department of City Planning (NYCDCP), 2006, New York City Department of Transportation, 2010b, Yanrong et al., 2014, Huapu, 2011, World Bank, 2012, Mamoli et al., 2012, Marissa et al., 2012, Cacciari, 2003)

The Figure 42 above presents information on the transportation models of these selected cities. Venice has unprecedented walkability of 80% of the total daily trips, while Beijing has 55% of walking and cycling trips per day and New York City and Kumasi have approximately 39% and 26%, respectively. Public transport's share stands at 6% in Beijing, 4% in Kumasi, 33% in New

York City and 8% in Venice. Most importantly, a critical evaluation of road fatality across these cities using same the Figure show high cycling /pedestrian related-accident especially in Kumasi (53%) and Beijing (36%). Interestingly, cycling /pedestrian related-accident in Venice appears to be the lowest (5%). This dataset in referenced the Figure also indicates cycling /pedestrian related-accident is almost two time higher than vehicular related crashes in cities like New York city and Beijing. Despite these fatality information, the overall assessment of these precedent cities' transportation systems suggests that they are sustainable to some degree and thus worth emulating.

While the Figure above points to a certain degree of overdependence on vehicles in these cities, it appears that pedestrian travel offers a broad range of benefits to both individuals and society. Private vehicles/cars, taxis, and mini-buses consume more non-renewable energy, emit harmful pollutants, cause traffic congestion and fatal accident. They are thus unsustainable transport modes. In contrast, transit systems with a high occupancy rate optimize road space, reducing traffic congestion, accident and emissions. (Maddox, 2013, Panter, 2010, Pardon and Average, 2012, Perdico´ulis, 2013, Shastry, 2010, Transportation, 2012, UNDESA, 2011, United Nations (UN), 2006, Wendt, 2009, Wilson-Chavez, 2013, Woodller et al., 2012, Charles et al., 2010, Singh and Singh, 2014, Singh and Jain, 2011, Lerman et al., 1978)

Even at half or one-third capacity, buses typically use far less fuel and emit fewer pollutants per passenger-km than cars (OECD/IEA, 2009). Another reason for selecting these cities is their population threshold. Each is home to between 250,000 and a million people. Two (Beijing and NYC) are mega cities. However, they differ in terms of weather, geographical coverage and country. Table 35 presents information on the location, geographic coverage, and demographic features of the four cities that render them appropriate in considering intra-urban pedestrian safety.

Table 35: Comparison of the main urban parameters of the precedent cities

City	Beijing,	Kumasi	NYC	Venice
Country	China, Asia	Ghana, Africa	United States of America	Italy, Europe
				
Population	11.51 million (2000)	1.17 million (2000)	8.406 million (2013)	260,060 (2012)
Coverage Area (km²)	6,336 mi² 16410.16 km²	98.07 mi² (253.819 km²)	22.82mi² (59.103529 km²)	160.1 mi² (414.398 km²)
Weather	61°F (16°C), Wind E at 0 mph (0 km/h), 94% Temperature and humidity both moderate	77°F (25°C), Wind SW at four mph (6 km/h), 82% Temperature and humidity both average	80°F (27°C), Wind NE at ten mph (16 km/h), 47% Cold Temperature and humidity both moderate	59°F (15°C), Wind N at nine mph (14 km/h), 72% Cold Temperature and humidity both moderate
Reported Traffic fatalities per 100000	5.6	10.2	2.8	-
GHG Kilogram per capita	700	837	3944	-
Traffic crash cost	$118000000-(2009)	$228000-(2006)	$1300000-(2012)	-

Source: Adapted from https://www.bing.com/images/;(Welle et al., 2015, The African Development Bank (AFDB), 2013a, The African Development Bank (AFDB), 2013b, Zhao, 2006)

Finally, each of these cities has an intra-urban pedestrian system that is worth emulating. They have made significant efforts to improve intra-urban pedestrian safety in a typical town center. The case studies demonstrate that it is possible to reduce car dependence in affluent and less affluent societies with high levels of auto ownership and improve the quality of travel.

5.5.2: Beijing

Beijing is China's political and cultural capital. Its history stretches back three millennia. Beijing is known for its modern architecture as well as its ancient features. It is home to architectural masterpieces such as the grand Forbidden City complex, the imperial palace during the Ming and Qing dynasties. (Gota and Fabian, 2012, Punte, 2010, Gota et al., 2012) note that Beijing is China's major city in terms of population growth and economic development. Urbanization, alongside rapid social and economic development has steadily accelerated, as has motorization. Beijing's population grew from 2.5 million people in 1954 to 7.8 in 1964 and the city was home to 10 million people in 1990. (Krambeck and Shah, 2006) and (Punte, 2010) note that this figure climbed to 13.6 million and 18 million people in 2000 and 2010, respectively

Transportation Characteristics

Urbanization has resulted in the rapid expansion of Beijing city (Sayeg and Charles, 2005). There has been a significant increase in demand for transport and the city is the most important transportation hub on Mainland China (Ng et al., 2012). At micro level, Beijing has a well-coordinated multi-modal transport system. It is home to China's biggest international airport, and has the largest rail system. Many national roads and expressways radiate from Beijing, causing traffic congestion in the city center, especially during peak periods (Sanyal, 2013). Changing land use-transportation patterns have given rise to both opportunities and challenges for urban transportation in Beijing. The city's changing land use patterns affect pedestrian behavior (European Commission, 2000), with negative environmental consequences (Joseph, 2002, Dobesova and Tomas Krivka, 2012). While walking is still a dominant means of travel in most Chinese cities, it is unsustainable (Sayeg and Charles, 2005).

Significant Challenges

Economic growth in Beijing has led to the exponential growth of the middle class, which has, in turn, increased the levels of urbanization and led to unprecedented growth in the number of private vehicles (Sayeg and Charles, 2005). A chaotic and congested traffic system, violation of traffic regulations and inadequate enforcement are the result, as are increased levels of greenhouse gas emissions (Huapu, 2011) (World Health Organization (WHO), 2013a). Another outcome is poor coordination of road design with bus stops and bicycle lanes (Yanrong et al., 2014). (Huapu, Ke, 2011) and (Huang, 2011) note that Beijing confronts severe land use-transportation issues, including poor crosswalks, inaccessible bus stops, and little regard for pedestrians' needs during redesign and construction. According to (Hao, undated), footpaths are often overcrowded, and the number of street crossings has declined. An independent study in Beijing by Chen, Meng, and Wang (2009) found that walking and cycling are the most traditional, energy conserving and environmentally friendly means of travel in both the central and commercial districts. The study evaluated two interchanges in Beijing (Huang, 2011) and revealed severe pedestrian (and bicycle) safety issues. It also concluded that pedestrians, cyclists, and motorists routinely violate traffic regulations (Yanrong et al., 2014, Urbanczyk, 2011).

While walking and cycling are crucial to sustain urban transportation systems, the evidence suggests that, in the past 20 years, the reverse has been the case in Beijing. (Yanrong et al., 2014, Asian Development Bank, 2015) note that walking and cycling are ideal for short trips, but this is sidetracked by overdependence on vehicles. This is ironic as the city's roads were traditionally suitable for walking and cycling. (Cervero, 2004) and (Suzuki et al., 2013) argue that the superimposition of new ring roads on the traditional superblock street network puts Beijing on par with two of America's most automobile dependent cities, Houston, Texas (with three ring roads) and Phoenix, Arizona (which features a symmetrical but massive superblock grid network). While a large proportion of Beijing's population traditionally used, cycling and walking daily, failure on the part of the city authorities to address pedestrian-vehicular conflict on roadways is undermining these forms of travel. As noted earlier, this is due to the city's rapidly growing population and increased private car ownership that far exceeds the growth rate of the population and Gross Domestic Product (Yanrong et al., 2014). It is estimated that financial losses caused by traffic congestion amount to $30,000,000 to $50,000,000 per month (Hao, undated). Per World global burden of disease project and epidemiological study, Beijing has estimated traffic-related death of 20.5 per 100,000 people. This figure is in line with similar statistical facts of most Middle-income countries (18.0 -25.0) but almost three times higher than the High-income countries. Beijing accident fatality rate in 2014 was 39.56% per million populations. These results show alarming traffic accidents.

The safety design approach, traffic legislations and urban development policies in Beijing: setting the pace for a seamless pedestrian system

Transportation is no longer a simple case of moving from one point to another but has become critical to human development. Seamless intra-urban pedestrian safety connections and an enjoyable and convenient travel experience are now seemingly out of reach. Integrated transport networks to support efficient pedestrian transfers are not in place in Beijing. However, the authorities are beginning to invest in pedestrian safety. Pedestrian infrastructure design strategies and transport-oriented development policies have become critical elements of the city's transport system. These lay a solid foundation to create efficient, convenient, and optimal multimodal development in Beijing. They include:

Exclusive Bus Lane design: In 1997, an exclusive bus lane was opened on Changan Street, with the aim of discouraging vehicular activities in the Central District. Traffic Calming Design Principle: In 2003 Beijing introduced speed reduction strategies. In central Beijing, the average travel speed was reduced from 45 kph in 1994 to 12 kph in 2003. Operating speeds are 7kph on several major arteries of the city and the peak period stretches over 11 hours. During peak times, 1/5 of Beijing's roads and intersections come to a standstill, with traffic speeds of less than 5kph (Cervero, 2004; Suzuki et al., 2013).

The Road Traffic Safety Law: In 2004, the Beijing government introduced the Road Traffic Safety Law to promote traffic safety and protect pedestrians and other vulnerable road users.

Stopping licensing of motorcycles and banning bicycles outright in the CBD: From 2005, Beijing no longer permitted vehicles and banned bicycles powered by diesel engines from urban areas. It also set quotas for the entry of private cars into the CBD (Cervero, 2004).

Restoring the streets that are part of the pedestrian system: In 2006, streets within the city that had grown narrow were restored and, and bike lanes were removed to incorporate a pedestrian system. The layout of the core area accommodates the pedestrian system and promotes pedestrian safety. Other policies include land use-transport integration and a high-density pedestrian development program (Murguía and United Nations Environment Programme Division of Technology, 2014).

Public rail transportation development: In 2008, Beijing invested heavily in an urban rail project. This project was part of preparations for the 2008 Summer Olympic Games. Some 300 km of rail transport was planned to be in place within four years.

Quotas: In 2008, Beijing adopted a policy that vehicles with odd license numbers and those with even numbers would be able to enter the city on alternate days. This is a successful short-term TDM scheme (World Bank, 2012).

Restrictions on new car purchases: In 2011, Beijing expanded the range of measures by restricting the number of new vehicles sold to 20,000 per month. This compares with the more than 60,000 a month sold in 2010. Buyers are selected via a monthly lottery among those who register their desire to buy a car. The use of vehicles registered outside Beijing is also restricted. In January 2011, the first month of this scheme, more than 200,000 applications were received (*China News*, 2011)(World Bank, 2012).

Municipal government program: In 2012 Beijing introduced a municipal government and empowering program. The newly established municipal government focuses on urban planning, engineering, and other built environment measures (Silva, 2013).

Reinvigoration of Traffic Calming Design: In 2013, the authorities implemented pilot traffic calming measures on six roads. According to a World Bank (World Health Organization (WHO), 2013a) report, these measures aim to reduce speed and improve safety. The design includes construction of speed humps, raised crosswalks, raised intersections, speed cushions, roundabouts, chicanes, and neckdowns. A before-and-after evaluation conducted in October ((World Health

Organization (WHO), 2013a) found that these interventions had significant impacts on three aspects of road safety in Beijing. The number of pedestrian killed was reduced from two to zero, the number of injured decreased from six to one, and average vehicle speed decreased by 9% in the selected areas.

5.5.3: Kumasi

Kumasi is the second largest metropolitan area in Ghana's Ashanti Region. It lies at the heart of Ghana and is the leading manufacturing center, cultural capital, prominent communication center and most importantly, a major commercial center(Amoako et al., 2014). Before 1995, the metropolis fell under the Kumasi City Council. Kumasi City is aesthetically pleasing with beautiful layout and green landscape elements. This has earned it the accolade of the "Garden City of West Africa." It grew outward from Adum, Krobo, and Bompata in a concentric form to cover an area of approximately ten (10) kilometers in radius. Growth was originally along the arterial roads due to pedestrian accessibility. This resulted in a radial pattern of urban development. The Kumasi metropolis is the most populous district in the Ashanti Region, and is home to 1,730,249 people, representing 36% of the region's total population (4,780,380). The 2000 Population Census put Kumasi's population at 1,170,270. It was projected to have a population of 1,625,180 in 2006 based on a growth rate of 5.4% per annum, accounting for just under a third (32.4%) of the region's population. The metropolis has a population density of 8,075 per square kilometer. Between 2000 and 2010, the population increased at a higher rate than previous growth.

Transportation Characteristics

The circulatory road network pattern in Kumasi comprises of five intra-urban arterials that include the first roads in Accra, the WA, Sunyani, Tamale, and Cape Coast Roads. These link Kumasi to other parts of the country as they all radiate from the center of the city. There are also four other primary highways, which connect other districts in the Ashanti Region to Kumasi. These are connected by a central circular ring road, which channels traffic from the city center (Hao et al., 2007). The first level roads support a network of existing and proposed districts, the local distributor, and access roads. The World Bank states that the total length of the road network is 430 kilometers. Of this, 26% is comprised of asphalt, and 53% of surface dressing, while gravel and earth roads account for 21%. Most traditional roadways were designed with minimal consideration for pedestrians.

Significant Challenges

Over the past two decades, the Kumasi CBD has transformed from an office and business environment to include significantly more mixed development. This resulted in dependence on taxis, and minibuses with low passenger rates and high emissions. This situation is exacerbated by the increase in private vehicle usage that was predicted to grow by 1,388.4% (669,942) in 2022. This is expected to induce sprawl and inefficient land use patterns. It has also affected the pattern of physical development within the city in the sense that, road infrastructure is behind physical development instead of the reverse (Adarkwa, 2011). At the same time, land use-transportation is affecting the pedestrian system and the volume and variety of pedestrian and vehicular traffic in the CBD. This has placed additional demand on fixed surface street transport and supporting infrastructure. Kumasi is an intermediate-size city in which the transport system is underdeveloped, and coordination and leadership capacity appear to be somewhat weak. However, poor accessibility and mobility have not been treated with the same sense of urgency as in the other case study cities (Africa Transport Policy Program, 2015).

Per World global burden of disease project and epidemiological study, Kumasi has estimated traffic-related death of 10.2% per 100,000 people. Kumasi accident fatality rate in 2014 was 36% per million populations. These results show alarming traffic accidents. Other problems include substantial traffic congestion, particularly during peak periods. Traffic in the Kumasi CBD causes high vehicle emissions and is compounded by weak enforcement of traffic regulations, inadequate provision for pedestrians and cyclists, poor road safety arrangements, and high accident rates (Poku-Boansi, 2008). Kumasi’s city center has a vehicle speed of just 16kph. Another bone of contention is how to synchronize on-street parking with pedestrians’ movement to ensure safety. Investment in pedestrian transport has not been a priority. Like Beijing, the problems confronting Kumasi can be attributed to rapid economic growth, which has had the effect of increasing motorization and urbanization across the city center.

The safety design approach, traffic legislations and urban development policies in Kumasi: setting the pace for a seamless pedestrian safety system

Positive trends and improvements in Kumasi include: Establishment of the National Road Safety Commission: This Commission, which was established in 1999, aimed to provide traffic education and enforce the law. It was set up in terms of the Road Safety Law: 1999 Act of Parliament (Act 567 of 1999). Among its chief duties are to oversee traffic safety management in Kumasi metropolitan area and enforce road safety laws. The law specifically covers speeding, jaywalking, inappropriate parking, hawking on pedestrian walkways, and motorcycles (May, 2010, UN-ECOSOC (United Nations Economic and Social Council, 2006). The commission is also saddled with responsibility for mass education.

Traffic calming Design Principle: Introduced in 2001, traffic calming strategies include reducing speed limits in CBDs and strip shopping precincts with high pedestrian activity. Rumble strips and speed humps are employed, and good results have been reported on the main Accra-Kumasi highway at the crash hot spot of Suhum Junction. The aim was to reduce the number of traffic accidents by around 35%. Fatalities fell by some 55% and serious injuries by 76% between January 2000 and April 2001 (Wee, Annema, & Banister, 2009). Kumasi has plans for traffic-calming measures in almost all residential and CBD streets in the coming years.

Traffic signal management system: In 2012, a traffic signal management system was introduced, including a central control center in Kumasi (Gyamera, 2012).

Advocacy program for increased visibility of school children: In 2013, Kumasi introduced an advocacy program for greater visibility of school children on roads (Murguía & United Nations Environment Programme Division of Technology, 2014).

Independent surveys and commissioned studies: Between 2010 and 2014 their surveys and commissioned studies examined pedestrian activities in the CBDs. The surveys by (Peprah et al., 2014, Tontoh, 2011, Service, 2010, Gyamera, 2012, May, 2010) involved a short questionnaire on travel and social-economic characteristics. Among other things, the purpose was to identify pedestrian travel challenges, infrastructural development, and support for a pedestrian system.

Promotion and institutionalization of urban land use transportation integration: Urban land use-transportation management was developed and institutionalized in 2014. It includes investment and reinvestment in traffic engineering, management, and area-wide traffic signal control in Kumasi metropolitan area. There is also provision for public transportation.

5.5.4: New York City (NYC)

New York City comprises of five boroughs located where the Hudson River meets the Atlantic Ocean. Manhattan is a key feature of NYC. This densely populated district is among the world's major commercial, financial and cultural centers(Jacobs, 1961, Newman, 2003). Popularly known as City, it never sleeps due to its bustling urban activities. New York City has an extraordinarily diverse population and is one of the few cities in the US in which four different racial/ethnic groups each constitute at least 10% of the population. Another feature of NYC is population growth. In 1790 and 1890, its population stood at 33,131 and 1,515,301 respectively. By 1970, 7,894862 people were living within the city. In July 2015, the US Census Bureau estimated NYC's population at 8,550,405, an increase of 375,300 residents (or 4.6%) over the April 2010 census. The figure for 2014 falls just short of the projection of 8,550,971 people by 2020. The World Bank notes that it was one of the first five cities in the world to achieve mega city status.

Transportation Characteristics

New York City has a dense population threshold and mixed land use development. This compact urban configuration is the defining characteristic of multimodal travel in NYC, which has a vast network of local roads, highways, and subway systems (both passenger and freight). Its transportation system also includes mass transit systems and pedestrian, and bicycle facilities. The city is also the hub of local and international airports and waterways. Indeed, it is the transportation hub of the US and the world.

Plate 2 : Junction of Broadway and Time square in New York City

Source:(Shelton, 2015)

New York City is also one of the world's most pedestrian-friendly cities (see Plate 2). Interestingly, it tells a tale of two cities. The city is a global retail and tourist center. Urban planning theory notes that when a large proportion of a city's population lives, works and visits as tourists in a relatively small landmass, there is less need to move, enhancing the potential for walking and public mass transportation. Combined with the conglomeration of places of employment, this has resulted in NYC having one of the most vibrant pedestrian cultures in America. A large longitudinal study confirmed that many tourists and residents regard walking in NYC as the most practical mode of travel. Despite these significant gains, the rate of pedestrian travel has slowed in recent years due to excessive vehicular travel (Singh & Jain, 2011).

Major Challenges

While NYC's roadways are amongst the finest and safest in the US and the world, like other mega cities, it confronts transportation challenges. Electronic spectroscopy information supplied by the NYC government confirms that as the city's population continues to increase, expanding daily travel in a relatively small space is not cost effective. The growth in intra-urban travel is causing congestion, even though there are restrictions on cars entering the CBD. This is particularly problematic during peak periods and parking is difficult to find and expensive. Traveling the streets of NYC has become increasingly unsafe due to vehicular and pedestrian conflict. Per World global burden of disease project and epidemiological study, New York City has estimated traffic-related death of 8% per 100,000 people. This figure though not as high as some cities in the world, but in comparison with other European cities, it is on a high side. This calls for an exploration of modal split transportation priorities, e.g., settling for a vehicular dominated city, expanding bike share programs, or making the streets safe for pedestrians. City administrators, planners and engineers thus need to apply their minds to the most appropriate strategies to improve intra-urban commuting times for residents and visitors.

The safety design approach, traffic legislations and urban development policies in NYC: setting the pace for a seamless pedestrian system

Improvements and safety approaches in the past two decades have saved the lives of pedestrians, motorists and passengers. They include:

Traffic Calming Design principle: In 1996, NYC introduced traffic calming measures to reduce speeding on core residential and commercial streets throughout the city (New York City Department of City Planning, 2004, Lu, 2013).

Reinvigoration of the Traffic Calming Design Principle: In 2004 ((New York City Department of City Planning, 2004, Lu, 2013, New York City Department of Transportation, 2009a) the city revisited the traffic calming and pedestrian safety measures adopted in 1996. Programs were adopted that target specific vulnerable populations and road users. The program includes engineering and education approaches.

Safe Route to school Program: This focuses on improving pedestrian safety around schools with high accident rates (New York City Department of Transportation, 2010b).

Safe Routes to Transit: This program was introduced in 2007. It aims to provide safe and more convenient access to bus stops and subway stations (New York City Department of Transportation, 2011, New York City Department of Transportation, 2012, New York City Department of Transportation, 2009a, New York City Department of Transportation, 2009b, New York City Department of Transportation, 2010c, Lu, 2013).

Launch of PlaNYC: Launched in 2008, this is a long-range, comprehensive plan for sustainable transportation development in NYC. It redefines some of the city's transportation practices towards a more multimodal approach to street design in contrast to previous approaches that prioritized motor vehicle mobility. Towards the end of 2008, NYC introduced the sustainable streets strategic plan that focuses on pedestrian safety, the adoption of complete streets standards and streamlined traffic calming. It includes capital construction projects, as well as a major redesign of the city's public spaces and streetscape. The records show that in 2008, national fatality rates per 100,000 residents were three times higher than in NYC (12% versus 3.5%). Compared with the ten other largest US cities, NYC is the safest. The fatality rate is less than half the average (3.5% versus. 8%) (New York City Department of Transportation, 2011, New York City Department of Transportation, 2012, New York City Department of Transportation, 2009a, NYC Department of Planning, 2013, New York City Department of City Planning, 2013).

Streetscape Design strategies: Introduced in 2009, these plans include curbs extensions, pedestrian refuge islands, speed bumps and bicycle lanes - all internationally recognized best practices. Curb extensions, pedestrian safety islands, and raised medians reduce pedestrian crossing times and distances. Other advantages include improving pedestrian visibility, making crosswalks more apparent to drivers, and calming traffic by narrowing roadways (Angotti, 2010, City of New York, 2010 , New York City Department of City Planning, 2013, NYC Department of Planning, 2013, New York City Department of Transportation, New York City Department of City Planning (NYCDCP), 2006).

Traffic Design standards and specifications: In 2009 NYC introduced a citywide design manual, which lists the essential safety design treatments used across the city. A study on the "New York City Pedestrian Safety Study & Action Plan," shows that between 1990 and 2009, there were tremendous improvements. Accidents involving all road users fell by 63% compared to the national decrease of 24%. The results suggest that roadways in NYC were nearly three times safer in 2009 than in 1990.

Safe Streets for seniors Program: This program was adopted in 2010. It includes street redesign projects that include features such as curb extensions, median extensions, and pedestrian ramps to improve pedestrian safety and mobility in neighborhoods with high rates of accidents involving elderly pedestrians.

Follow-up study on the Green Light for Midtown project: In 2010, NYC conducted a follow-up study on this project. It identified the causes, common factors, and geographic distribution of pedestrian accidents between 2005 and 2009. The findings suggest that traffic calming and pedestrian safety measures have been effective. A 35% decrease was recorded in pedestrian accidents and a 63% decrease in injuries to motorists and passengers in the study area after completion of the project (New York City Department of Transportation, 2010a, New York City Department of Transportation)

Pedestrian Safety Study and Action Plan: This study commenced in 2011 and focused on priority interventions in pedestrian safety. It resulted in some amendments to the administrative code of the City of New York, in the form of Local Laws 11 and 12. This law requires the NYC Department of Transport to identify the 20 locations where the highest number of pedestrian accidents occur each year for priority intervention (New York City Department of Transportation, 2011, New York City Department of Transportation, 2012)

Exclusive Bicycle lanes project: The introduction of bike lanes has also enhanced safety for all road users. The city's roadways are designed to prevent dangerous speeds, especially when pedestrians and cyclists are present; motorists are not permitted to exceed 20-30 miles per hour. The NYC Vision Zero project - Transportation Alternatives notes that speed enforcement is a cost-effective way to control and reduce dangerous speeding on roadways. Safe speed detectors are installed to reduce the number of fatal accidents (Transportation Alternative (Transalt.org), 2011, Lu, 2013, NYC Department of Planning, 2013, New York City Department of City Planning, 2013, New York City Department of Transportation).

Pedestrian-oriented re-engineering approach: Between 2007 and 2013, NYC introduced an aggressive pedestrian-oriented re-engineering approach. Despite dynamic pedestrian-oriented street reconfiguration between 2007 and 2013, citywide pedestrian fatalities have not fallen. In fact, between 2012 and 2013 the death rate increased dramatically while that of other street users fell.

The Vision Zero project: In 2013 the current administration announced a new road design policy called Vision Zero. It aims to put an end to deaths from all traffic accidents, regardless of the mode of transport. The pedestrian policies adopted by NYC have reduced traffic fatalities and injuries. The city complies with international organizations' recommendations on speed bumps and bicycle lanes (Lu, 2013, Transportation Alternative (Transalt.org), 2011, New York City Department of Transportation, New York City Department of Transportation, New York City Department of Transportation)

5.5.5: Venice

Venice is the capital of northern Italy and lies within the Veneto region. The city has physical peculiarities since half of it is spread over water. Venice is a moderate size city built on more than 100 small islands in a lagoon in the Adriatic Sea. It is the most visited recreational city in Italy and is known for its artistic, historical and environmental beauty. Venice's historic center is about 4 km or 2.4 miles off the coast of Northern Italy. Around 22 million people from all over the world visit the city each year (up from just two million in the 1950s). Tourism thus generates much of Venice's income. However, statistics show that the city is gradually losing both residents and tourists.

Transportation Characteristics

Venice is spatially compact, with small, aesthetically pleasant, uncrowded streets. It is a refreshing and safe experience to walk across Venice (Francois-Joseph & Ralf, 2014; Ochs, 2014; Victoria Transport Policy Institute, 2014). There are five main ways to travel into Venice: car, train, bus, plane, and cruise ship. The connection is through the mainland via the Venice Railroad Bridge, and a road causeway named the Ponte Della Libertà ("Bridge of Liberty"). Venice is a typical pedestrian city, with travel by both foot and on the nearly 100 canals with private and public boats (see Plate 3 below). Walking is the primary mode and travelling by boat the secondary one. In the historical center of Venice, the air quality is good due to the low number of vehicular trips. The city's travel patterns are thus unique. A significant portion of traffic results from taxis.

Plate 3: Venice St. Mark square

Source:(Hass-Klau, 2016, Mamoli et al., 2012)

Significant Challenges

The fact that the residents of Venice commute to work on foot or use public transportation does not exempt the city from the problems that confront the average major city. The city confronts many traffic challenges alongside environmental, spatial and social issues. Cars are not allowed in Venice; the city's vehicles comprise boats. However, these vessels cause noise pollution and congestion. Unique to Venice is the *moto ondoso*, or wave movement, that is a major environmental problem. Venetian canals and buildings are significantly affected by the continuous massive wake force produced by boats, experiencing destabilization as the canal walls deteriorate over time. Boats also cause noise and water pollution. Furthermore, while 80% of daily travel in Venice is on foot, the city is an inaccessible labyrinth, especially for the elderly, children and visitors. The Venice Smart City online website acknowledges this problem. A study by the University of Venice (IUAV) and the municipality noted that frustration and confusion are common tourist walkability experiences in the city. Furthermore, little data is available to inform pedestrian planning.

Other challenges include inadequate transportation linkages between residential areas and commercial, retail and recreation facilities within Venice and reduced transit feeder services from residential neighborhoods to major transportation corridors. There is a shortage of rail and bus services, and streets or paths which encourage cycling and walking. Congestion is caused by through traffic from outside the community and there is a lack of parking for visitors during the peak tourism season. The traffic situation on both islands (private and public boats concentrated in the peak hours of the day) and on the mainland (private transport – cars and trucks) has significant social and environmental consequences. The wave motion ruins houses' infrastructure, and fuel emissions compromise air quality. The Venice Smart City initiative aims to redesign and incorporate the historical center and the terminal area (including train stations, Tronchetto and Piazzale Roma) which cannot currently absorb and ensure pedestrian flows. It is also not capable of facilitating the interchange between different intermodal transport modes (Till et al., 2015b).

The safety design approach and urban development policies in Venice

Setting the pace for a seamless pedestrian system

In 1970, Venice introduced a car-free policy that remains in force and is famous throughout the world. It aims to make the city attractive, sustainable and healthy and to provide public transport that will bring about a renaissance in urban life.

Venice also introduced traffic calming in 1990 and set a speed limit of 10km/h or less within the city. Studies confirm that since 1990, 85% of the road network in the city has been subject to traffic calming. Plans are in place to cover the entire city. Play streets/home zones have been identified in neighborhoods and speed limits of as low as 10km/h or less have been imposed. There are no statistics on the number of such measures because they are often part of overall traffic-calming schemes (Cacciari, 2003, Buehler et al., 2016b).

In 2012, **the City of Venice embarked upon a pilot of the overall mobility approach** (that focuses on pedestrian sustainability), otherwise known as Sustainable Urban Mobility Planning (SUMP). This enabled a high level of participation in safe and healthy school arrivals. The goal of the pilot was to create awareness among children and parents of healthy and safe school travel. Stakeholders that include children, parents, teachers, planners, and politicians, identify local challenges in school travel and come up with new ideas for healthier and safer school trips.

They are also empowered through **participation in planning and implementation**. Launched in 2014, the Venice Smart City project aims to improve pedestrian safety by integrating human scale design and progressive governance initiatives. It provides services based on people's real needs (Monheim, Till et al., 2015a)

5.6: Basic good practices identified, and specific lessons learned from the precedent cities

The purpose of this section is to determine overall sustainability of these precedent cities. To achieve this aggregation methodology is applied and these cities ranked (0 -2) -Worse to (8-10)-best ranking parameters). The ranking is based on performance in relation to indicators already explained above. Table 36 provides snapshot of an interpretation of rating scale).

Table 36: Interpretation of rating scale

Score	Interpretation
0-2	Worse
2-4	Fair
4-6	Good
6-8	better
8- 10	best

Source: **Author's construction (2016) ©**

From Table 37 below among these four cities Venice and New York City are more sustainable with respect to pedestrian safety with Kumasi city being the least sustainable. This comparative analysis shows a gap between best pedestrian performance city (Venice) even New York City and Beijing among other indicators.

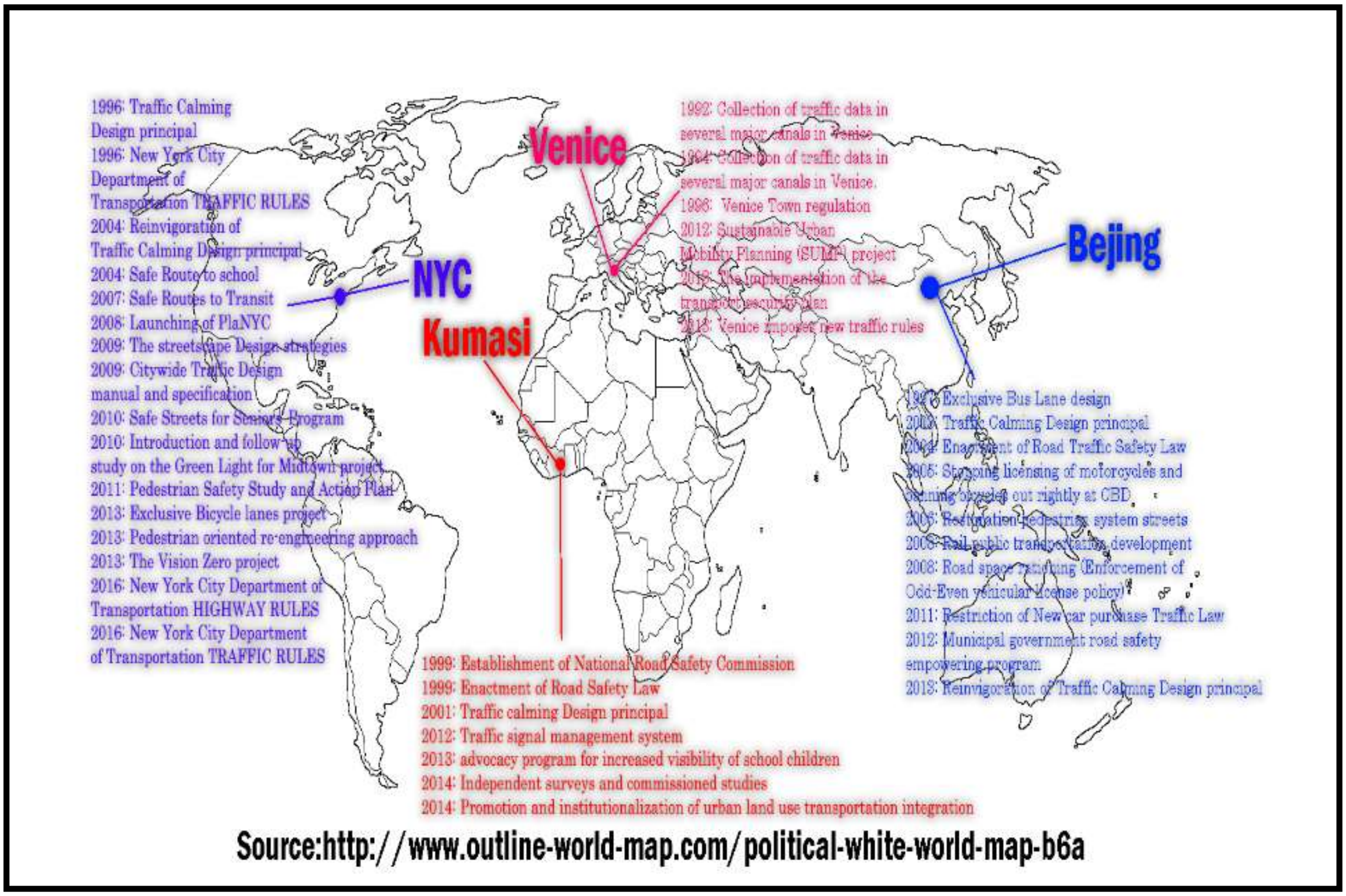
Table 37: Comparative analysis of the precedent cities sustainable indicator

	Transportation Characteristics	Overcoming Significant Challenges	The safety design approach and urban development	Aggregated score	Aggregated %	Rating /rank
Venice	9	8	9	26	87	1
New York City	8	8	9	25	83	2
Kumasi	5	5	8	17	57	3
Beijing	5	6	8	19	63	4

Source: **Author's construction (2016) ©**

Nonetheless, the summary of the results of the precedent analysis in Figure 43 shows some similarities in the conceptualization and operationalization of improving intra-urban travel and safety measures in these cities. They became markedly safer after the implementation of their pedestrian policies and strategies in the period under review (1996-2016). These measures aim to protect vulnerable road users, enhance road safety and expand the use of public spaces for both pedestrian and vehicular traffic. Overall, these examples of good practices show that there is need to take intra-urban pedestrian safety and vehicular travel seriously. This can be achieved by combining mixed land use-transportation measures with broader initiatives to strengthen intra-urban travel inclusion.

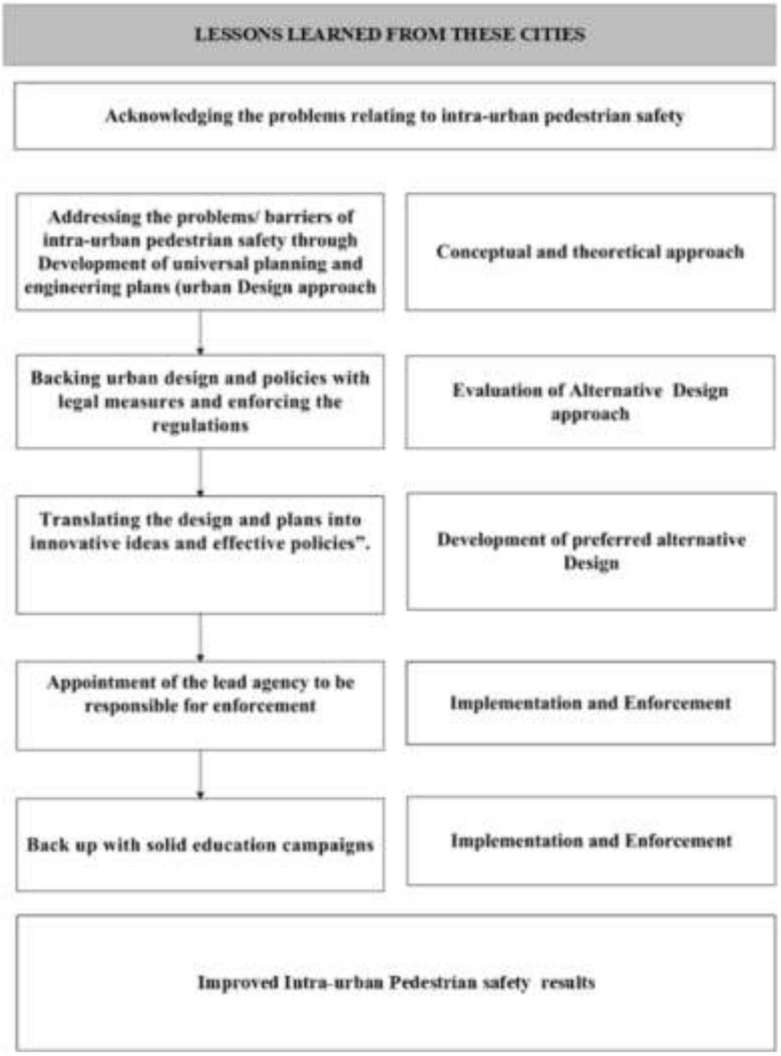
Figure 43: Regional similarities in the conceptualization and operationalization of intra-urban pedestrian safety



Source: Author's construction (2016) ©

The lessons learnt from these cities are summarized in the roadmap in Figure 44. The roadmap recommends methods to improve intra-urban pedestrian safety, based on experiences from the four cities. The figure shows that these cities acknowledge that intra-urban vehicular and pedestrian travel and security is a significant problem. To address this, there is a need to start with planning and engineering strategies. These translate into comprehensive planning and innovative design in a collaborative process that includes policies, enforcement of laws and regulations, and education.

Figure 44: Roadmap of seamless pedestrian system using specific lessons gained from the cited cities



Source: Author's construction (2016) ©

The aim of these measures is to adapt successful strategies implemented elsewhere to local needs. Beijing, Kumasi, New York City and Venice have developed comprehensive public pedestrian and city design strategies that incorporate pedestrianization in the overall street structure, thus promoting walkability and environmental sustainability.

5.7: Conclusions from the literature review

Consideration of pieces of literature starts with understudying and unloading relevant conceptual and theoretical framework. Besides, there is extensive discussion on Land use and transportation. Back tracking to the last forty years, this part of land use and transportation study of works of literature cover among other things culture and conflicts between the duo. The thrust is to help the reader understand different aspects land use /transportation evolutions, coordination, and effects on overall mobility of people. Additional Pinpointed area of close and extensive review is the elevated global risk of dying in a road crash. The study review also covers Road traffic fatality intolerability especially among Pedestrians and cyclists (pattern and preventability). In addition to these other reviews examines economic and social costs of the global traffic accident. This study report dealt with Road traffic fatality trend with emphasize on small and middle-income countries, Africa, Nigeria and Lagos. In addition to other academic reviews, this study protrudes more into broad Road Traffic fatality regarding Innovative European road safety policies and lesson learned. The later parts review of relevant literature also covers case study analysis of success story of improving pedestrian safety throughout the world primarily using four major cities. Africa(Ghana), America (New York) Asia (Beijing), and Europe (Venice). These counties pedestrian transportation improvements have been of international standard and 20years of enviable records and good standing ability to addressing pedestrian issues.

These examinations of precedent serve as a good practice example for improving pedestrian safety in Lagos-Nigeria and Africa in general. This collection of good practices and lessons learned in some ways serve more like an acquisition of knowledge and experience involving harvesting existing knowledge on the topic, drawing reasonable conclusions from these four nations. Overall, there are the number of appreciable and stunning revelations emerging from these reviews that are germane to improving pedestrian safety. Achieving walkable city requires some scientific conceptual and theoretical application. In this study, prior review of relevant academic and professional's pieces of literature help better-integrating concepts and theories with everyday life through highlighting the importance of improving pedestrian safety. Additionally, material learned from concepts and theories applied to benefit the study and serve as an excellent way for the researcher to applying lessons to real-world situations. It also helps in pinpoint fundamental basis for addressing other modal splits problems.

Many academic, professionals and international communities have the relatively different approach to Land use and transportation planning, often not realizing there are other points of view. More prospective and future research efforts are required to gain a better understanding of why conflicts in Land use /transportation as part of urban development indicators. The land uses transportation planning show how past commentary on these planning as important indicators have changed over time and still changing without underscoring contemporary dynamics. The studies identified further that elevated risk of dying in a road crash remains staggering in small and middle-income countries. Africa nations stand out as the world's most dangerous region for traffic fatalities. While The corrective and evaluative commentary debated, though, reviews affirm that Road traffic fatality will continue to be the problematic issue of discourse worldwide. The analysis shows that Road traffic fatality is becoming intolerably high among Pedestrians and cyclists small and middle-income countries most importantly in African nations. Lessons learned from some selected countries if well replicated will serve as a model for others nation with less or high fatality situations. These literature inquiries are critical and serve as center point improving pedestrian safety. Conducting more studies on this subject will add more to existing body of knowledge. It is evident from the research review that improving pedestrian safety is very immersed efforts which are widely in practice throughout the world.

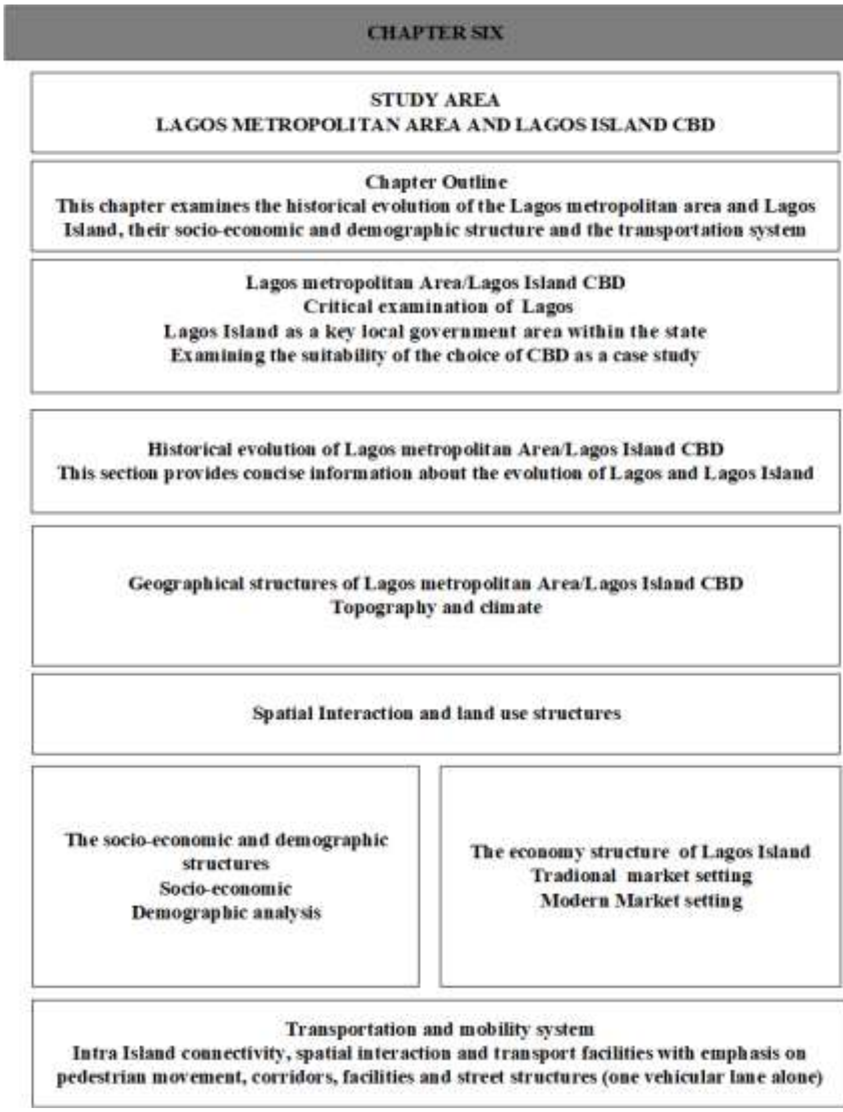
5.8: The Chapter Summary:

This chapter is a continuation of the literature review on land uses and transport planning with a focus on precedent studies. It is a comprehensive chapter that explores pedestrian safety challenges and good practices from perspectives of cities in both developed and developing countries. some examples are drawn from various cities across the globe, detailed insight is provided from Venice, Beijing, Kumasi and New York which form key precedent studies used in this study. This follows at the backdrop of a detailed overview of the Nigerian experience.

6. CHAPTER SIX: LAGOS METROPOLIS (AND LAGOS ISLAND CBD)

6.1: Chapter outline

Figure 45: Outline of chapter Six



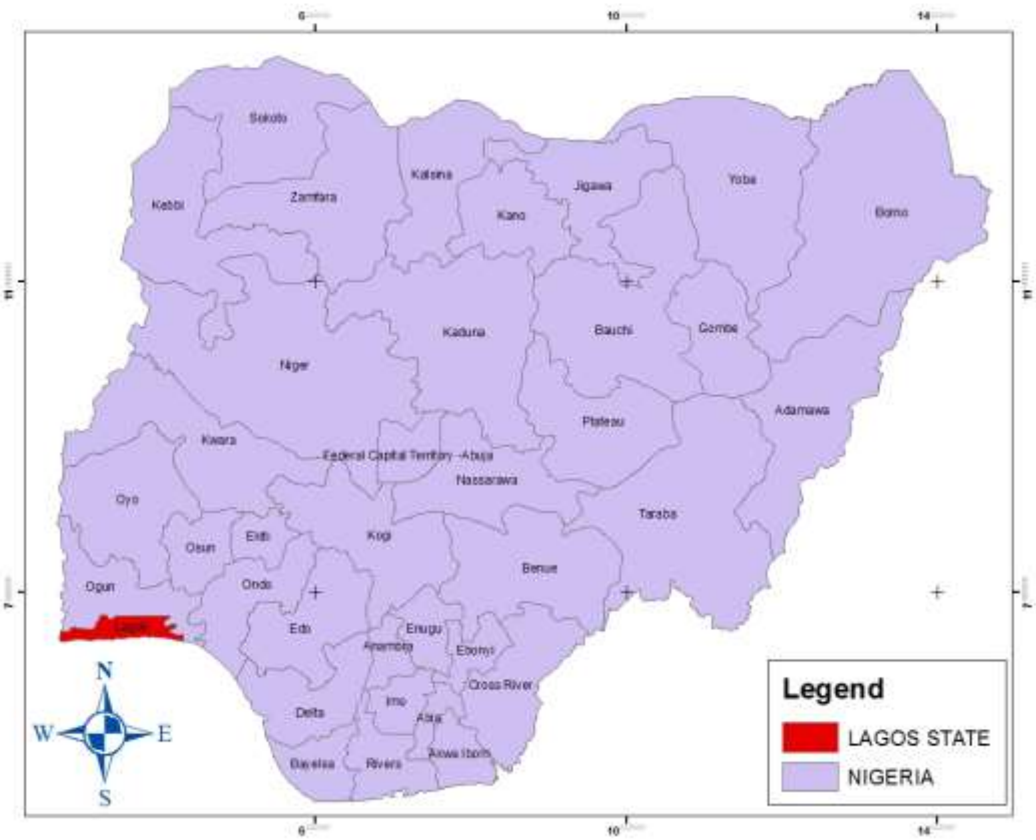
Source: Author's construction (2016) ©

Proponents of the case study method believe that the study of a small geographical area provides grounds for establishing the empirical reliability or generality of the findings. One may add that intense exposure to a case study reduces bias in an empirical study. The Figure 45 below provides detailed outline of what this chapter is all about. A case study approach was adopted to examine real-life pedestrian situations, issues, and problems in the study area. This chapter examines the historical evolution of the Lagos metropolitan area (with emphasis on Lagos Island), their socio-economic and demographic structures, economic base and the transportation system. A very broad geographical area (Lagos Metropolis) was narrowed down to a more easily researchable area (Lagos Island CBD). This enabled the researcher to examine the problem and data at the micro level for adaptation at the macro level.

6.2: Lagos in the national context

Lagos is one of the most rapidly urbanizing areas in the world. It is Nigeria's nerve center., former capital city and is situated on the southwestern coast of the country. Lagos State is one of the 36 states that make up the Federal Republic of Nigeria. While it covers the smallest area of all the states, it is the most populous, The State is bound in the south by 180 km of Atlantic coastline, in the north and east by Ogun State and in the west by the Republic of Benin. Figure 46 shows a map of Nigeria highlighting Lagos State.

Figure 46: Map of Nigeria showing Lagos State

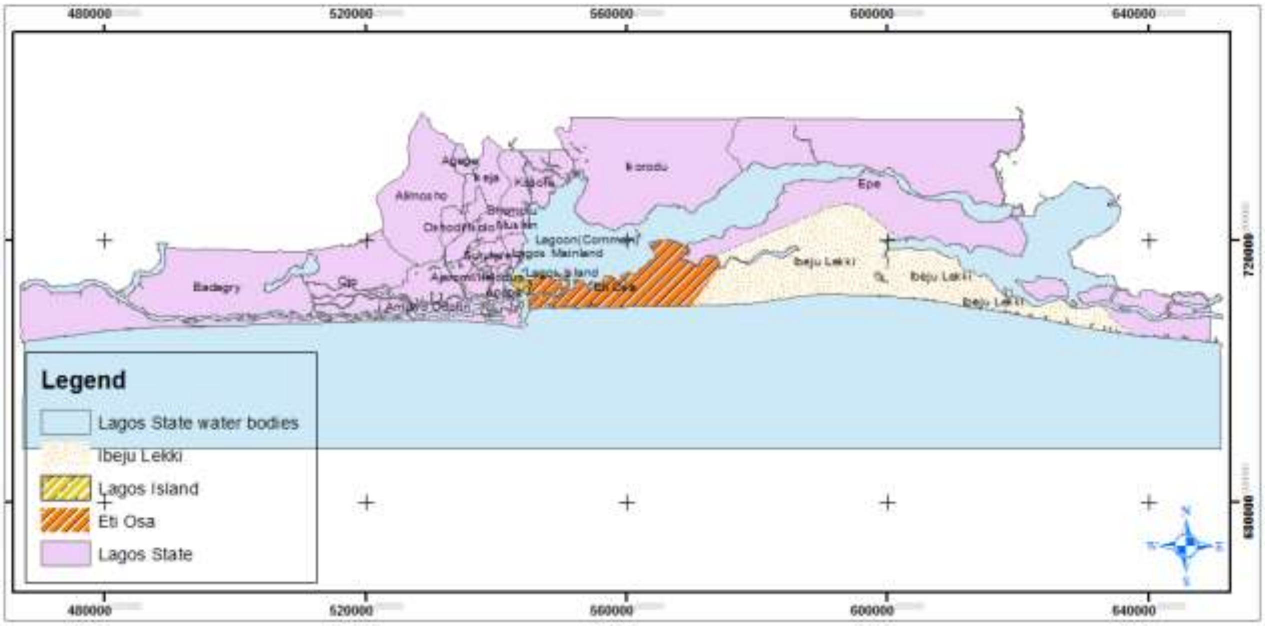


Source: University Lagos, Department of Surveying and Geo-informatics, University of Lagos (2015)

6.3: Overview of Lagos metropolitan area:

The Lagos metropolis covers 16 of the 20 local government areas (LGAs) in Lagos State. Its two main areas are the Mainland and Lagos Island; these are the original part of the city. (see Figure 47 below)

Figure 47: Lagos Metropolitan area map



Source: Author's construction (2016) ©

The Mainland consists of rapidly developing settlements and the Islands comprise of Lagos Island, Victoria Island, and Ikoyi Island. These Islands are split from the Mainland by the main channel that drains into the Atlantic Ocean or Lagos harbor. The Mainland consists of Yaba, Ebute-Metta, Mushin, Ojo, Apapa, Oshodi-Isolo, Somolu, and Surulere. Figure 4 shows the Lagos Metropolitan area, lagoon, harbor, and port. The Lagos metropolis represents a group of Islands spread across creeks and a lake. It comprises small settlements with farming and fishing communities and urbanized settlements. Table 38 below outlines the geographical and spatial characteristics of the 20-local government areas (LGAs) in Lagos State. In addition, Table 38 also provides Lagos at glance.

Table 38: Land mass/water area of the 20 local government structures in Lagos State

LOCAL GOVERNMENT AREA (LGA)	Land mass and water area in SQ KM		Total land/water area		Population
	LAND MASS	WATER AREA	IN SQ	% of	
AGEGE	17	0	17	00.48	1,033,064
AJEROMI/IFELODUN	13	0.9	13.9	00.39	1,435,295
ALIMOSHO	137.8	0	137.8	03.85	2,047,026
AMUWO/ODOFIN	153	26.1	179.1	05.00	524,971
APAPA	25.5	13	38.5	01.08	522,384
BADAGRY	363	80	443	12.39	380,420
EPE	641	324	965	26.98	323,634
ETI-OSA	154.1	145	299.1	08.36	983,515
IBEJU-LEKKI	643	10	653	18.25	99,540
IFAKO/IJAIYE	43	0	43	01.20	744,323
IKEJA	49.92	0	49.92	01.40	648,720
IKORODU	200	145	345	09.60	689,045
KOSOFE	74.4	10	84.4	02.36	934,614
LAGOS/ISLAND	5.2	4.06	9.26	00.03	859,849
LAGOS/MAINLAND	19.62	0	19.62	00.55	629,469
MUSHIN	14.05	0	14.05	00.39	1,321,517
OJO	163	19	182	05.09	941,523
OSHODI/ISOLO	41.98	0	41.98	01.17	1,134,548
SHOMOLU	12.1	2.5	14.6	00.03	1,025,123
SURULERE	27.05	0	27.05	00.76	1,274,362
TOTAL	2797.72	779.56	3577.28	100	17,552,942

Sources: (Lagos State Government (LASG), 2009, Lagos State Government (LASG), 2010a, Lagos State Government (LASG), 2010b, Lagos State Government (LASG), 2011, Lagos State Government (LASG), 2012, Lagos State Government (LASG), 2013a, Tugbobo, 1996, Tugbobo, 2013)

6.3.1: The growth and development of Lagos metropolis

Lagos State evolved through an organic development process. This section examines pre-colonial, colonial and post-colonial urban growth patterns in Lagos

Spatial Characteristics of Lagos during Pre-Colonial period

Historically, Settlements of Lagos existed before of the 17th century (People, Population, and Settlement of Lagos State, 2003). The Lagos grew out of a small nucleus of fishing and farming settlements in the seventeenth century. Previously, it was known as Oko (Yoruba for farm') or Eko ('war camp'). The Yoruba are the main ethnic group and smaller groups in Lagos. The composition of these groups includes, the Aworis in Ikeja and Lagos Island, the Eguns in Badagry and the ljebus in shomolu, Ikorodu and Epe. Lagos was also originally home to other descendants and non-indigene of the Yoruba repatriated from various countries. Development gained pace during the 18th century and hinterland areas were absorbed to promote political and commercial stability. In pre-colonial times, Lagos occupied less than a third of a five-sq. km. Island surrounded by a thick belt of mangrove forests creeks and swamps along its shores, with the interior mainly comprising of swamps, creeks and dry land. The north-western extreme was the first home and settlement of the founding fathers in the eighteenth century and later became the first quarter (Isale-Eko) and settlement for the indigenous population. The centre of a new prosperous village inhabited by fishermen and farmers alongside the palace of the Oba (king) and several smaller palaces of local

Colonial period

In 1860, Lagos served as the capital and seat of administration during the amalgamation of the former colonial administrations and the Federal Capital of Nigeria from 1914. Britain's annexation of Lagos led to migration from other parts of Nigeria, especially rural areas, to access the opportunities offered by colonial rule. There are several factors responsible for prominences of Lagos during colonial rules. Firstly, Lagos State was the first seat of the colonial government, resulting in infrastructural and population growth. These contributed to the growth, development, and eminence of the metropolis in the Nigerian urban system. Secondly, the operational communal land tenure system was partly responsible for the way in which the metropolis developed during the colonial era. The traditional rulers served as custodians and held the land in trust for the community. Thus, saddled with the responsibilities of allocating lands to foreigners and repatriates who wished to settle in Lagos. Land allocations were based on culture and social origin. For example, this communal land tenure system enabled the various ethnic groups on the Island to live in separate quarters, which made segregated planning easy during this period. In addition, this period laid the foundations for the landforms that followed. Land allocation system that was in place during pre-colonial era enabled the technical division of Lagos into four functional planning quarters with different landscapes during colonial rule. For the sole purpose of the British administration these functional planning areas comprised Isale-Eko, the Saro quarter, the Brazilian quarter and the Marina (these are graphically illustrated in Figure 48 by the red, purple, yellow and green rings). These four physical planning subdivision areas contributed to Lagos' physical and conceptual crystallisation during the colonial administration.

Figure 48 : First Settlements of old Lagos island.

Source: (Mabogunje, 1968)

Land allocation system obviously orchestrated an unequal urban sectoral development planning and infrastructure provision. This in turn helped consolidation and the morphological partitions that prevailed in the mid-nineteenth century in Lagos. Development of these four functional planning quarters, enhanced building segregation codes and lopsided infrastructure provision by the colonial administration. These planning functional districts hosted indigenes, a heterogeneous European community, freed slaves and migrants from Sierra Leone and Brazil, respectively. Thirdly, one obvious feature of this era is the dysfunctional, haphazard development and poor planning implication of major centres and indigenous settlements within colony such as "Isale-

Eko”. The area became rapidly overcrowded and deteriorated with an adverse urban development pattern. This deterioration was exacerbated by the British regime that did not treat the expatriate and indigenous communities the same. While the indigenous area was neglected, in contrary the European residential quarters along the Marina where most residents could afford permanent, imported, building materials in line with the European style were treated with utmost care. The privileged white residential neighbourhoods were explicitly developed at the expense of the residential quarters of the urban majority. During this time the Saro quarters was home to merchants and returnees from the Caribbean; hence the concentration of commercial development and warehouses along the Marina. The Brazilian community was mainly involved in crafts and introduced Brazilian architectural styles throughout the city (Fourchard, 2012). Fourthly, the growth of the city of Lagos during colonial regime included of the construction of railway linking the city (Island) in 1865. The port and the hinterland; the development of the Lagos harbour in 1908 and 1917; and its status as the joint termini of major land, sea and air routes. Plate 4 demonstrates the conspicuous spatial hierarchy evident in colonial development where rail infrastructure was used to delimit the boundaries of development between Lagos’ quarters. The picture shows the elitist northern and southern residential neighbourhood segments of the Afro-Brazilian and Saro-quarters southern of Lagos distinguished by building patterns.

Plate 4:Sectoral development and spatial hierarchy in colonial era where rail infrastructure was used to delimit the boundaries

Source: archival material http://www.nairaland.com/865653/old-lagos-pictures/3 accessed October 2016

Finally, the colonial administration shaped what is today called town planning principles, policies, architecture, and urban management in Lagos. Several urban planning studies such as (Adedamila, 1977, Dayomi, 1983, Gbadamosi, 2013, Braimoh and Onishi, 2007) and (Oduwaye, 1999) attest to the fact that planning issues have been evident since the 19th century when Lagos was described as a cosmopolitan and disorderly city. During this period, though with limited success the colonial administration attempted partial enforcement the relevant laws, especially in terms of ameliorating the conditions and the physical environment of the northern parts of Lagos where the indigenous population lived.

Oil boom (1970s/80s) period to date

Oil boom era was a period of socio-economic change and growth during 1971-1980. During this era, revenues from crude oil exportation displaced the more stable and sustainable revenue flows from other trade exports, agriculture and mining. This era started with the discovery of a large petroleum reserves in commercial quantity in the mid-1950s, coupled with the oil-boom resulting from the Arab oil embargo on the USA in 1973. This development affected the agricultural sector adversely. This is one of the remarkable post-independence development. Post-independence, Lagos remained the political capital of Nigeria from 1960 to 1991. Before independence in 1960, Lagos metropolis' economy was dominated by export and commercial activities. Its industrial sector grew during the oil boom era and today industry and agriculture are the mainstream of the economy. Despite global price fluctuations, agriculture contributes about 65% of GDP and represents almost 70% of total exports in Lagos metropolis. During the boom, inflation, unemployment, and productivity rates remained relatively healthy. Lagos is shaped by the political (Colonial presence) and administrative roles it has played during after exit of the colonial administrators. It was the center of political opposition to colonial rule till 1960. Since 1960 has grown to become the most important city in West Africa in terms of the circulation of people, goods, and services. Thereafter, Successive administrations and developments resulted in a dramatic rise in land values, spatial expansion and competition for space. (Braimoh and Onishi, 2007, Ajose, 2010).

Lagos State government policy favors strong economic management. Increased productivity kept prices reasonably stable and the unemployment rate stood at 1.5%. It was during this period that the first National Development Plan (1962-1968) was drafted to ensure that states like Lagos Colony (as it was then known) maintained vibrant economies. In terms of the plan, Lagos State government was required to provide infrastructure for development. The state also invests in economic development to alleviate poverty. Due to constraints on individual savings, levels of private investments were low (George, 2010, Oduwaye and Lawanson, 2010, Oduwaye, 2015). The state experienced rapid development as well as continuous urbanization faster than the global trend because of the oil boom.

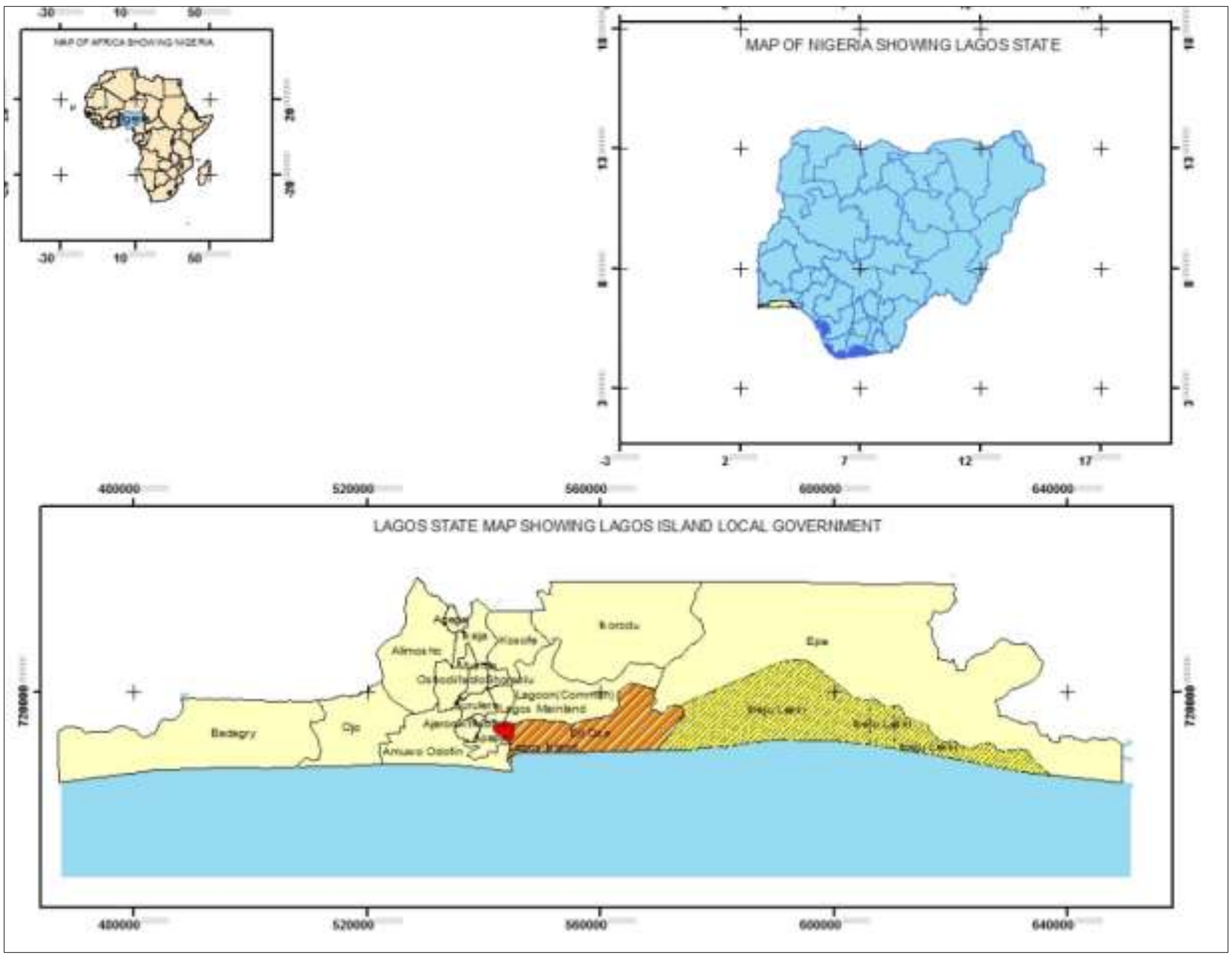
The quality of life diminished in the last two decades of the 20th century, with increased urbanization and unprecedented urban development. This resulted in high demand for transport services and associated infrastructure (Atubi, 2012b, Filani, 2012, Atubi, 2013).Contemporary Lagos continued to reflect the legacy of European rule, especially in terms of segregated residential areas. Lagos State was created on 27 May 1967 in terms of the State (Creation and Transitional Provisions) Decree No. 14. With the relocation of the capital functions of the Federal Government of Nigeria to Abuja on 12 December 1991, Lagos ceased to be Nigeria's political capital. However, it remained the center of commerce. Today, Lagos is a huge metropolis that straddles some 80% of the local governments (third tier of government in Nigeria) in the state. In the early 2000s, Lagos State witnessed significant development in both the northern and eastern directions of the Mainland and areas such as Ikotun, Egbe, Isolo, Ojota, Ogudu, Ikorodu, Ketu, Ikosi, Iyana-Ipaja, Age, and Abule-Egba and into the neighboring state of Ogun witnessed-development. Today, the city of Lagos boasts a concentration of capital assets, trade, public investment and leading institutions. (Koolhaas and Cleijne, 2002) described this mega city as a model of hybrid, self-organizing urbanism. It is both a port city and the hub of Nigeria’s external trade.

6.3.2: Topography and Climatic conditions

Geographically, Lagos-Nigeria (see Figure 49) lies between latitude 60° 22’ and 60° 41’ north of the Equator and longitudes 20° 42’ and 40°21’ east of the Greenwich Meridian. The average population density is 1,054/ km^2 (1697/sq. mi). The topography of Lagos is dominated by its system of islands, lagoons, and sand bars; low-lying terrain and swamps, with the highest point of

Lagos Island being only 22 feet (7 meters) above sea level. In terms of climate, the whole area lies within the tropical zone of Nigeria and its climate is characterized by hot and wet conditions. Temperatures rarely exceed 32° C (90° F), but humidity levels are high, and the nights are warm. March is generally the hottest month of the year and July the coolest. The urban center has a tropical, humid climate with two peak periods of rainfall, from April to July and between October and November. There is a brief dry season in August and September and a longer one from December to March. The main dry season is between December and early February when the Harmattan winds blow in from the Sahara Desert.

Figure 49: Map of Lagos in the context of Nigeria



Source: Author's Construction October 2016

These features explain why inhabitants favor walking. The creeks, Lagos lagoon and the rivers act as arteries for the massive quantities of logs from out-of-state sources. The dominant vegetation of Lagos State is tropical swamp forests, which consist of freshwater and mangrove forests. The wetlands offer fertile alluvial and red-yellow soil, luxuriant undergrowth and tropical hardwoods. Drainage is characterized by a maze of lagoons and waterways which constitute around 22% or 787sq. km of the state's total land mass. Red mangrove and mangrove shrubs, stilt-rooted trees with dense undergrowth and raffia thrive in these areas as well as valuable trees as teak, tripod chiton, Seletrocylon (Arere), Banclea Diderrichil (Opepe) and Terminalia Ivorensis (Idigbo). Table 39 provides a comprehensive comparative analysis of geospatial and demographic information on Nigeria and Lagos State (1991-2006).

Table 39: Geospatial and demographic analysis of Nigeria and Lagos State (1991-2006)

Indicators	Nigeria	Lagos state	Lagos state %
Area (Km2)	923,768	3,577	0.40
Population (1991)	88,992,220	5,725,116	6.40
Population Density in 1991 (person per km^2)	96.34	1,600.54	-
Population (2006) *	140, 431,790	9,113,605	6.44
Population Density, 2006 (person km2)	151.56	2,519.58	-
Mean Household Income in 1996/97 (N)	5,149.80	7,524.30	-
% Rural Population in 1991	63.72%	6.31%	
% Urban Population in 1991	36.28%	93.69%	
% Rural Population in 2000	63.72	5.0%	
% Urban Population in 2000	36.28	95.0%	

Sources: (NPC, 2006); Lagos State Government Digest of Statistics (2011)

6.3.3: Economic growth

While Abuja is now the country's administrative and political capital, Lagos remains its industrial, commercial and financial backbone. Indeed, it is arguably the most economically important commercial center in Nigeria and the nation's largest urban area. Gandy (2005, 2006) notes, that, at independence in 1960, Lagos was fast becoming not just the commercial nerve center but also the 'Venice of West Africa'. It is the pre-eminent cultural center in West Africa and a vibrant socioeconomic hub and focal point of Nigeria and sub-Saharan Africa. Furthermore, it generates a significant part of the country's GDP. During the colonial era and at independence, Lagos was the leading industrial center in the country. It remains Nigeria's economic powerhouse and is responsible for around 32% of the Federation's industrial production with more than 200 factories manufacturing products such as beer, cooking materials, cloth, steel, aluminum, and motor cars.

Lagos experienced rapid vibrant economic growth from the 1960s to the early 1990s. During the oil boom in the 1970s, its economy was stronger than that of South Korea, making it a target for foreign investors. Lagos accounts for more than 60% of the nation’s industrial and business establishments and 90% of international trade (Aina, 1994; UN, 1995; McNulty, 1988). The state is responsible for more than 50% of national economic development. Resource mobilization coupled with transparency and accountability, led to significant increases in revenue generation, which rose from N600 million per month in 1999 to an average of N5.023 billion per month in 2006 and peaked between N7 billion and N8.2 billion per month in early 2007. In August 2015, the GDP of Lagos’ formal economy was estimated at $136.6 billion, contributing a quarter of Nigeria’s GDP. The Lagos GDP is growing at a rate of 10% per annum and it is predicted that it will reach $355 billion in 2025. This is attributed to significant investment by both local and foreign investors and the state government’s sound fiscal policies. Favorable business and economic conditions and its prime location in West Africa, which means that it is an access point to African nations, have resulted in a thriving commercial sector in Lagos at both formal and informal levels. On the downside, the UNDP (2008) estimated that 51% of men and 54% of women resident in Lagos survive on US$1 or less per day. Furthermore, Lagos has suffered economic decline and environmental degradation.

Urbanization in Lagos -Population/Density

Available empirical data on the Lagos population is out of date, scanty, contradictory and sometimes misleading. This is of grave concern as reliable population estimates are essential for planning purposes. This study thus relied on international sources such as UN-Habitat, the World Bank and other recognized sources of urban population statistics. Having started life as a small fishing hamlet along the coast of the Atlantic, Lagos’ growth has been astounding. The Lagos Metropolis is home to more than 75% of the population of Lagos State and more than a third of that of all Nigeria’s urban centers. It is the second fastest growing city in sub-Saharan Africa and the seventh fastest in the world. With a population of over 10 million and population density of 20,000/sq. km, Lagos is a megacity in every sense (UN, 2012;(Akinmoladun and Oluwoye, 2007, Ayeni, 1981, Federal Highway Administration(FHWA), 2010, Filani, 2012, United Nations (UN), 1994, United Nations (UN) Department of Economic and Social Affairs, 2014, United Nations (UN), 2006, Oduwaye and Lawanson, 2010, Okwuashi et al., 2008). Per the Federal government, Nigerian Population Census, UN-Habitat and the World Bank, Lagos is the smallest state in Nigeria, but the biggest when population is used as the yardstick. Its population grew from approximately 20,000 in 1850, on a land area of 2.8km^2 to 25,083 and 28, 518 in 1866 and 1871, respectively on 3.97km^2. Between 1911 and 1952 (the census year), it rose from73,766 to 621,803, with an average area of 65.51km^2. Overall, within the space of a century, the population increased from 32,508 in 1891 to approximately 6,085,781 in 1988, of which 90% lives in urban areas (see the Table 40). The World Bank notes that, Lagos is home to 36.8% of Nigeria's urban population (United Nations Environment Programme (UNEP-IETC), 2008, United Nations Human Settlements Programme, 2002, United Nations Human Settlements Programme, 2014c, United Nations Human Settlements Programme, 2014b, United Nations Human Settlements Programme, 2014a).

Table 40: Lagos Population Growth

Year	Population	Land Area(sq.km)	Density/sq. km
1850	20,000	2.8	
1866	25,083	3.97	6,318
1871	28,518	3.97	6,400
1891	32,508	3.97	8,200
1911	73,766	46.08	1,601
1921	99,690	51.64	1,925
1931	126,108	65.51	1,925
1952	680,803	69.68	3,838
1963	1,400,000	6968	9,547
1973	2,437,335	178.36	13,665
1975	3,500,000	178.43	N/A
1978	3,800,000	179.36	N/A
1979	4,200,000	180.50	N/A
1985	5.8000,00	205.28	N/A
1988	6,085,000	264.18	20,000
1990	7,717,000	298.00	26,567
1995	10,233,000	302.10	33,884
2000	13,420,000	355.00	34,285
2006	15,500,000	400,00	N/A

Source: Compiled by author from different population analyses (Nigerian Population Census, UN-Habitat, and the World Bank)(Lagos State Government (LASG), 2013b, Lagos State Government (LASG), 2014, Lagos State Government(LASG), 2013)

It is currently estimated that Lagos State is home to 17 million of Nigeria's 170 million inhabitants (UN, 2012). While the country's population is growing at an annual rate of 4% to 5% and the global rate stands at 2%, in Lagos, the rate is two to three times higher. The UN notes, that, Lagos also experiences higher than average increases. In 1950-1959, 1970-1979 and 1990-1999 its average annual population growth rate was high at 10.2%, 8.0% and 5.3%, respectively and was one of the highest among cities in West Africa. Table 41 shows average annual urban population growth rates in typical West Africa cities between 1950 and 2000. Table 42 provides population size and urban agglomeration in selected megacities in the world in 2014. Given this trend, it is predicted that Lagos' population will grow by 10% per annum and reach 24 million by 2020. It is the second biggest metropolis in Africa and one of the fastest growing urban agglomerations in the world. Indeed, the UN and World Bank state that given its current growth rate, it will soon reach the top of the list. The question is whether the state government has the capacity to provide the physical, social and environmental infrastructure required of a mega city (Sharma et al., 2011).

Table 41: Average annual population growth rates in urban population, West Africa

CITY	Average Annual Growth Rate (%)		
	1950-1959	1970-1979	1990-1999
Lagos Nigeria	10.2	8.0	5.3
Abidjan, Cote d'Ivoire	11.8	8.6	5.0
Dakar, Senegal	5.1	5.1	4.4
Ibadan, Nigeria	2.9	2.7	4.0
Conakry	11.2	8.3	5.7
Accra, Ghana	4.7	1.9	3.1

Source: UN (1999)

Table 42: Population size and urban agglomerations of selected megacities in the world as at 1 July 2014

Rank	Megacity Country Continent	Population	Annual Growth Rate
1	Tokyo Japan Asia	37,833,000	0.60%
2	Delhi India Asia	24,953,000	3.20%
3	Shanghai China Asia	22.991,000	3.40%
4	Mexico City Mexico N. America	20,843,000	0.80%
5	Sao Paulo Brazil S. America	20,831,000	1.40%
6	Mumbai (Bombay) India Asia	20,741,000	1.60%
7	Osaka Japan Asia	20,123,000	0.80%
8	Beijing China Asia	19,520,000	4.60%

Rank	Megacity Country Continent	Population	Annual Growth Rate
9	New York City USA N. America	18,591,000	0.20%
10	Cairo Egypt Africa	18.419,000	2.10%
11	Dhaka Bangladesh Asia	16,984,000	3.60%
12	Karachi Pakistan Asia	16,126,000	3.30%
13	Buenos Aires Argentina S. America	15,024,000	1.30%
14	Kolkata India Asia	14,766,000	0.80%
15	Istanbul Turkey Europe & Asia	13,954,000	2.20%
16	Chongqing China Asia	12,916,000	3.40%
17	Rio de Janeiro Brazil S. America	12,825,000	0.80%
18	Manila Philippines Asia	12,764,000	1.70%
19	Lagos Nigeria Africa	11,614,000	3.90%
20	Los Angeles USA N. America	12,308,000	0.20%

Source: World urbanization prospects: 2014 revision

6.3.4: Land use and Planning in the Lagos metropolis

Traditional spatial development pattern and cultural structure in Lagos

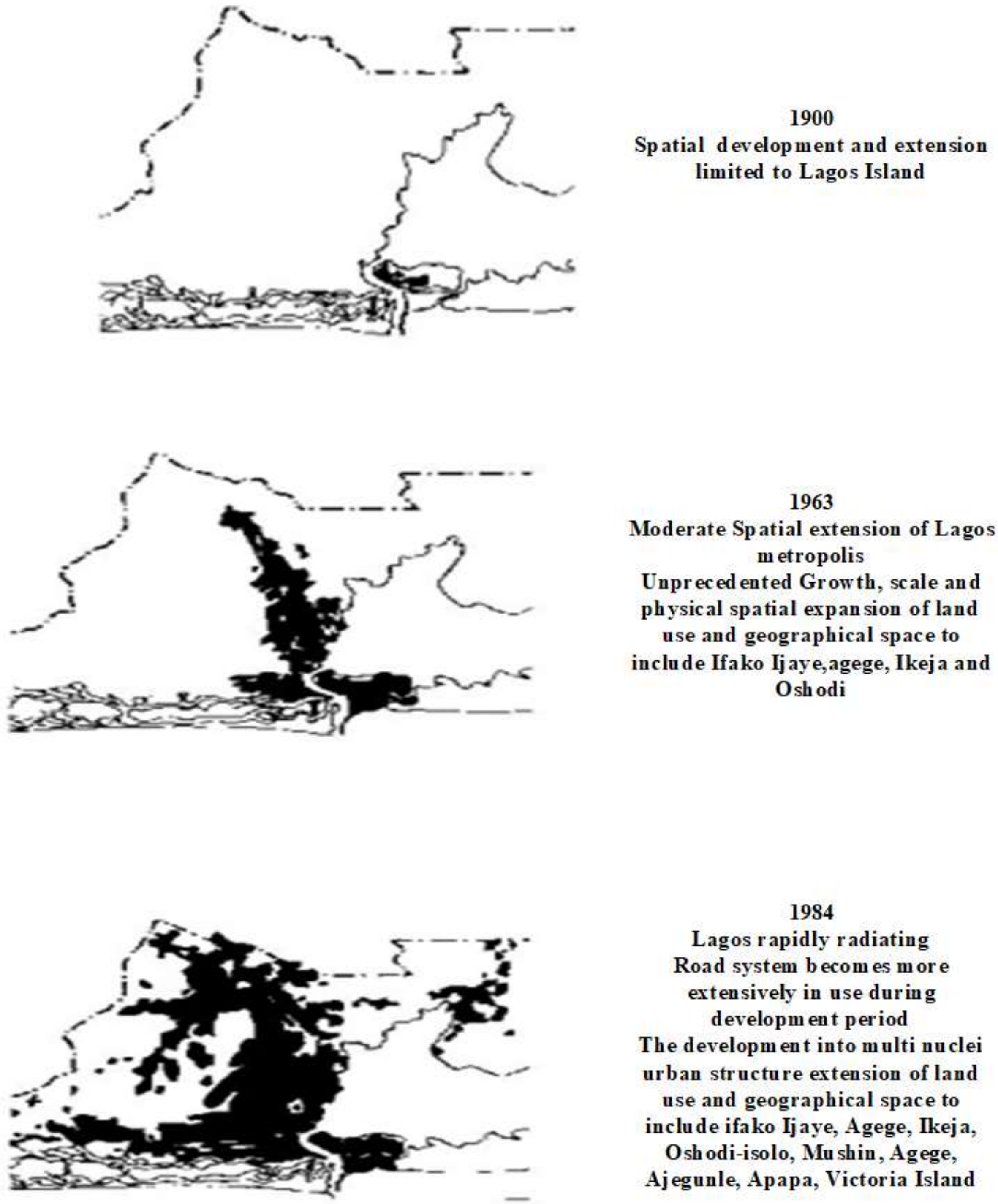
Lagos is a highly-sophisticated city that is home to the descendants of pre- and post-colonial immigrant settlers that have fused with the indigenous population. It is known for increasing social stratification and different lifestyles. Lagos’ growth pattern reflects that of many African cities. The original town was based on sound urban planning and spatial principles. Contrary to popular belief, Lagos State has a long history of urbanism and cooperative building efforts that preceded the colonial era. Ethnic and culture enclaves were the basis of urban planning, as were markets and subsistence agriculture. The morphology of the traditional core area of Lagos followed the typical Yoruba (south-western) classical town plan.

The ancient city plan resembles a wheel, with the king's palace and the community shrine at the hub and a series of roads radiating from the palace and connecting the town to the center. Lagos retains these features that are influential in the city’s urban planning, politics, and religious and social composition. Traditional urban planning in Lagos reflects a typical concentric layout to achieve compactness and accessibility and ensure walkability. All the main access routes converge at the center where the King's palace, town meeting points, and the market are located. This is a replica of other native Yoruba towns. However, it should be noted that the Yoruba are a dynamic and heterogeneous group, making it difficult to generalize about their living patterns and spatial arrangements.

Trends and spatial dimension of Land use in Lagos metropolis

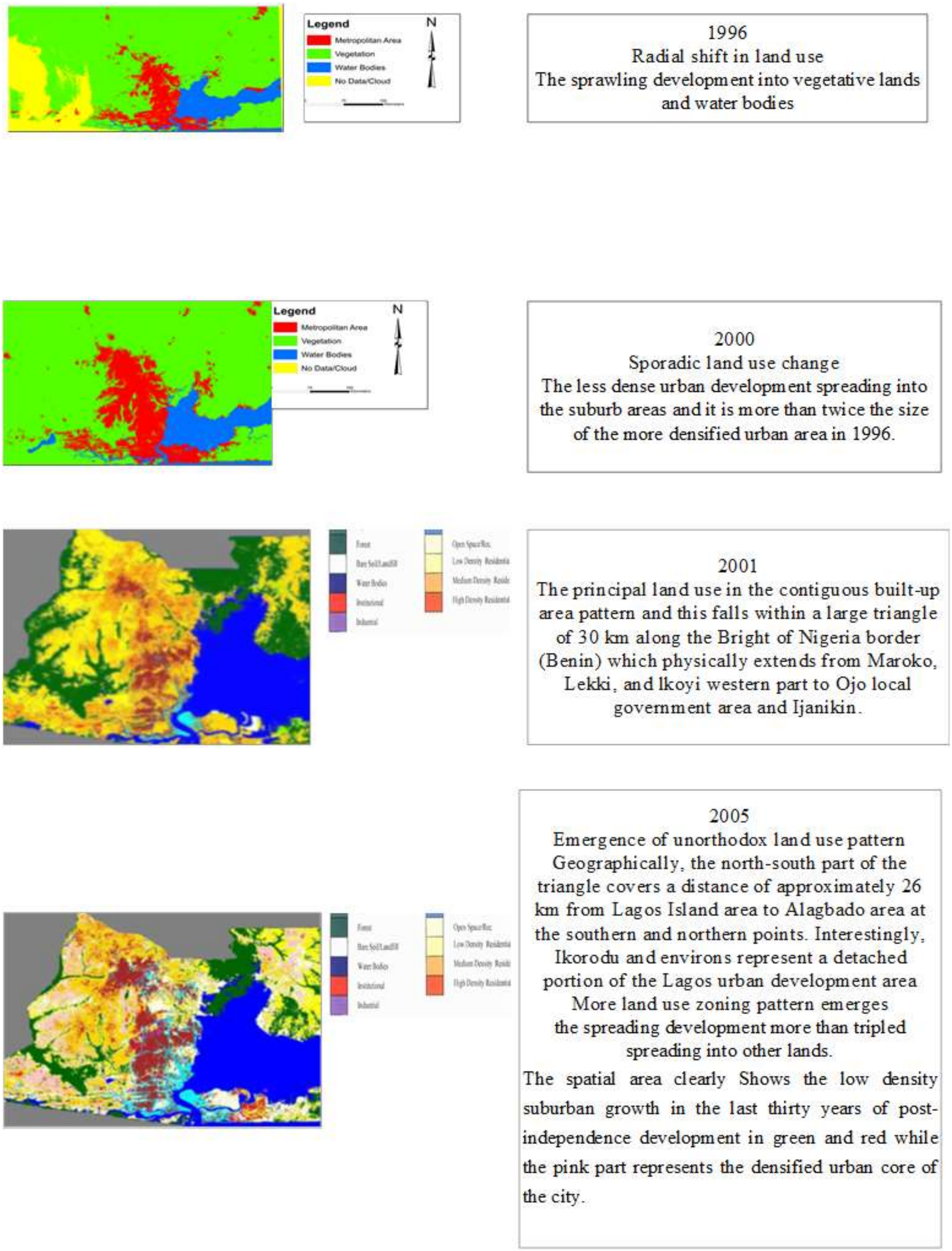
Lagos has undergone a series of land use transformations, an expected process in the development of any settlement (Abiodun et al., 2011a, Ajose, 2010, Braimoh and Onishi, 2007, Gbadamosi, 2013). Gandy (2015) characterizes the evolution of land use in Lagos as 'amorphous Urbanism'. This refers to an urban system which exhibits an amorphous style of no kind, stratification or character. Figure 50 and 51 show growth trends in Lagos Island over time. Ancient land use formations and features dictated the extent and direction of development over the years. The figure shows that, in the early 19th century, there was limited land use expansion. In 1963 immediately after independence, land use is considerably different from the pattern in 1900, and shows signs of polarization, which is evidence of amorphous Urbanism. In later parts of the 19th century (1996) and beginning of millennium (2000-2015) there was drastic change in physical structure of Lagos. These land use spatial changes in turn orchestrated emergence of peculiar zooning patterns across the state.

Figure 50: The physical expansion of Lagos in 1990 – 1984



Source: Adapted from Mabogunje (1968:260) and Margaret (1991).

Figure 51: The physical expansion of Lagos in 2001 – 2005



Source: Adapted from Adepoju (2007)

Land uses in Lagos include vegetation, a few water bodies and a built-up area (residential, commercial, industrial, institutional, open space and recreation, transportation, and circulation). In 2005, residential areas occupied about 9 669 hectares (52.1%) of the total metropolitan area (see Table 43 below).

Table 43: Lagos land use and Area (1984 to 2005).

Land Use Type	1984 (m^2)	2001 (m^2)	2005 (m^2)
Water Bodies	2979359638.344	2963818889.079	2958065850.1011
Built-Up-Area-residential, industrial, commercial, recreational,	770613896.351887	942856236.890501	974725556.002479
Vegetation	1968779938.26496	1806364142.1974	1774934270.10664
Undeveloped	20936851.015917	47393000.653493	11643473.49959
Total	5739690323.9775	5760436270.821	5719373159.7098

Source: (Abiodun et al., 2011b)

6.3.5: The mobility and transportation structure

Transportation Modes and Characteristics in Lagos metropolis

Human settlements require adequate, dependable, secure and affordable transport systems. Development cannot occur without transportation. People need to be able to access services that are not readily available in their areas and need to travel for recreational and social purposes (World Bank, 1976). Lagos offers numerous forms of transport. The most common and traditional are those that carry commuters between different parts of the state, mainly by means of a footpath (road) system (80% of daily trips) and using live animals (15% of daily trips). Sea and air transport complement these traditional modes.

Walking and Animal-powered carriage as the predominant 'traditional' transport (before 19th century):

Lagos is an important commercial center with one of the biggest, busiest and most extensive route networks in the sub-Saharan region of West Africa. As the endpoint of trans-African routes, it remains one of the most important trade and transit routes. Like the medieval streets, transportation through the traditional footpaths (roads) system remains the main mode of travel. A traditional walkway system includes walking and animal-powered carriage transportation**.** Lagos represents one of the foremost Nigeria indigenous walking town before the arrival of the colonial administration and even after independence. Walking enables movement from farms to market places and places of recreation. Studies show that the quality of life improves in a community where pedestrian travel is encouraged. During the pre-colonial era, more than two-thirds of all surface travel in Lagos occurred on foot, even though only one-third of the circulation space was available to pedestrians. Animal-powered transportation was also popular. However, the colonists' need for a more efficient means to transport goods and services opened Lagos' doors to the rail revolution.

Rail transportation- Legacy of European government

The need to move goods and services led to the growth of rail transportation. The rail system was proposed in the 18th century as an alternative to walking and animal-powered transport modes. Construction of the Carter Bridge commenced in 1896 to connect Lagos Island with the Mainland. In 1895, work began on extending the railway from Iddo on the Mainland to neighboring communities such as Ibadan; this was opened six years later (March 4, 1901). Local services operated from the market towns of Ifo, Ilaro, Idogo, and Abeokuta, with quick stops within the Lagos metropolitan area. Interestingly, due to the error made in closing the railway station at Iddo, Lagos was without any public wheeled transport to connect it with the railhead. A tramway was mentioned as a possible solution in the official colonial government report for 1899. In 1901, the government decided to build a 2ft. 6in. gauge line over Carter Bridge and construction commenced. The Lagos Steam Tramway was opened on 23 May 1902. From 1930 through to the post-independence era, rail was the cheapest mode of transportation in Lagos. As the Federal Capital of Nigeria, Lagos suffered severe traffic congestion and short distance passenger train services within the Lagos metropolis were introduced in the 1960s.

Waterway mode of transportation

Waterway transportation emerged in the mid-20th century to support other modes and was the predominant travel mode from the waterside area of the Island and the Mainland to the hinterland. While waterways remain vibrant modes of transportation at the global level, this is not the dominant means of moving people, goods, and services in Lagos. This is due to the fact that the existing waterways were planned to move passengers between traditional communities such as Apapa, Ikorodu, and Victoria Island.

Vehicular transportation system

The emergence of a vehicular transportation system in Lagos in the early 19th century marked the beginning of a new era. Traditional travel models gave way to this new way of commuting. The majority of roads in the Lagos metropolitan area are choked with motorized transportation of all sizes, to the detriment of other modes. While it remains possible to walk to farms, workplaces and businesses centers, vehicles have taken over the roads and streets of Lagos. It is no coincidence that walking became a lost skill in Lagos in 1960 when people started to drive in large numbers.

Modern Transportation Modes and Characteristics

Modern day transportation in Lagos retains traditional patterns through the pedestrian system and non-motorized transportation (NMT) and vehicular systems. Other means of transportation include air, rail, and water.

Walking and non-motorized transportation (NMT)

Walking remains a primary travel mode in the Lagos metropolitan area. Despite the small area set aside for pedestrian travel, it is a primary mode for most residents. The streets of modern Lagos are wider to accommodate vehicles. However, pedestrian infrastructure is aging at a time when there is increased demand for these essential services. Previous studies(Amoako et al., 2014, Poole, 2008) show, that, one of the biggest challenges to intra-urban mobility is the inability to provide decent and reliable facilities for pedestrians and non-motorized transport users. Lagos metropolitan area has a peculiar example, government inability to provide enabling facilities to keep with population growth makes it an important point of consideration. Within 8years Lagos government could only embarked on facilities for pedestrians and non-motorized transport users as depicts in Table 44. The Table shows number of overhead bridges and road facilities that were built over five years (2007–2015), with a few on-going projects. This is grossly inadequate considering the dearth of these facilities before this period and the growing population in Lagos State.

Table 44: Road Projects and Facilities in Lagos State (May 2007-March 2011).

ROAD PROJECT		Road Facility			
Completed	Length (km^2)	Overhead Link Bridge		Pedestrian Bridge	
		Completed	On-Going	Complete	On-Going
21	19.69	-	-	-	5
33	22.47	1	4	1	-
45	77.94	2	-	-	-
47	51.58	1	-	2	1
4	4.36	-	1	-	-
150	176.03	4	5	3	2

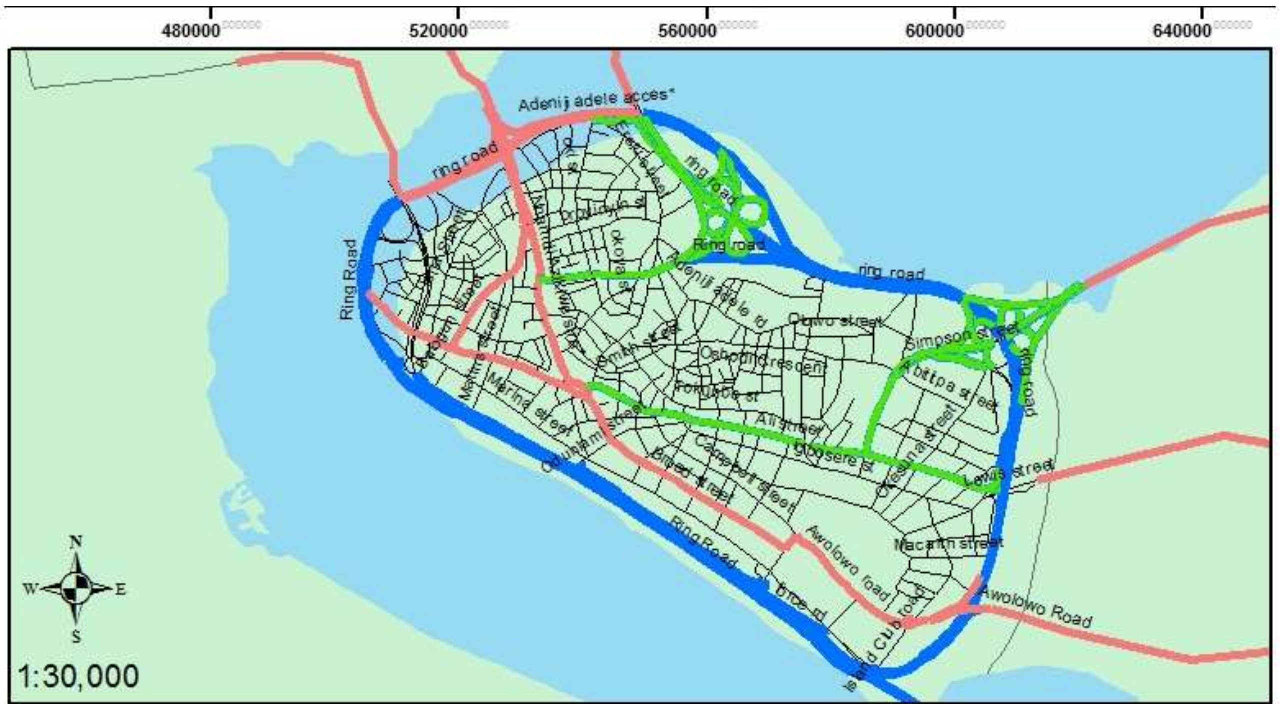
Source: Lagos State Government Ministry of Works and Infrastructure (2011)

Although data on the planning and scope of pedestrian infrastructure and maintenance in Lagos State is not available, it is clear that there is a paucity of pedestrian traffic facilities and inadequate road maintenance. Most of the feeder roads are unpaved and lack basic pedestrian facilities like drainage, footpaths, traffic lights and road signals.

Vehicular

In contemporary Lagos, private vehicular travel is the primary method for many people. Indeed, almost nothing is done to encourage walking in the Lagos urban community. Thus, unrestricted private vehicle use continues to escalate. Seven to ten million passenger trips take place daily in Lagos, with more than 95% by road, principally by walking, autos, buses and taxis, and commercial motorcycles. The modern road network structure on the Mainland is exclusively for vehicular use with highways and bridges connecting different areas. Road development started in the early 1970s. Vehicular flow paths have been both responses to and catalysts for the increased size of metropolitan Lagos. They include Western Avenue, which directly links Lagos Island through Eko Bridge and runs south to the Apapa Wharf area. These roads connect several large suburban regions, including Lagos Island, Ikeja, and Ketu. The Lagos-Badagry Expressway is a dual double-lane facility that merges at the eastern end with Apapa Road. The other main urban vehicular arterial road, Agege Road, runs south from Agege to Jibowu. It links the Herbert Macaulay/Muritala Mohammed Corridor running south to Iddo, and down to Lagos Island via Carter Bridge. The Third Mainland Bridge, the Lagos-Abeokuta Expressway, and the Lagos-Ibadan Expressway are the major controlled-access highways in the northern parts of Lagos. They also serve as inter-state highways to Oyo State and Ogun State, respectively. The construction of the Eko Bridge, and the dynamic reconstruction of Ikorodu Road into a ten-lane dual carriageway made a significant contribution to road development in Lagos. Figure 52 provides graphical illustration of road system within Lagos Island local government area.

Figure 52 Map showing roads in Lagos Island local government area



Source: Author's Construction, October 2016

The Third Mainland Bridge, the Apapa-Oworonsoki Expressway, and the Victoria Island-Epe road revolutionized modern road development. Likewise, the Lagos-Ibadan Expressway and the Lagos-Abeokuta Expressway are major corridor highways in the north of the town that serve as interstate highways. The Lagos-Badagry Expressway serves outlying towns to the west of Lagos Road in the Lagos metropolitan area and is classified as an international or intercity road. According to the Lagos Urban Transport Project (2002), international and intercity roads are usually the first roads or arterial roads, while intra-city roads are routes within a city and may be minor or major (arterial). About a third of the roads in Lagos State (43%) are asphalt concrete while some 23.2% are bituminous.

Rail mode of transportation

Rail mass urban passenger transit is a major feature of the 21st century that moves people and goods in large numbers. Post-independence, it was important to provide an efficient transport system. The rail system became the preferred means to move large numbers of people. Transit passenger trains, as well as local services account for more than 80% of passenger travel in Lagos. Around 100,000 passengers per month are transported by rail between Agege on the northern outskirts of Lagos and the terminals at Iddo and Apapa. While the level of service fell in 1987 due to aging locomotives and rolling stock, it was re-introduced under the Lagos Zone Rail. Mass Transit Program. In late 1992 agreement was reached with the Lagos State Government to revitalize the service in the form of the Jubilee Mass Transit Program. It is ironic that today, the rail system is once again moribund due to poor management, a lack of investment in infrastructure, a poor maintenance culture and a lack of foresight on the part of the authorities. The Lagos Island CBD is expected to experience significant intermodal travel transformation when the Blue Line rail system and ongoing reconstruction at the Marina axis are complete. Like other cities in developed and developing countries, businesses are concentrated in particular zones or districts which determines the pattern of traffic flow, particularly travelling to work, making intra-modal transportation a collective responsibility

Air Transportation

Air travel is another feature of urban travel in Lagos. There are two major airports in Lagos State, the Muritala Mohammed International Airport and the Ikeja local airport. Both are located in the Ikeja CBD, which doubles as the capital of the province. This mode of travel has assisted inter-state and international travel from Lagos.

Waterways services

The Lagos State Regional Plan (2005) noted that, travel by non-bus public transport (waterways) in Lagos had declined by 1.%. According to Egobi (1999 and Oni (2004), these services are unreliable, inadequate, and irregular in metropolitan Lagos, despite its abundant waterways. Private sector participants are not encouraged to develop the waterways. Proper development and maintenance of the waterways would go some way in addressing the chaotic traffic situation in Lagos State. Water transport has the potential to become an attractive mode of travel for suburban residents (e.g., the short distance between Lagos Island terminal and Apapa Warf) and for low-income communities such as in Makoko, Ajegunle, and Ikorodu.

6.4: The Lagos Island local government area

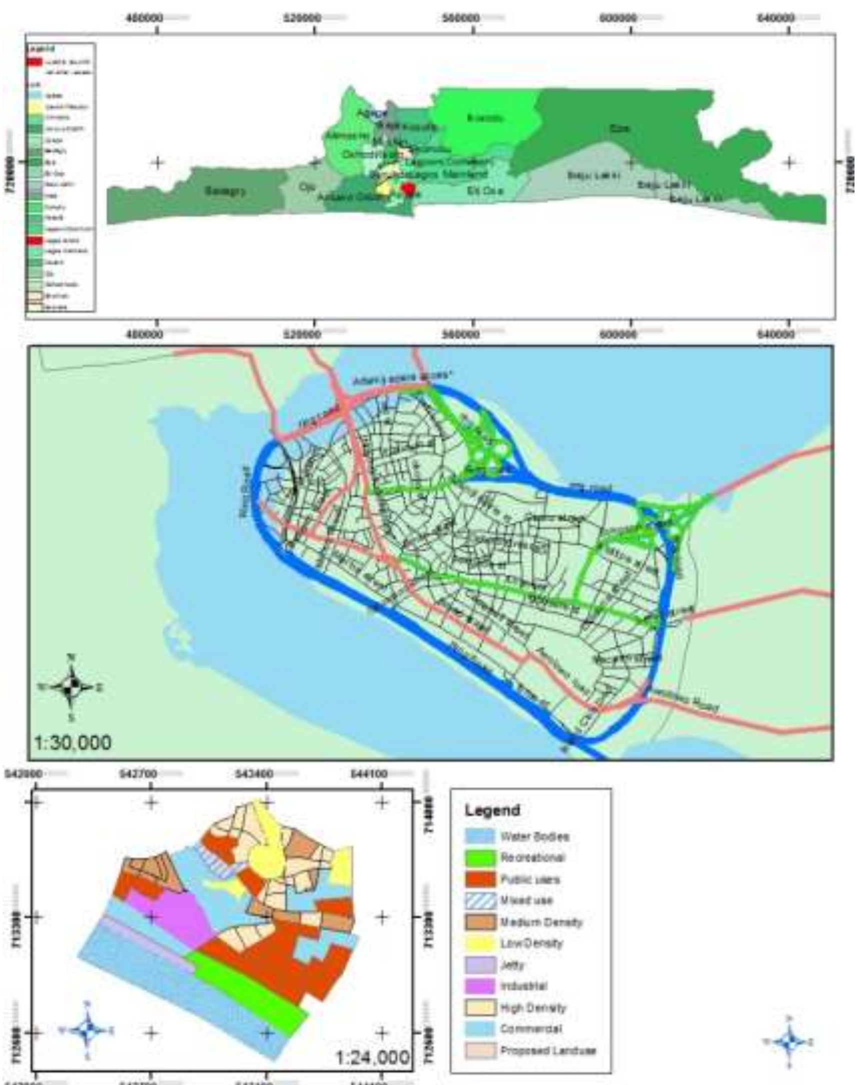
6.4.1: The growth and development of Lagos Island

The Lagos Island LGA has the same history of growth and development as other urban areas in Lagos. The old Western Region administered the Lagos metropolitan area in conjunction with Agege, Badagry, Epe, Ikorodu, and Mushin until Lagos State took off as an administrative entity. In 1976 Ikeja replaced Lagos Island as the capital of Lagos State. Lagos Island is the cultural center of Lagos. Popularly known as Isale Eko, it housed the Brazilian Quarters where the slaves that returned from Brazil resided. Bounded by Lagos Lagoon, a large protected harbor, Lagos Island is home to the Yoruba fishing village of Eko, which evolved into the modern city of Lagos. It is thus arguably the primary local government region in the Lagos metropolitan area. The earliest incarnation of Lagos was an Awori-Yoruba fishing community located on the islands and peninsula that form the modern state. Lagos Island was inhabited by families who claimed a semi-mythical ancestry from a figure called Olofin. Their modern descendants are the nobility known as the Idejo ('white cap chiefs') of Lagos. In the 16th century, Lagos Island was reputedly sacked by the Benin King's troops during that kingdom's expansionary era; thus, the emergence of the name Eko. The monarchs of Lagos claimed descent from the warrior Ashipa who happen to be a prince of Benin loyal to the Benin throne. Ashipa's son built his palace on Lagos Island, and his grandson moved the seat of government to the palace from the Iddo peninsula.

In 1730 the King of Lagos invited Portuguese slave traders to the island, where a flourishing trade soon developed. During the mid-19th century, the Yoruba hinterland experienced near-constant warfare due to internal conflicts and incursions from neighboring countries to the north and the west. By then, the fortified Lagos Island had become a major center of the slave trade. The colonial government suspended importation of slaves from this colony in 1807 and Britain extended the ban to its other colonies in 1833. Towards the end of 1851, a naval expedition bombarded Lagos into submission, deposed King Kosoko, and installed the more amenable King Akinoye who signed the colonial treaty. This opened the way for the illegal slave trade in Lagos in 1852. A few months later, tensions broke out between the new ruler, Akitoye, and supporters of the deposed

Kosoko. Kosoko's attempts to take the over the kingdom was unsuccessful. After consulting with local chiefs, the consul declared Dosunmu (Docemo), the eldest son of Akitoye, king. Lagos Island then became a base from which the British gradually extended their jurisdiction, shaping the protectorate and the hinterland. The morphological trend was driven by the demands of trade and security rather than by any deliberate policy of expansion. The Lagos Island LGA is the core/center of the metropolitan area and even the state. It has higher population density than the surrounding lower order commercial districts of the Lagos metropolitan area, and is characterized by high levels of business activity. Geographically, the Lagos Island LGA is dominated by the Lagos metropolitan CBD, Victoria Island and the Ikoyi island axis (see Figure 53) (LAMATA, 2010

Figure 53: Map of Lagos State showing the Lagos Island LGA in the regional setting



Source: Author's construction (2016) ©

The Lagos Island LGA shares boundaries with the Lagos Mainland LGA in the north, the Atlantic Ocean in the south, Eti-Osa in the east and Apapa LGA in the west. The Lagos harbor district of Apapa faces the western side of the Island. Figure 54 shows Lagos metropolitan area in map and below the map is the Lagos Island and the Lagos Island CBD. Due to urbanization and gentrification, the Lagos Island CBD expands to the northern part of the metropolitan area, with development in other directions limited by the lagoons and ocean. There are high levels of building density on Lagos Island and the land has some of the highest values in the city. Thus, one of the reasons why Lagos Island continues to grow in a steady pattern. Plate 5 below attests to the nature of growth.

Plate 5: Lagos Island CBD in 1929 and 2010

1929

2010

Source: http://mapsof.net/nigeria/lagos-island-map accessed, October 2016

6.4.2: Economic base and population growth

The Lagos Island LGA is a major socio-economic base for Lagos. Commercial activities are clustered in this area due to the diverse socio-economic characteristics of the Island that offer different economic opportunities. For example, Table 45 shows the total revenue of the Lagos Island local government and other/local council development areas in Lagos State. Lagos Island LGA's position as a driver of Lagos' economic growth benefits Lagos and Nigeria and is likely to filter through to the rest of sub-Saharan Africa. The Lagos Island LGA is home to more than 15% of Lagos' population. Workers in the informal sector of the Lagos Island LGA create more revenue than the rest of Lagos, with average GDP per job in Lagos nearly 30% higher than the Nigerian average. Lagos Island's CBD is a significant net tax contributor providing a net contribution of 1.5 billion Naira, in 2007/11, equal to 2.6% of all tax collected in that year. While Lagos Island LGA is experiencing economic growth, population growth is keeping pace with economic development.

Table 45: total revenue for Lagos Island LGA and other/local council development areas between 2007 and 2011

Year	Lagos Island LGA	Other 19 LGAs	Lagos State
2007	733,106,570.70	15,398,435,630.46	16,131,542,201.16
2008	582,183,294.52	15,482,335,811.87	16,064,519,106.39
2009	1,901,431,753.44	50,731,512,895.88	52,632,944,649.32
2010	2,261,833,508.2	45,107,014,043.86	47,368,847,552.06
2011	1,284,836,789.24	24,681,020,563.01	25,965,857,352.25

Source: Audited Annual Financial Report of the Local Government/Local Council Development Areas in Lagos State: 2007, 2008, 2009, 2010, 2011

6.4.3: Land use and planning

The spatial extent of the Lagos Island LGA has increased substantially, as has the intensity of land use. The land use pattern that emerged was a linear settlement pattern along major road and the waterway transportation system. Before the preparation of the Lagos State Regional Master Plan and the subsequent Metropolitan Lagos Master Plan, there were widespread problems due to uncoordinated urban development and inadequate development control in Lagos Island LGA. The land area is largely shared between residential and commercial uses. However, the spatial extent of the industrial area far outweighs that of residential use. Land use activities are a function of income, population density, building conditions, poverty levels, development potential, the economic base and commercial activities. As a multi-nucleus, urban center, Lagos Island LGA has metamorphosed into a standard suburban area. The most noticeable effect of globalization on the Island's cityscape is the radical shift in the land use pattern. Commercial and mixed uses are rapidly replacing residential use and multi-story office blocks within residential neighborhoods are now a common phenomenon.

6.4.4: Mobility and transportation

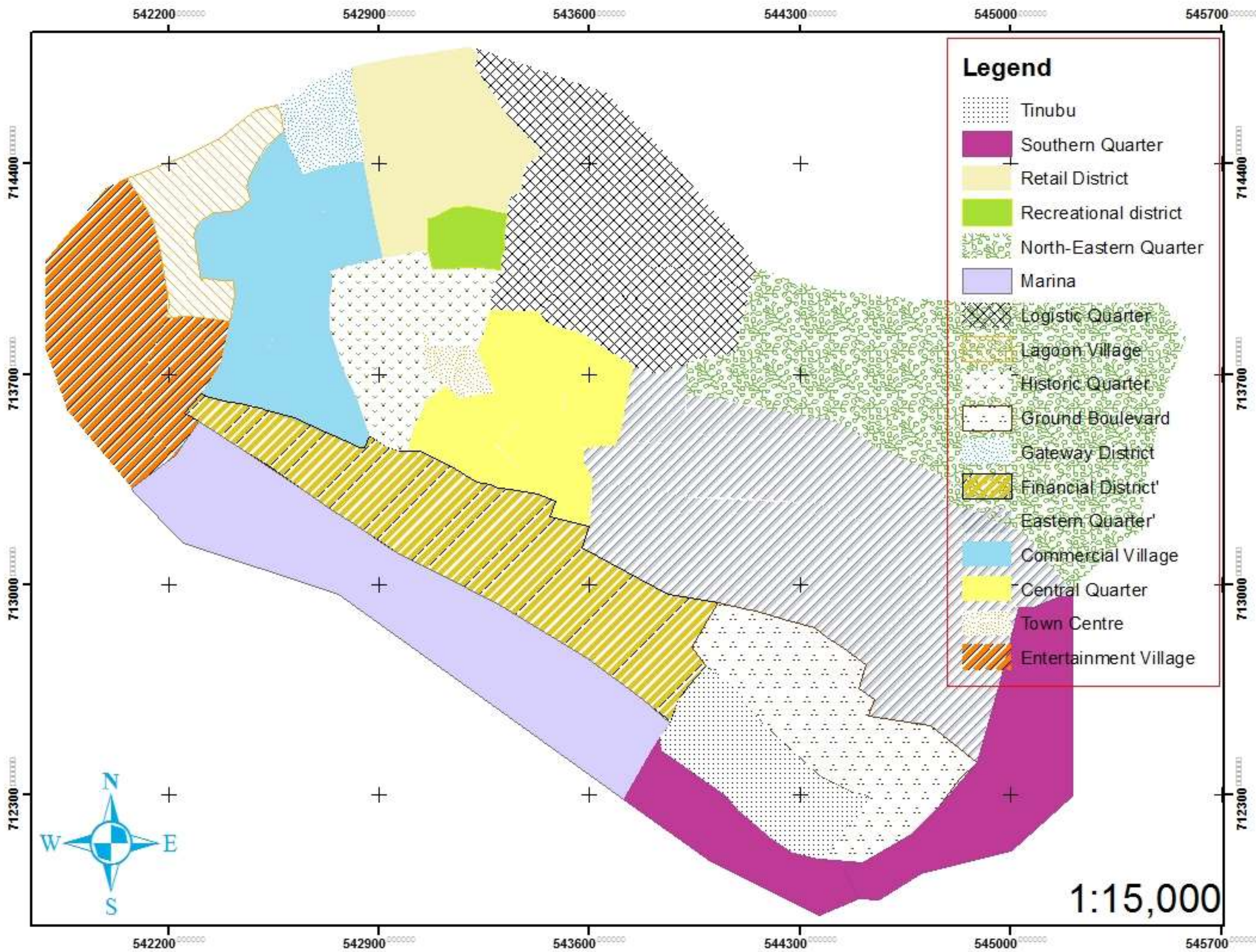
Transportation and communication facilities are poorly developing in Lagos Island LGA. According to the Metropolitan Lagos Master Plan, in the year 2000, transportation infrastructure occupied a substantial part of the Lagos Island CBD. Despite the fact that the Lagos Island LGA is the largest commercial, economic and industrial center in Lagos, its mobility and transportation are not commensurate with this status and it has the worst mobility and transportation problems in Lagos. The transportation facilities that are available are often expensive and inefficient and are considered as elitist. Unrestricted vehicle use has led to calls for a pedestrian 'revolution'. The study identified four major consequences of excessive vehicular use. Firstly, pollution resulting from vehicle emissions has reached serious levels in in the Lagos Island LGA and urban centers around Lagos. Vehicular transportation accounts for roughly 95% of carbon-monoxide emissions, 65% of hydrocarbons, and 40% of nitrogen oxide. It is responsible for 15% of the particulates in the city air as well as significant doses of toxic heavy metal. The foul air that residents of Lagos urban centers breathe is a serious health hazard and has resulted in a string of life-threatening diseases. Secondly, excessive vehicular use in the Lagos urban community has socio-economic implications. Traffic congestion leads to lost working time and astronomical fuel costs. The social costs include intimidation by large, fast, noisy vehicles, injuries and deaths. It is estimated that congestion in the Lagos urban center results in costs of $1 billion (approximately N160 billion) each year. Furthermore, residents lose more than three billion hours to traffic congestion per annum. It is estimated that, reducing the time lost by 20% would cost the state at least $1 billion (about N160 billion) per year. These statistics underscore the gravity of traffic congestion and the long-overdue need for measures to improve intra-urban transportation in Lagos State. Thirdly, energy and environmental concerns are one of the root causes of the pedestrian revolution in the Lagos urban center. Walking is an extremely neglected energy source. Cars in Lagos consume at least 60% of the country's petroleum. For example, 2.5 million residents of Lagos use more energy than 1.3 million Indians and Chinese combined. Environmental degradation is the most critical consequence of excessive vehicular use.

6.5: The Lagos Island CBD

6.5.1: The growth and development of Lagos Island CBD

Lagos Island CBD covers a land area of approximately 9.26 square kilometers (land mass and water area about 5.2 and 4.06 square kilometers, respectively). The Lagos Island CBD is primarily surrounded by water and the sand filling of the hinterland in the western swamps initiated during the colonial period continues in order to reduce mosquito breeding. Plans are also afoot to construct a large bridge between Victoria Island and the Lekki Peninsula. The famous square in Lagos Island CBD was constructed to mark the amalgamation of the north and south protectorates to form Nigeria in 1914 and the Lagos city hall is the seat of the island's local government. Land use within Lagos Island CBD is predominantly devoted to business. The CBD has long been the commercial hub of Lagos. Figure 54 shows the spatial structure of the Lagos Island CBD.

Figure 54: Map Showing Spatial Structure of Lagos Island CBD

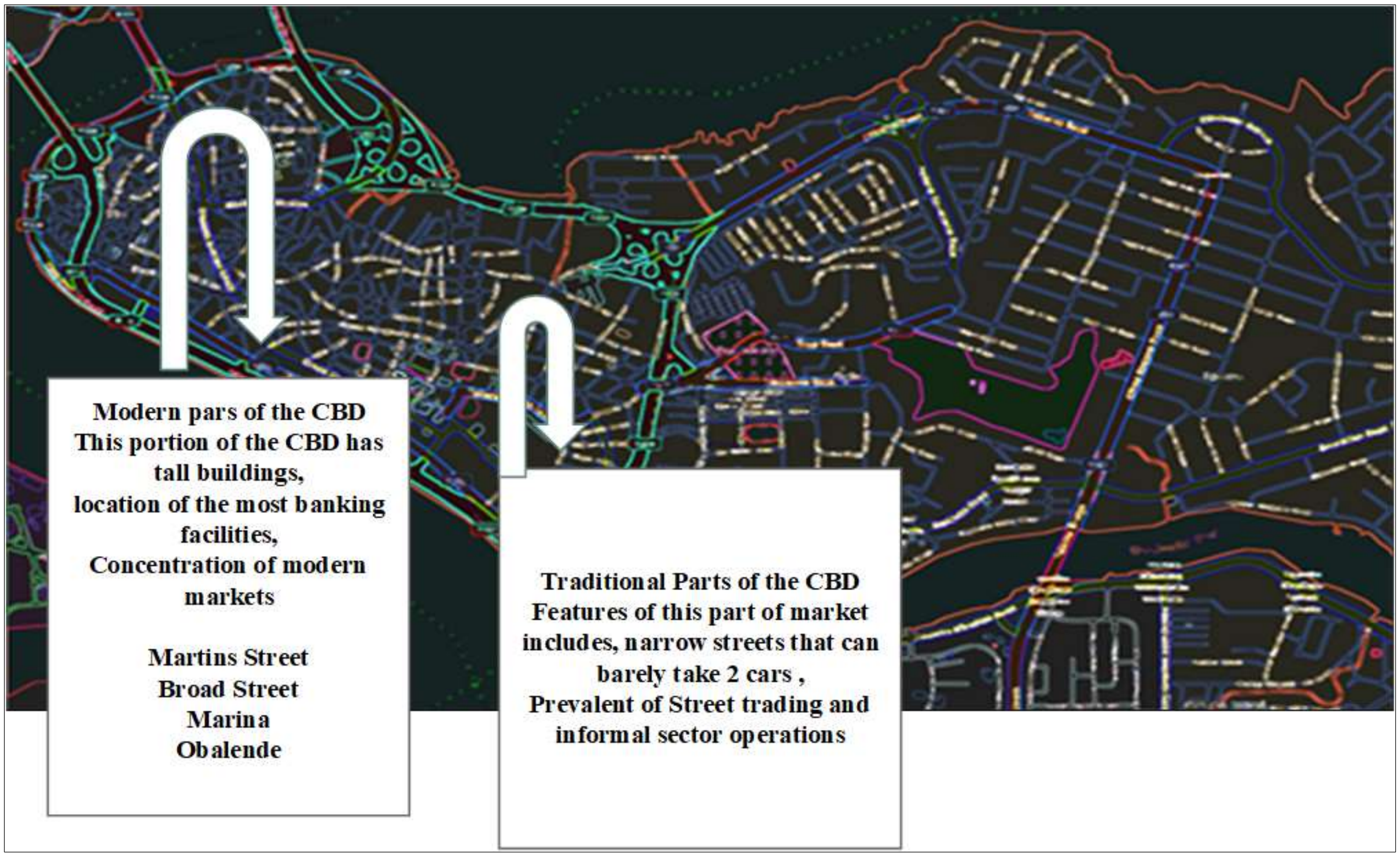


Source: Author's construction (2016) ©

Modern and traditional parts of the CBD

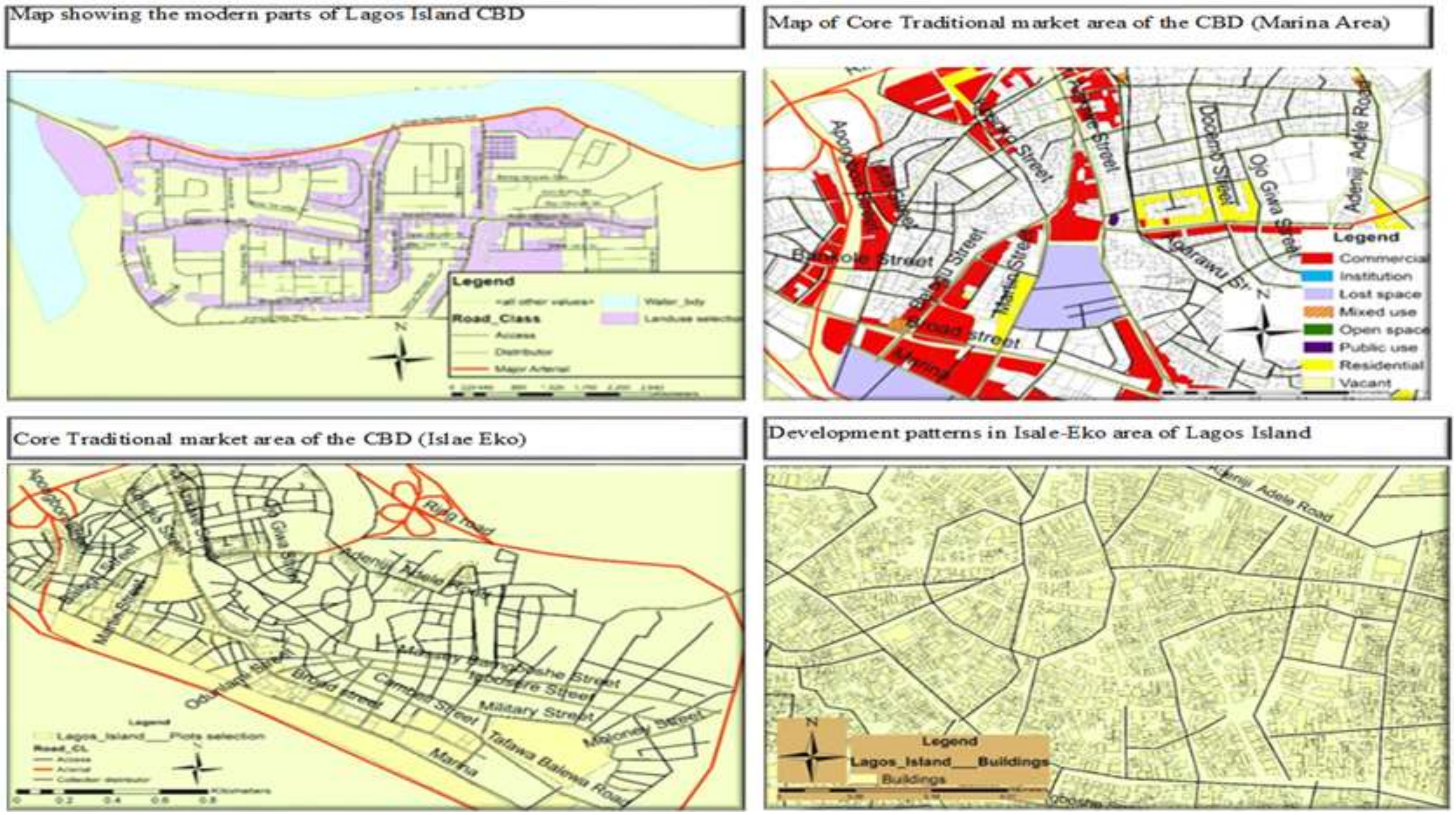
As shown in Figures 55 and 56, downtown Lagos consists of both modern and traditional parts of the CBD. The Lagos Island CBD grew more rapidly in recent times. Both parts of the CBD are home to formal and informal markets.

Figure 55: Map showing the traditional and modern parts of the Lagos Island CBD



Source: Author's construction (2016) ©

Figure 56: Additional maps showing the traditional and modern parts of the Lagos Island CBD



Source: Author's construction (2016) ©

The historical center of metropolitan Lagos includes the traditional (eastern parts) and the modern (western business district) parts. These evolved to become the commercial nerve center. They are both accessible via the Eko Bridge through to the Apogbon area. From there, one can walk to Ebute Ero, Idumota, Nnamdi Azikiwe and Dosunmu Streets, and Idumagbo and Adeniji Adele Roads. Other areas include Martins Road, Broad and Balogun Streets, Oluwole, Mandilas, Tinubu Square and adjacent areas. The Lagos Island CBD includes the core CBD, Ikoyi, Victoria Island and more recently the Lekki-Epe axis. Table 46 provides of selected streets in the traditional and modern parts of the CBD.

Table 46: Selected streets in traditional and modern parts of the CBD

Traditional CBD	Modern CBD
Narrow streets Street trading Pedestrian car conflicts Mixed land use (1st floor–warehouse,2nd-floor shop and 3rd floor (residential use)	Tall buildings Parking restrictions More financial institutions Market more organized
Adeniji Adele Road	Victoria Island
Glover	Kosoko
Iga Idunganran	Balogun
Igbosere	Nnamdi Azikiwe Street
Inner Marina/CMS	Dosunmu Street
Jankara	Messy Street
Obalende	Martins
Oju Olokun	Broad Street
Okesuna	Ereko
Sura Street	Ikoyi

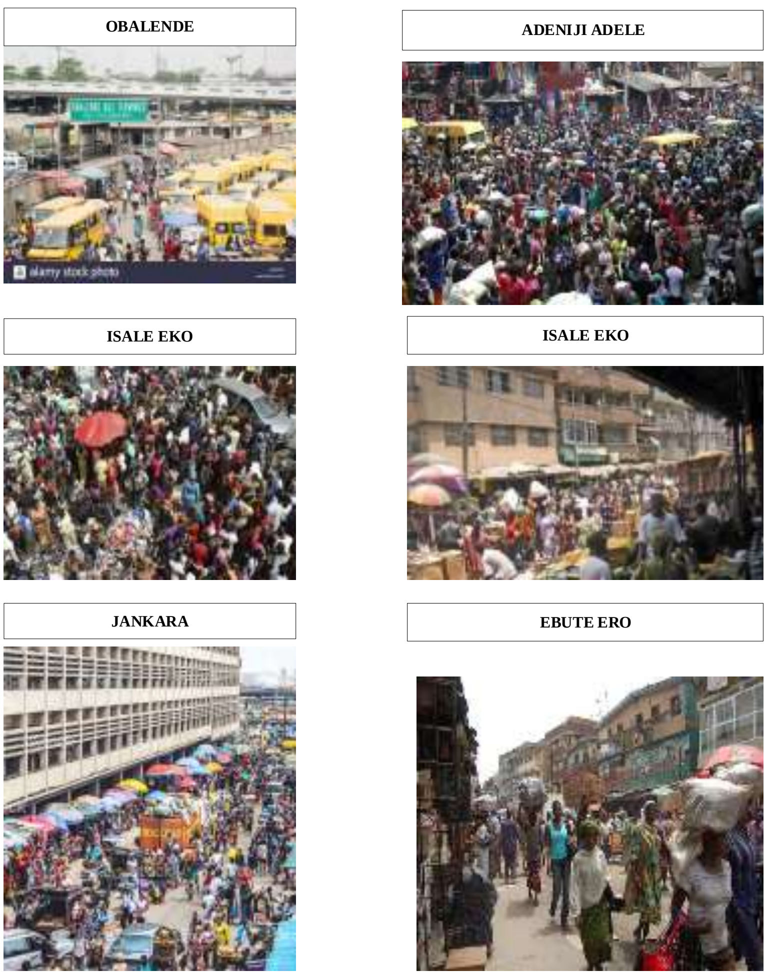
Author’s construction (2016) ©

Combined, these areas provide a direct means of livelihood to approximately six million people and indirectly to even more by way of the multiplier effect. In both the traditional and modern parts of the CBD landlords and developers earn high income from commercial activities due to ever increasing rent, and traders that own large shops also prosper. These areas are also home to retailers, hawkers, transporters, load carriers and refuse collectors. Bank branches have opened to serve the markets and traders as well as government offices. Due to excessive urbanization and public gentrification, the city has expanded to the northern part of the CBD, with development in other directions limited by lagoons and the ocean. Building density in the traditional part is high and land in the modern part is some of the most valuable in the city.

The traditional part (core) of the Lagos Island CBD

The traditional part of the CBD is concentrated on eastern side of the Island that host markets and poorer residential areas. Daily influx of people to these parts of the CBD is enormous (see Plate 6). Land use is disorganized, and the markets are poorly structured with small stalls. Parts of the markets are home to purpose-built office buildings**.**

Plate 6: Selected Traditional parts of the Lagos Island CBD



Source: Compilation by author at https://www.google.com;and accessed October 2016

Those that cannot secure a store for business engage in informal street trading on the streets (see Plate 8) For example, the Oluwole district is at the heart of the traditional part of the CBD. Situated on the edge of the Isale Eko quarters, it is the only section of the Lagos Island CBD that bears any resemblance to a typical Yoruba CBD. In the traditional parts of the CBD buildings that have not been demolished and replaced with multi-story structures are partitioned into shops and small cubicles. Nonetheless, many traders are still seeking space to rent. The core area is congested due to narrow roadways. The mixed land use pattern in the traditional part of the CBD does not encourage the free flow of traffic, with roads usually reduced to one lane. On-street trading further encroaches on roads, obstructing traffic flow. There is a lack of bus terminals, lay-bys, and parking lots that are usually found in CBDs. Vehicles, especially large trucks make U-turns at non-designated points, broken down vehicles are left unattended, and motorcyclists do not heed the rules of the road, making it difficult for pedestrians to move freely and safely. Large parts of the roads in the traditional area/illegal and/or tolerated trading areas/markets have been converted to open markets. Traders have also set up shop on the sidewalks as displayed in Figure Plate 7 below.

Plate 7: Roadside trading on a Pedestrian walkway in Lagos Island

Source: Compilation by author at [https://www.naij.com/547357-photos-see-traders-taken-pedestrian-lanes-lagos.html in October 2016](https://www.naij.com/547357-photos-see-traders-taken-pedestrian-lanes-lagos.html)

The modern part of the Lagos Island CBD

The modern part of the Lagos Island CBD is situated in the west and is home to many company headquarters and entertainment spots. It includes Victoria Island and Ikoyi that have several sizeable shopping areas. The reconstructed Bar Beach is located on the seashore along the Atlantic front. Eko Atlantic City is one of the new cities under construction. Located on land reclaimed from the Atlantic Ocean, it is expected to be around four-square miles. The modern part of the Lagos Island CBD is dominated by high-rise buildings and businesses. It is one of the most affluent areas and has some of the most expensive real estate in Nigeria. This part of the Island is an important financial and commercial center where many Nigerian and international corporations have their headquarters and it also accommodates the city's largest wholesale marketplaces (such as the famous Balogun Market, Martins Street and Tinubu area). Plate 8 below shows the modern part of the Lagos Island CBD.

Plate 8: Examples of modern aspects of the Lagos island CBD (Marina and Tinubu Square)

Source: Compilation by author at https://www.naij.com/547357-photos-see-traders-taken-pedestrian-lanes-lagos.html in October 2016

There are a significant number of hotels and nightclubs in the western parts of the Island as well as a major recreational park and one of sub-Saharan Africa's largest golf courses. However, congestion and reduced parking space caused many companies to seek new locations from the 1970s to the 1990s. This led to the construction of purpose-built office buildings in the modern parts of Lagos Island such as the core CBD, Victoria Island, Ikoyi and the Lekki-Epe axis. The traditional areas are now considered as the Modern Central Business District (MCBD) of Lagos due to the growing number of companies that relocated there. The Victoria Island and Ikoyi axes are situated on the western half of Lagos Island and are joined to it by a landfill. For example, Ikoyi connects to Victoria Island via a bridge on the main road over Cowries Creek. The new part of the Lagos Island CBD was originally home to the middle-class. However, recent studies confirm that it is now occupied by the upper middle-income class.

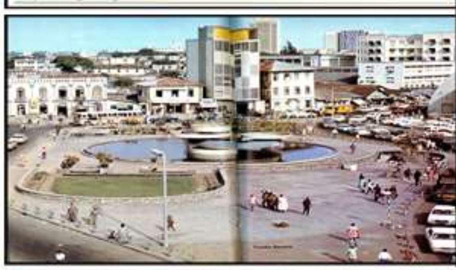
6.5.2: Economic and population growth

By the end of the 20^{th} century, the world's 20 most populous cities with significant economic potential were no longer located in Europe and America, but in the developing world. The Lagos Island CBD is among these areas. Its spatial structure has dualistic features. On the one hand, it is the financial and socioeconomic base of Lagos and on the other it is home to well-established commercial activities deeply rooted in ethnic homogeneity, kinship, and a community land tenure system, rather than merely in economic segregation. Commercial activities strengthen the economic and tax base of the Lagos Island CBD. Indeed, its economic value stands at more than N10 trillion per day. Commercial activities have offered significant economic opportunities to traders, both women and men. Approximately 40 to 60 % of the population of Lagos Island is engaged in trade and commerce. While much of this business takes place in offices, shops, and stores, most trading activities occur on the streets and roadways. The Lagos Island CBD is also a financial district where the country's largest insurance companies, commercial banks, financial institutions, and multi-national corporations' headquarters are located. It is home to entrepreneurs involved in large-scale transportation, hospitality and entertainment businesses as well as small and medium enterprises. Of the more than 50 merchant banks operating in Lagos, about 80% have their head offices in Lagos Island CBD. Others have branch offices that might be considered pseudo head offices, based on the volume and value of their transactions in relation to other branches and the head office. Lagos Island also has far more formal and informal sector activities than other CBDs in Lagos as well as in sub-Saharan Africa. The commercial and financial activities that it hosts enhance the economic potential of Lagos State and the country as a whole. To put this potential in perspective, 85% of Nigeria’s commercial activities are domiciled on Lagos Island. Furthermore, it is home to more than 70% of investors in Lagos State.

6.5.3: Land use and Planning in the Lagos Island CBD

The CBD is the geographic, cultural, and government center of Lagos Island. It offers a variety of residential options, places of employment and entertainment and eating establishments that serve the entire region. The CBD has now expanded to cover neighboring Islands as well as the adjacent Mainland. Land use in the Lagos Island CBD is a mix of office, retail, institutional, recreational, and some manufacturing, along with different densities of housing from older, single family homes to new apartment buildings. Lagos Island is an LGA, Nigeria's leading commercial nerve center, and a residential community and is home to light industry, and other land uses. The zoning of the CBD favors core business activities. The CBD contains various areas that have developed over time. Plate 9 below shows multiple land uses in Lagos Island in the past and the present.

Plate 9: Various land uses in Lagos Island in the past and present

		**Public use Famous Cathedral Church of Christ is the oldest Anglican Cathedral in Nigeria**
		**Commercial use Broad Street, Lagos Broad Street Lagos - Now-&-Then**
 	 	**Recreational Tinubu Square**
		**Transportation Carter Bridge**
		**Residential Campos street**

Source: Compilation by author at [https://www.naij.com/547357-photos-see-traders-taken-pedestrian-lanes-lagos.html in October 2016](https://www.naij.com/547357-photos-see-traders-taken-pedestrian-lanes-lagos.html)

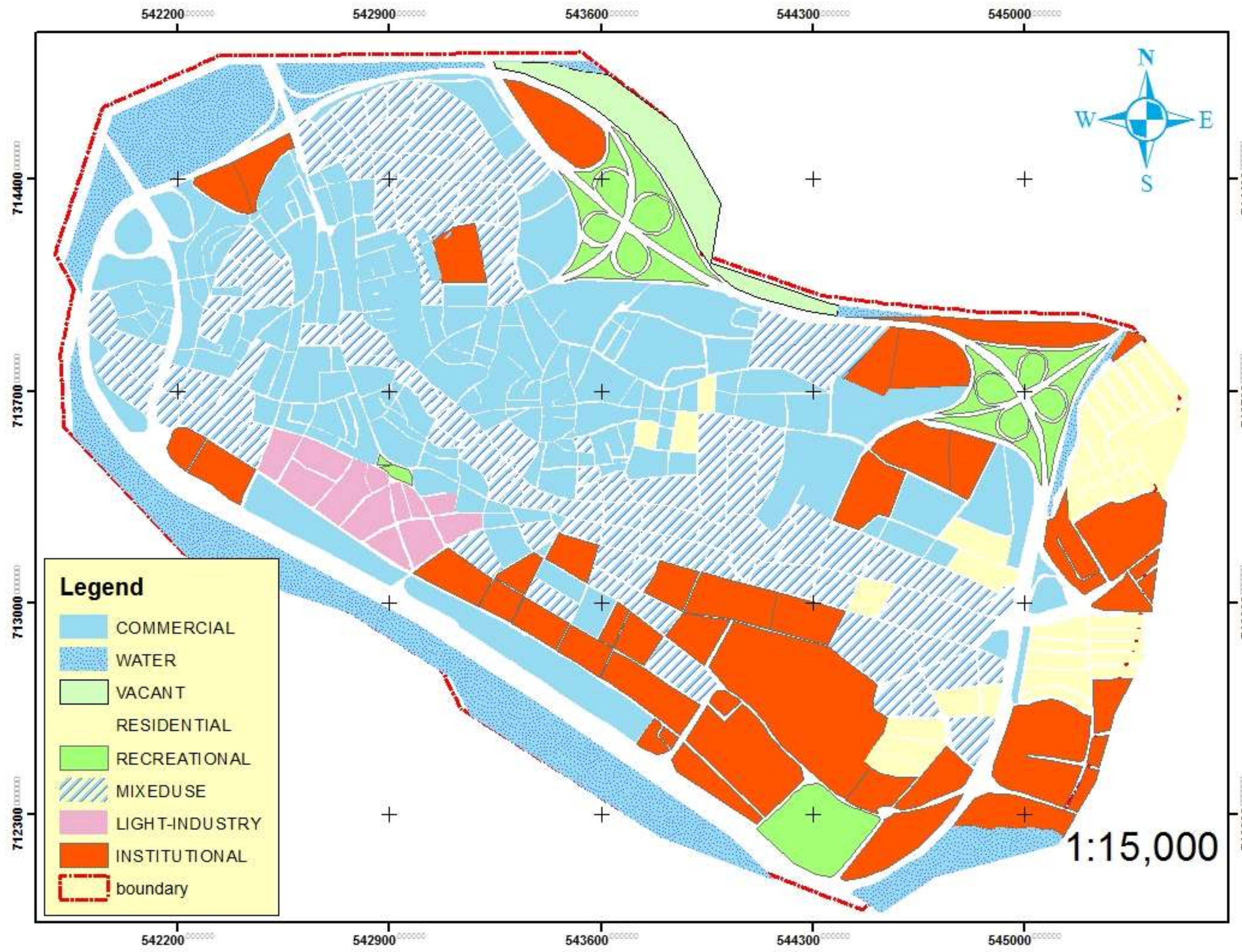
Commercial activities are the predominant land use. A more in-depth analysis of land use in Lagos Island is presented in Table 47 Figure 57 shows the land use analysis and the dominance of commercial development. The metropolis is referred to as a champion city due to its physical and spatial characteristics and could be regarded as a prototype of the urbanization process at work in the global South. However, this poses numerous challenges.

Table 47: Lagos Island land use analysis

LAND USE	AREA	HECTARES	PERCENTAGE
Commercial	1604380	160.438	24.01984731247285
Institutional	1216089	121.6089	18.20657954996809
Light industry	135768	13.5768	2.032639792268549
Landscape	193369	19.3369	2.895008573383839
Mixed use	1215421	121.5421	18.19657864120288
Recreational	71416	7.1416	1.069198952659321
Residential	326493	32.6493	4.888063930360139
Vacant	122767	12.2767	1.837996356854582
Circulation	1154912	115.4912	17.29067296983423
Water	638778	63.8778	9.563413920995516
TOTAL	6679393	667.9393	100

Source: Author's construction (2016)

Figure 57: Land use analysis in the study area



Source: Author's construction (2016)

Mixed land use

Mixed development amounts to approximately 18.2% of total land use in Lagos Island and comprises residential use bounded by the Marina in the environs of Warehouse Road and commercial and industrial activities from Warehouse to Creek Roads. The proliferation of business activities has resulted in the conversion of residential and some industrial/commercial buildings (in the case of multiple floor buildings, the 3rd floor is used for a warehouse, the 2nd floor for shops and the 1st floor for residential purposes). Most of these conversions are illegal and no environmental impact studies were conducted. Several streets have witnessed massive conversion from residential to mixed land uses. These include Simpson and Oke Arin Streets and their environs, Ademola Adetokunbo, Evans Street, Isalegangan and environs, Idumota, Adeniji Adele, Adeyinka Oyekan and John Pachi Streets, Saint Naincess Street and environs, Balogun Street, Ring Road, Ereko, India and environs, Etim Inyang and Ozumba Nbadiwe. The result is increased traffic congestion on the major arterial roads during peak periods. High densities and increased commercialization have undermined pedestrian infrastructure and compounded traffic problems in neighborhoods surrounding the CBD.

Institutional/public land use

Institutional land use constitutes 18% of the total land use coverage. It is concentrated in the commercial district. Lagos Island is also home to a significant number of public institutions and places of worship such as the Anglican Cathedral and Catholic Church, as well as the Central Mosque. Many businesses' headquarters are in and around the Lagos Island CBD, as are leading primary and secondary academic establishments that cater for around 15,000 full-time students. Figure 65 below provides a snapshot of Public buildings in Lagos Island CBD.

Recreation and Leisure Use

Recreational use makes up 1% of land utilization in the study area. While nearly every street in the Lagos Island CBD is home to historical sites, sightseeing tours are rare. One of the essential functions of the Lagos CBD is to accommodate entertainment, cultural gatherings, and community celebrations. This distinguishes the CBD from other general retail areas. The concentration of entertainment and major local restaurants in Lagos Island CBD attracts many visitors on a daily basis. It is also home to Nigeria's national museum. The Lagos Island government authorities estimate that recreational activities support more than 5,000 jobs. Major tourist attractions include the famous Tinubu Square, the museum, entertainment and amusement parks. Plate 10 below indicates Tinubu Square in Lagos Island.

Plate 10: Tinubu Square in Lagos Island

Shortly after 1960

1970

1980

2010

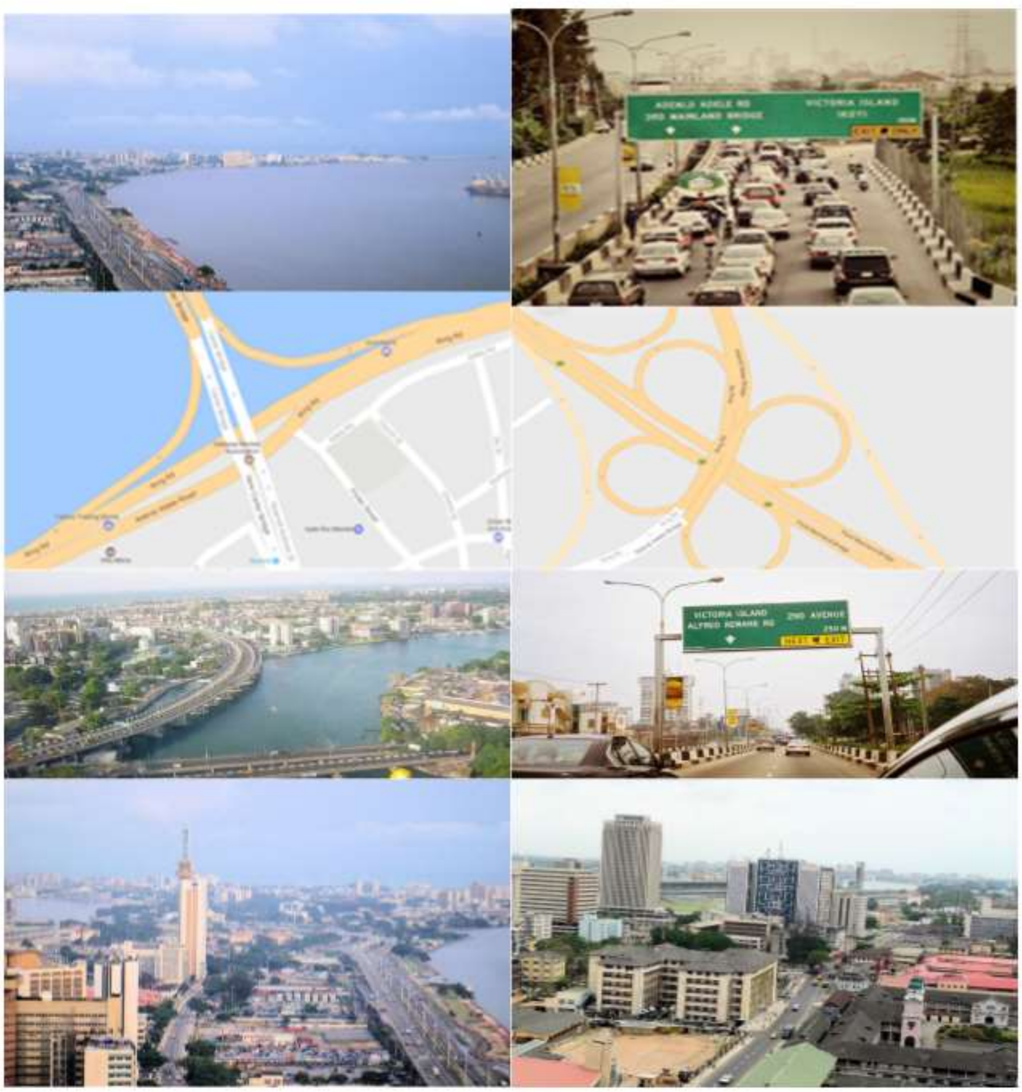
Source: Compilation by author https://www.google.com/search accessed October 2016

The former Secretariat, built in 1906 to house the colonial offices, is another historical monument that stands a short distance from the Lagos Island Hospital. The Marina portion of the CBD is home to Africa's tallest building and magnificent sculpture as well as NITEL house where the colonial governors lived until 1960. Another building of interest is the former office block for the passenger and freight steamship service en-route to London and the West African coast. The famous Tafawa Balewa Square occupies the former racecourse site and nearby is King's College and the old supreme court buildings.

Circulation

The Lagos Island CBD is the hub of the city's public transport routes and the focal point for the major road networks (see Plate 11). These functions account for approximately 17% of total land use in the Lagos Island CBD. Lagos Island has expanded to the neighboring and adjoining Mainland. It is joined to the Mainland by three large bridges, which cross the Lagos Lagoon to the district of Ebute Metta. Trade has encroached on most of the available circulation space in the CBD and street traders compete with vehicles/pedestrians.

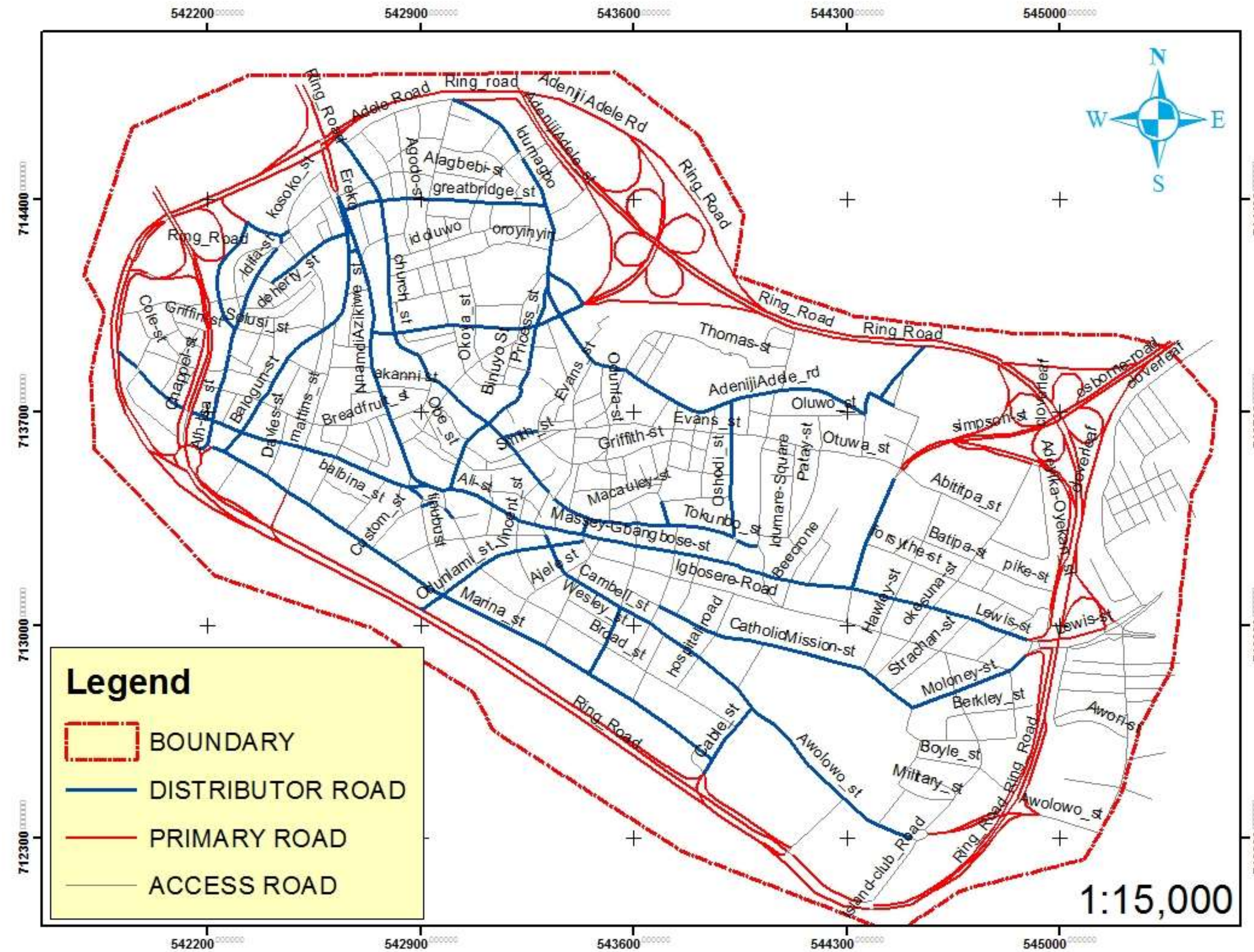
Plate 11:Major roads connecting the Lagos Island CBD



Source: Compilation by author [https://www.google.com/search accessed October 2016](https://www.google.com/search)

The concentration of companies in the modern and traditional parts of the CBD renders human and vehicular movement difficult as they compete with trucks offloading goods, people transporting their merchandise in wheel barrows and hawkers. Every road space has been converted into a stall. Successive Lagos State governments expanded development of the western parts, culminating in the construction of a highway connecting Victoria Island to Epe. Lagos Island City is also home to a few high quality residential areas. Both the traditional and modern parts suffer from traffic congestion due to large-scale commercial activities. The massive daily movement of people on various road hierarchies (see Figure 58) puts considerable pressure on transportation infrastructure in the CBD. This results in productivity losses and commuters wait hours for buses

Figure 58: Road hierarchies in the Lagos Island CBD



Source: Author's construction (2016) ©

Residential use

The Lagos Island LGA is made up of 14 residential quarters occupied by indigenous populations with occupations such as trading and a mix of civil service and professional jobs. The CBD residential area is a mix of dwellings of various ages and density. Recently, there has been a shift to mixed-use, higher density housing. A typical mixed-use project has four floors, with apartments on the 3rd and 4th levels and shops and storage facilities below.

Light Industry

Light industry in the study region is growing at a faster rate than in any comparable CBD within the Lagos metropolitan area and the country.

Commercial land use

Core commercial land uses accounts for 160.44 of the total 6,779,393 hectares or 24%, representing almost a quarter of the ground area. Commercial activities are concentrated along major traffic corridors. In addition, The Lagos Island CBD houses the headquarters of numerous transnational corporations, financial institutions and national conglomerates. Most importantly the central Bank of Nigeria and other commercial landmarks of note. It is also home to the largest stock exchange in Nigeria and Africa as well as various banking institutions. It is important to note as well that Many people thus visit the CBD not only to shop but banking transactions due to vehicular and pedestrian accessibility. Table 48 provides selected financial institutions in the Lagos Island C

Table 48: Location of financial institutions in Lagos Island CBD and accessibility to Vehicular and Pedestrian Traffic

Bank	Location of Branches	Vehicular Accessibility	Pedestrian accessible
Access Bank Nigeria Limited	Apongbon and Broad Street	Yes	Yes
ACFL Microfinance Bank Limited	Odunlami Street	Yes	Yes
Acuity Microfinance Bank Limited	Adeniji Adele Road	Yes	Yes
Afribank Nigeria Plc	Abibu Oki Street, Broad Street, Sanusi Olusi Street, Oke-Arin, Martins Street	Yes	Yes
Bank PHB Plc	Igbosere Road	Yes	Yes
BOI Microfinance Bank Limited	Marina-Lagos	Yes	Yes
Broadview Microfinance Bank Limited	Odunlami Street	Yes	Yes

Bank	Location of Branches	Vehicular Accessibility	Pedestrian accessible
Calm Microfinance Bank Limited	Great Nigeria House Lagos	Yes	Yes
Cash Cow Microfinance Bank Limited	Igbosere Road	Yes	Yes
Chanelle Microfinance Bank Limited	Nnamdi Azikiwe Street	Yes	Yes
Credit Express Microfinance Bank Limited	27 Kakawa Street	Yes	Yes
Diamond Bank Plc	Enu-owa Street, Broad Street, Balogun, Nnamdi Azikiwe Street, Oke-Arin Street & Marina	Yes	Yes
Ecobank Nigeria Plc	Broad Street	Yes	Yes
Equatorial Trust Bank Limited	Alakoro Street, Oke Arin, Enu-Owa Street, Idumota Branch, Marina-Lagos, Sandgrouse, Alakoro Street	Yes	Yes
FBN Microfinance Bank Limited	Marina, Lagos	Yes	Yes
Fidelity Bank Plc	Idumagbo Avenue, Off Nnamdi Azikwe Street, & Balogun	Yes	Yes
Fin Bank Plc	Davies Street, Idumagbo Avenue, Abibu-Oki Street, Iddo and Oke Arin	Yes	Yes
First Bank Nigeria Plc	Marina, Broad Street, Moloney, Odunlami	Yes	Yes
First City Monumental Bank Plc	Tinubu Street, Broad Street, Idumagbo, Idumota, Oke-Arin	Yes	Yes
Flourish Microfinance Bank Limited	Issa Williams Street	Yes	Yes
Guaranty Trust Bank Plc	Catholic Mission Street, Broad Street, Nnamdi Azikiwe Street	Yes	Yes
Intercontinental Bank Plc	Broad Street I &II, Marina, Moloney Branch, Nnamdi Azikiwe Street, Oroyinyin Street	Yes	Yes
Lagos Island Microfinance Bank Limited	Igbosere	Yes	Yes
Mayfield Microfinance Bank Limited	Broad Street	Yes	Yes
New Heights Microfinance Bank Limited	Broad Street	Yes	Yes
Parkway Microfinance Bank Limited	Broad Street	Yes	Yes
UBA Microfinance Bank Limited	Marina-Lagos	Yes	Yes
Wizetrade Microfinance Bank Limited	Broad Street	Yes	Yes

Source: Author's Compilation, 2016

There are more than ten traditional markets strategically located within the CBD. Table 49 illustrates the intensity of commercial land use activities in Lagos Island CBD compounded by the uncontrolled growth of street trading and the conversion of residential buildings, leading to the chaotic traffic situation.

Table 49: Location of markets in Lagos Island CBD

Market	Location	Description	Street trading	Traffic congestion	Pedestrian Infrastructures
APONGBON	Apongbon Street	This market is situated on Apongbon street from whence it derived its name. It is known for foreign merchandise and street trading. A preliminary investigation shows that pedestrian activities are prevalent in this market. The location of this market has reduced the flow of traffic to the CBD. Some traders live and work within the same building.		Yes	No
BALOGUN	Balogun Street	This market is situated on Balogun street from whence it derived its name. Balogun market is one of the domestic markets in the Lagos Island CBD. It has no precise geographical delineation and sprawls into adjacent streets and neighborhoods. The market is primarily devoted to street trading activities. Some traders live and work within the same building. Goods are displayed on road setbacks and walkways. This Balogun Market causes chaotic conditions which impede the flow of traffic.	Yes	Yes	No
DOSUNMU	Idumota environs	Idumota Market is almost exclusively devoted to the sale of babies' and children's clothing. It is mainly marked by street trading which reduces the flow of traffic.	Yes	Yes	No
EBUTE ERO	Ring road, Ereko, India & environs	This market is known for wholesale trade in consumables and clothing. Street trading causes chaotic conditions.			
IDUMOTA	Balogun, Ereko, and environs	Street trading causes chaotic conditions and inadequate flow of traffic.	Yes	Yes	No
ITA FAJI	Evans Street, Isalegangan & environs	Surrounded by three streets, it is characterized by extended street trading and chaotic conditions, with inadequate flow of traffic.	Yes	Yes	No

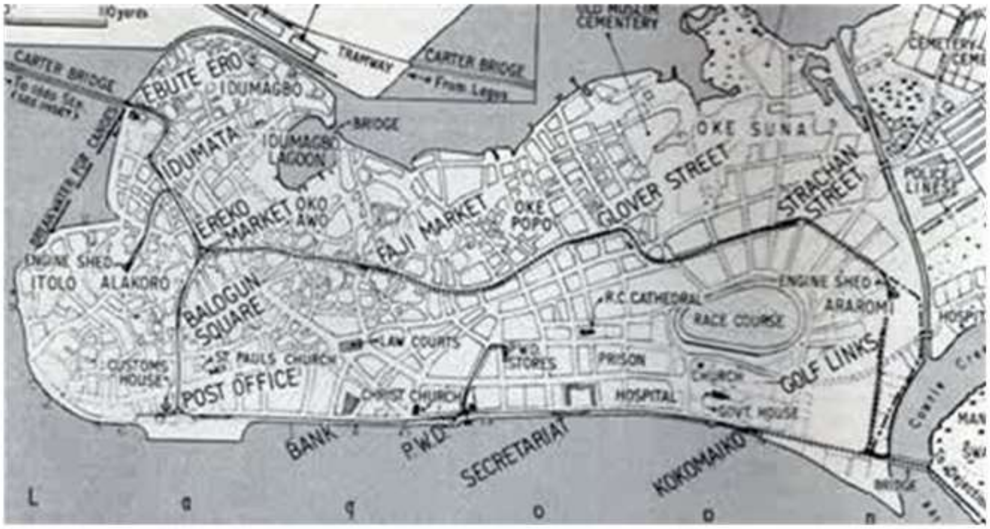
Market	Location	Description	Street trading	Traffic congestion	Pedestrian Infrastructures
JANKARA	Adeniji Adele, Adeyinka Oyekan Street, John Pachi Street, All street Naincess Street & Environs	Jankara is a fusion of old and extended markets in deteriorating condition. Food items and herbal teas are sold on the street, reducing the flow of traffic.	Yes	Yes	No
OKE ARIN	Oke Arin Street and environs	This is also a fusion of old and extended markets in deteriorating condition where food items and herbal teas are sold on the street, causing chaotic conditions. This part of the CBD is a lively, mixed-use district, often transitioning (spatially) between residential and commercial/industrial areas. Oke Arin is an antique market within the CBD where many traders live and work in the same building. There is inadequate flow of circulation of pedestrians.	Yes	Yes	No
SURA	Simpson Street and Adeniji	The Sura Market is a prime example of commercial uses stifling residential land use.	Yes	Yes	No
TINUBU	Tinubu Square	Located near Tinubu Square, it is mainly devoted to street trading which impedes the flow of traffic.	Yes	Yes	No

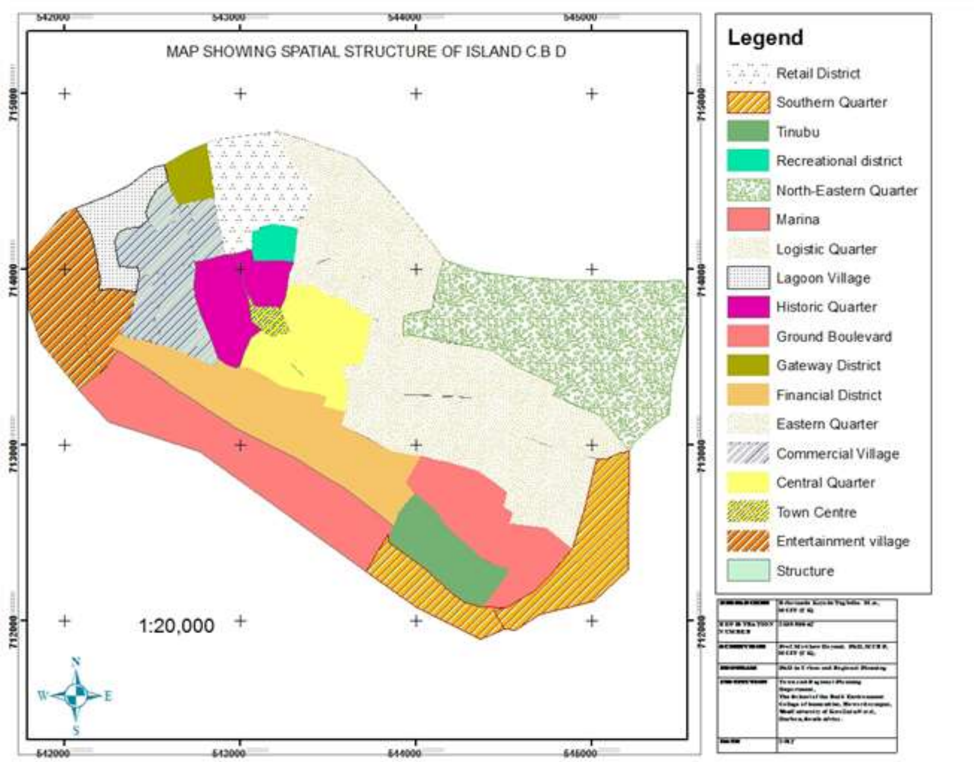
Source: Author’s construction (2016) ©

For example, Balogun Market has the largest number of traded goods. Some sections of the markets are set aside for products, while others focus on general merchandise. Balogun Market has the densest concentration of traders as multi-story buildings dominate sections of the mark. The CBD has experienced spatial growth since 1960 till date (see Figure 59).

Figure 59: Spatial location of markets in Lagos Island CBD

BEFORE





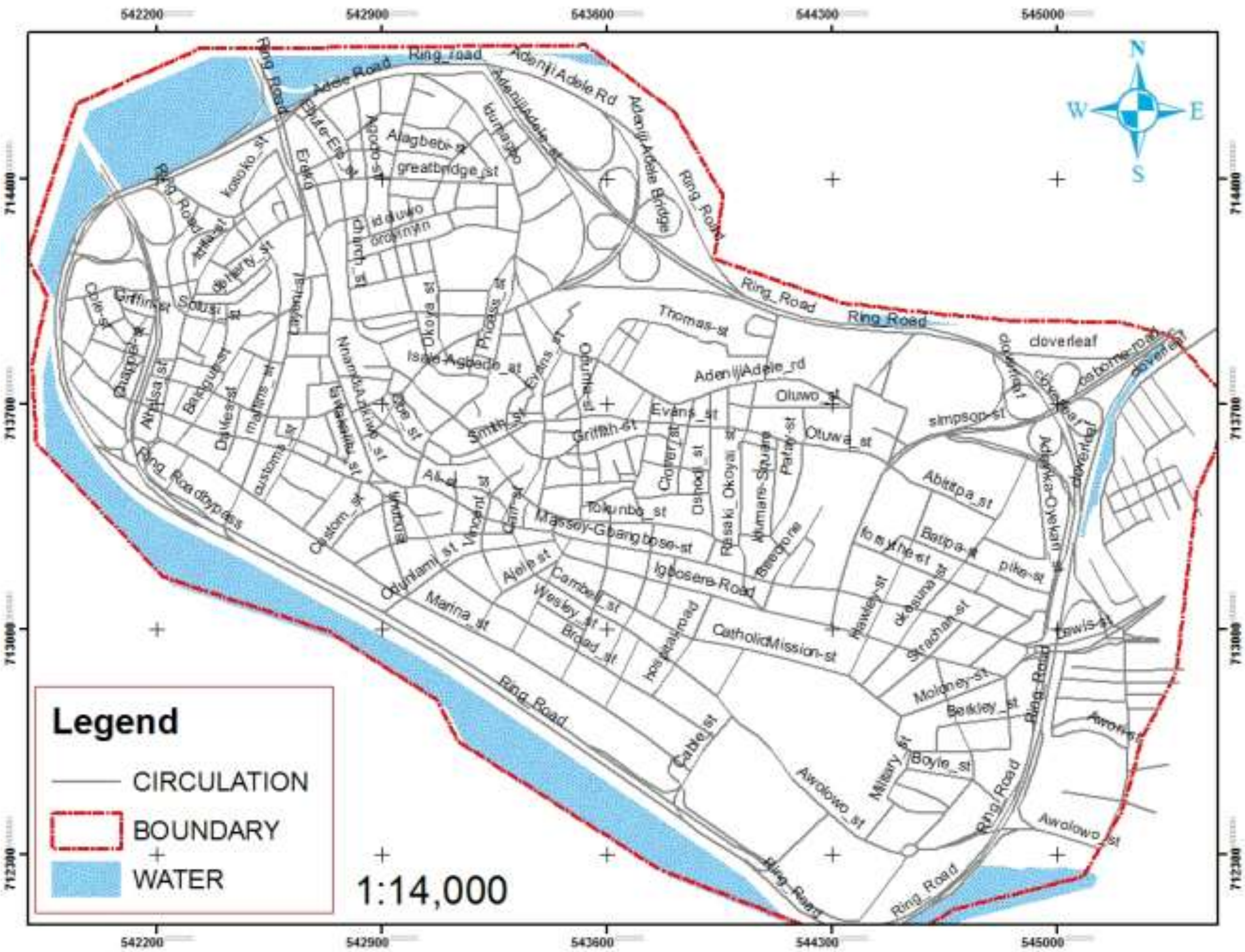
NOW

Source: Author's construction (2016) ©

6.5.4: Mobility and transportation

On average, more than 500,000 vehicles (approximately 1.4 million passenger trips) enter and leave the Lagos Island CBD for metropolitan Lagos every working day in a typical week. A Lagos Metropolitan Area Transport Authority (LAMATA) report indicates that approximately 47,675 commuters use mass transport in the Lagos Island LGA on a daily basis (LAMATA, 2010). The three main terminals in the LGA are Igbosere, Idumota, and Idumagbo with a total number of 150, 400, and 250 transport operators, respectively. Of the 350 arterial routes within the metropolis, Lagos Island has 102 arterial roads (29%) (see Figure 60); the Mainland 119 (34%); Apapa 39 (11%) and Ikeja 90 (26%).

Figure 60: Lagos Island CBD circulation



Source: Author's construction (2016) ©

Of the 90 roads that traverse Ikeja (the study area) 37 serve the mainly commercial and mixed commercial/industrial zones. Only 20 traverse the predominantly commercial axes while the remaining 17 serve institutional and industrial areas and 57 residential neighborhoods. Figure 61 provides a graphical illustration of the Lagos Island circulation system. The Figure provides of a major road from Mainland to the Lagos Island CBD. Accordingly, Figure 61 shows that the three pictures on the right depict the old Carter bridge of the 60s. The left images depict the new look of carter bridge)

Figure 61: Lagos Island Carter Bridge Now and Before

Source: Compilation by author
http://www.everyculture.com/MaNi/Nigeria.html#ixzz4VelTb58UAccessed in October 2016

Vehicular Transportation

Given these circumstances, Lagos Island is characterized by vehicular and pedestrian traffic congestion on most streets throughout business hours. It is estimated that this commercial center generates more than 250,000 vehicles and over half a million people per day. This is three times the number in other commercial centers in Lagos State. According to World Bank (2002), the total two-way passenger traffic crossing the three bridges between the Lagos Mainland and Lagos Island in 2001 was 1.59 million per day of which 77% were public transport passengers. This represents annual growth in passenger demand of nearly 3.4%. During peak houses, routes leading to the CBD are heavily congested, causing long delays. Furthermore, most intersections within the Lagos Island CBD lack appropriate signal systems, compounding the traffic problems. Traffic congestion in Lagos Island is mainly the result of inadequate traffic planning and management as well as unlawful use of available space. Streets in the CBD littered with illegally parked vehicles. Again, major routes lack bus stops. The fact that no regulations require individual or corporate parking for customers and employees within 500 feet of the core CBD has led to myriad parking problems in the downtown and core CBD area.

The Pedestrian system in the CBD

Up until the early 1950s, walking in Lagos Island was a pleasurable experience. Plate 12 illustrates the peaceful pedestrian environment in the CBD at that time. However, today, it is a major challenge for a pedestrian to walk in the CBD without coming into conflict with vehicular traffic. Pedestrian accidents and traffic congestion are growing by the day. The main reason is that there no organized pedestrian facilities in the core CBD. Most pedestrians' cross major streets that lack sidewalks and pedestrian bridges. They compete with vehicles and traders, resulting in high accident rates.

Plate 12: Broad Street Lagos 1950s (Note the barefoot pedestrians)

Note the barefoot pedestrians

Source: Compilation by Author http://www.nairaland.com/1112009/did-british-rulers-leave-too accessed in October 2016

While it is acknowledged that groundbreaking attempts have been made to build new roads over the lagoon to improve traffic flow and encourage pedestrianization, much remains to be done. One of the hallmarks of a thriving CBD is pedestrian activity, not only for commercial or entertainment purposes, but for the sheer pleasure of walking and the variety of things to see and discover along the way. Walking should be the preferred mode of movement between areas in the downtown. However, a pleasant walking experience depends upon perceived safety, and a high degree of interest in the route traveled. Safe walking areas are those that are separate from traffic and parking, and wide enough so that at least two people can walk comfortably side by side.

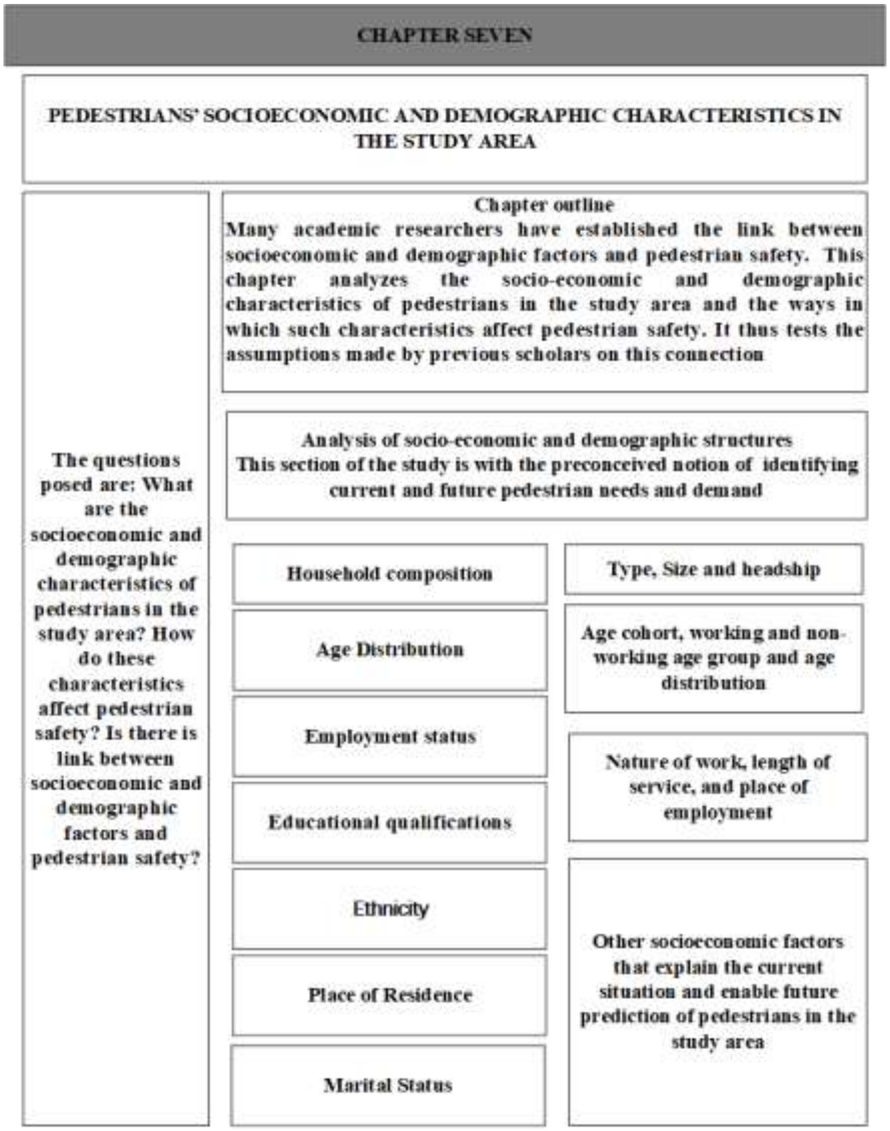
6.6 The Chapter summary:

This chapter discusses the case study. It presents the evolution of Lagos within the context of Nigeria. This chapter, which is a combination of secondary and primary data. The chapter provides very rich statistical and pictorial evidence of the nature of activities in Lagos. This chapter presented largely on the basis of findings from the Lagos Island Central Business District case Study. The findings are based on a thematic analysis of variables which Include transport modes, pedestrian facilities, pedestrian safety and access, physical environmental issues and potential social deterrents and walkability audi

7. CHAPTER SEVEN SOCIO-ECONOMIC AND DEMOGRAPHIC CHARACTERISTICS OF PEDESTRIANS IN THE STUDY AREA

7.1: Chapter outline

Figure 62: Outline of chapter seven



Source: Author's construction (2016) ©

World-wide, road accidents kill pedestrians of all ages and socio-demographic status, especially in developing countries. Socio-demographic characteristics offer insight that informs policies and decision-making in urban planning. Strategies to promote pedestrian safety and thus walking should be informed by such information, as should predictions of pedestrian movement. There is link between socio-economic and demographic factors and pedestrian safety. Furthermore, pedestrian road accidents correlate strongly with socio-economic and demographic factors. These include population density, education, occupation, household headship, per capita income, marital status, age, and education status. This chapter analyzes the socio-economic and demographic characteristics of pedestrians in the study area and the ways in which such characteristics affect pedestrian safety. It thus tests the assumptions made by previous scholars on this connection. Figure 62 sets out the structure of the chapter.

7.2: Pedestrians' socio-economic and demographic characteristics in the study area

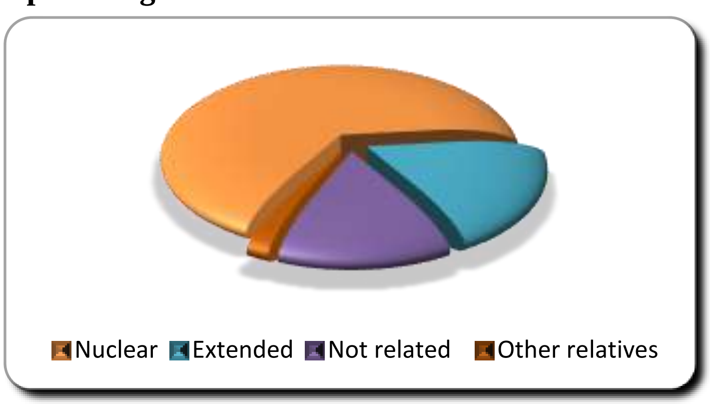
The socioeconomic and demographic characteristics of pedestrians' in the study area were analyzed to improve pedestrian mobility and enhance their safety at critical points along major corridors. The variables examined include household composition, age, gender, educational qualifications, self-reported ethnic group, marital status, employment status, duration of stay and family size.

7.2.1: Household composition

Family type

For this study, a family refers to people in intimate relationships by virtue of birth, biological relationships, marriage or other relationships such as a de facto relationship, fostering or adoption.

Figure 63: Household size and composition and effects of poverty on pedestrian trip making



Source: Author's household survey, October 2016©

Figure 63 shows that 488 of the 751 study participants, representing 65% were part of a nuclear family, while135 were part of an extended family (18%). Only 15 (2% of the sampled population) claimed to be part of a household with people to whom they were not related. Thus, many of the participants in the Lagos Island CBD lived in a nuclear family (see Table 50). A small family unit is more likely to prefer convenient living and to be within walking distance of the study area. With the findings, this study confirms that large families are relatively present.

Table 50: Household composition – family type

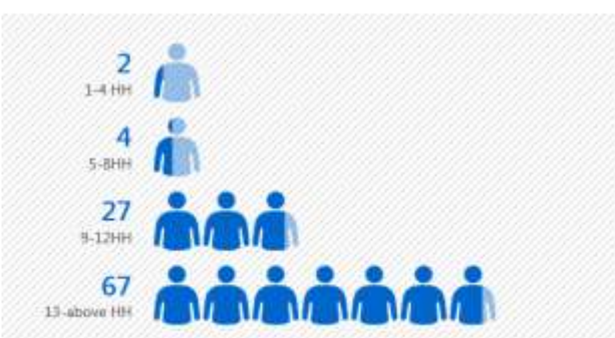
Parameters	%	Frequencies
Nuclear	65	488
Extended	18	135
Relatives	15	113
No relation	2	15
Total	100	751

Source: Author's household survey, October 2016©

Household composition – family size

Sixteen participants or 2% of the sample stated that their households consisted of one to four members, while 28 (4%), 204 (27%) and 503 (67%) lived in households with five to eight, nine to 12 and 13 and more members, respectively. One of the study's interesting findings was that more than 500 of the sampled population belonged to a family with 13 or more members. This suggests that, like any typical African CBD, the study area is densely populated. Figure 64 provides an illustration of household size.

Figure 64: Household composition -family size



Source: Author's household survey, October 2016©

This has significant implications for vehicular and pedestrian transportation. According to Table 51 from the field analysis, the observed average household size is close to 13 persons per household. This was calculated by estimating standard deviation and variance, which stood at 2.663 persons per household and 7.119 persons per household, respectively.

Table 51: Average household family size

Occurrence (X)	Frequency (f)	Freq*X	(X-men)	(X-mean) 2	f* (X-men) 2
2.5	16	40	-10.36	107.32	1717.115
6.5	28	182	-6.36	40.444	1132.418
10.5	204	2142	-2.36	5.567	1135.737
14.5	503	7293.5	1.64	2.691	1353.66
Total	751	9657.5	-	-	5338.929
Mean	12.869				
Variance	7.119				
SD	2.663				

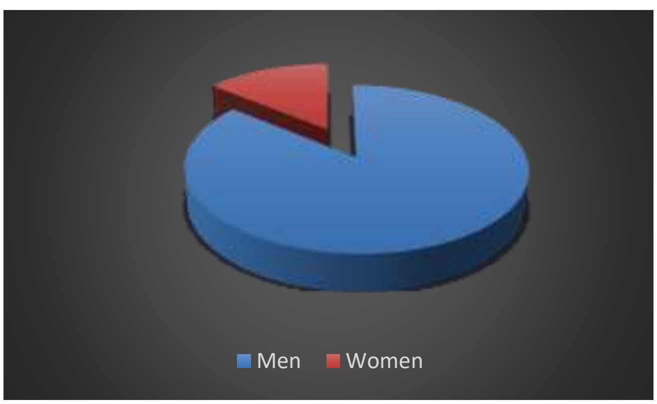
Source: Author's household survey, October 2016©

This dense population is far above the average of four people per household in the US and across European countries. Thus, a viable pedestrian system that will improve the safety of this vulnerable group should be paramount in urban planning for the Lagos Island CBD.

Household composition - family headship

Fifty per cent of the participants (376) claimed to be the head of their households. Of these 323 (86%) were male and 53 (14%) were women (see Figure 65 below).

Figure 65: Head of household



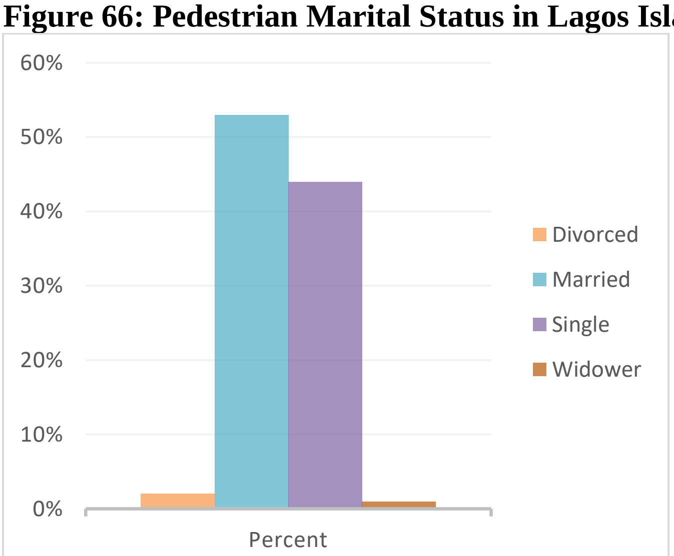
Source: Author's household survey, October 2016©

There is thus a substantial difference between men's rates of participation in pedestrian activities and their female counterparts. These results suggest that men that are heads of households are likely to be more at risk of accidents involving pedestrians. Furthermore, it is probable that men make more pedestrian trips than their female counterparts. This is likely due to their status as heads of households. These findings show that the trend in other parts of the world for more women to take on the role of head of the household does not hold true in the study area. A report on "U.S. women on the rise as the family breadwinner", states that in six out of ten American households with children under the age of 18, the mother is the breadwinner.(Moor, 2013, British Heart Foundation Centre 2015). However, in typical African communities, this is not the norm and, indeed is considered socially and culturally unacceptable. This applies to most developing countries. Once again, these results should inform planning for safe intra-urban travel in the Lagos Island CBD.

7.2.2: Marital status

The results show that 398 (53%) of the 750 participants were married and they confirmed living with their nuclear family. Three hundred and thirty (44%) were single and divorcees and widowers accounted for 15 (2%) and 8 (1%) of the sample, respectively (see Figure 66). The data thus suggest that most married respondents prefer making some trips by walking.

Figure 66: Pedestrian Marital Status in Lagos Island CBD



Source: Author's household survey, October 2016©

The fact that more married participants preferred to walk suggests that they are less likely to be at risk of death or injury due to motor accidents vehicles than their unmarried counterparts. In the Western world, most insurance companies assume that married people have a lower accident risk than single individuals. Married people thus pay lower premiums. Furthermore, married pedestrians are likely to be more conscious of road safety and make use of available pedestrian facilities due to their family responsibilities.

7.2.3: Age distribution

It is important that an intra-urban pedestrian system promotes safety for different age groups. Indeed, studies have found that while walking is gender-neutral, it varies significantly by age. With this study, it is very important to note that the share of walking and other modal trips increases with age. Table 52 below shows that the study participants' ages ranged from 18 to 73 years.

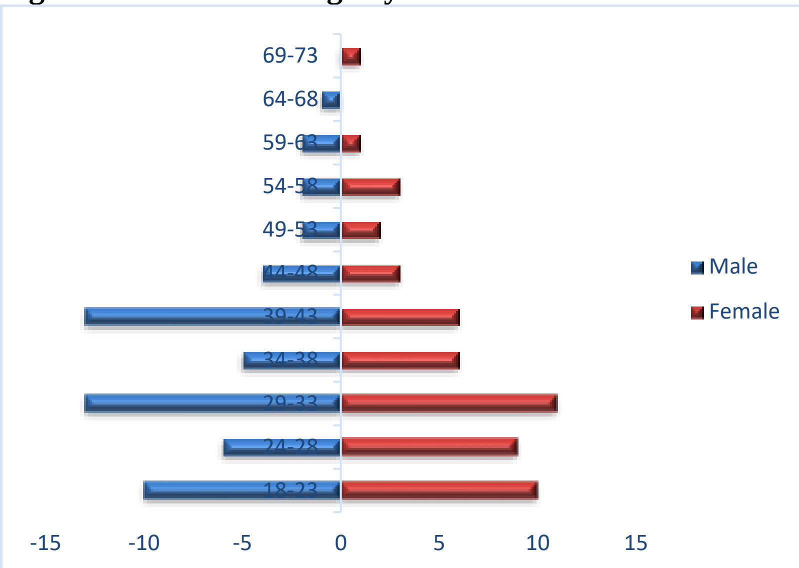
Table 52: Age distribution

Ages	Percent	Male		Female		Frequencies
18-23	20	10	75	10	75	150
24-28	15	6	45	9	68	113
29-33	24	13	98	11	82	180
34-38	11	5	38	6	45	83
39-43	9	3	22	6	45	67
44-48	7	4	30	3	22	52
49-53	4	2	15	2	15	30
54-58	5	2	15	3	22	37
59-63	3	2	15	1	8	23
64-68	1	1	8	0	0	8
69-73	1	0	0	1	8	8
Total	100	48	360	52	391	751

Source: Author's household survey, October 2016©

A quarter of the respondents in the study area (180) were in the age group 29-33 years, with only 16 (2%) aged 64-73. Figure 67 sets out the age profile of the participants in the Lagos Island CBD.

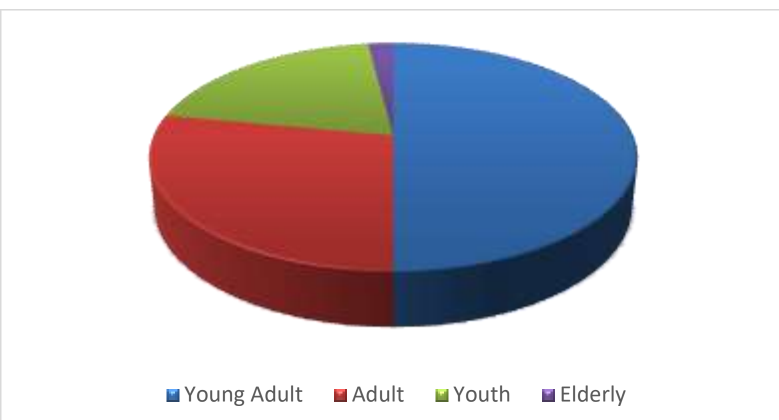
Figure 67: Pedestrian Age Pyramid



Source: Author's household survey, October 2016©

From this data, four cohort /age groups were identified, and the characteristics associated with these cohorts were determined. They are the youth (18-23 years), young adults (24-43 years), adults (44-63 years) and the elderly (64 and older). Figure 68 below shows that 50% of the pedestrian population sampled in the study area was young adults.

Figure 68: Age cohorts



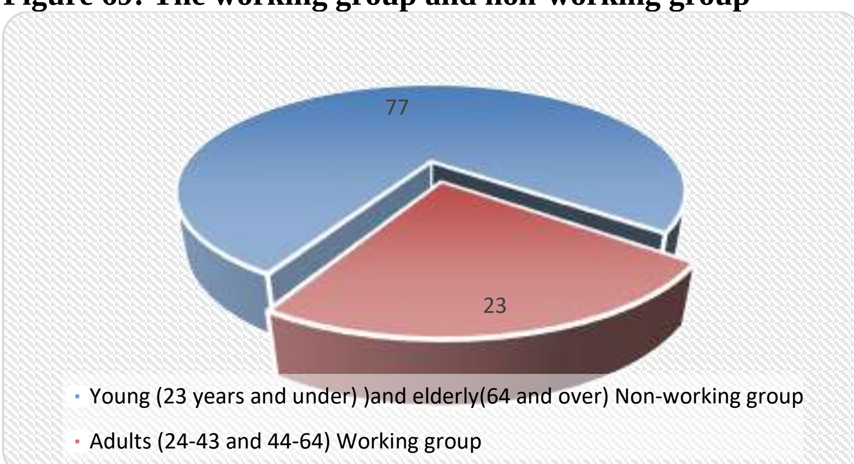
Source: Author's household survey, October 2016©

Furthermore, 20% (150 out of 751) of the participants were young people between the ages of 18 and 23 and 378 (50%) were aged 24 to 43. The population of Lagos Island CBD thus comprises mainly young adults and adolescents. Several inferences can be made from this finding. The first is that there is likely to be a high level of pedestrian activity in the study area as young people are more capable of and more likely to walk than their older counterparts. However, studies have found that a youthful population is associated with higher rates of pedestrian /vehicular accidents, pointing to the need to invest and to improve pedestrian safety in the study area. Finally, a youthful pedestrian population could point to high levels of unemployment and be associated with lower household income.

Working and non-working groups

The 150 study participants in the youngest (18 years and under) and oldest (64 and over) age categories (23% of the study sample) were identified as the non-working group, while those in the age groups 19-43 and 44-64 (601 out of 751 representing 77%) were categorized as the working group. Figure 69 provides snapshots of the working group and non-working group in the study area.

Figure 69: The working group and non-working group



Source: Author's household survey, October 2016©

The modal age of walkers in the study area

Table 53 presents a statistical analysis of the average age of pedestrians in the study area. Their arithmetic mean age is calculated by applying the following scientific formula:

$$x = \frac{\sum f x}{\sum f}$$

Table 53: Statistical analysis of arithmetic mean age of pedestrians

	Occurrence(X)	Frequency(f)	Freq*X	(X-mean)	(X-mean)2	f*(X-mean)2
18-23	21	150	3150	-13.482	181.765	27264.746
24-28	26	113	2938	-8.482	71.945	8129.755
29-33	31	180	5580	-3.482	12.124	2182.408
34-38	36	83	2988	1.518	2.304	191.253
39-43	41	67	2747	6.518	42.484	2846.429
44-48	46	52	2392	11.518	132.664	6898.516
49-53	51	30	1530	16.518	272.844	8185.306
54-58	56	37	2072	21.518	463.023	17131.862
59-63	61	23	1403	26.518	703.203	16173.67
64-68	66	8	528	31.518	993.383	7947.063
69-73	71	8	568	36.518	1333.563	10668.501
Total	Total ->	751	25896	-	-	107619.507

Source: Author's household survey, October 2016©

The computed arithmetic median age of the pedestrians is 34 with a standard deviation of 12. Tables 54 and 55 show variations in the mean ages of male and female pedestrians. The statistical analysis shows that the median age of male and female pedestrians is 32 and 30, respectively; the average age is thus 31. To add to this empirical analysis, an attempt was made to differentiate between the median ages of female and male pedestrians. The average age was calculated by computing the median (mean) for the sampled male and female participants in the Lagos Island CBD.

Analysis of the age spread of male and female pedestrians

The statistical analysis shows that the mean age for a male pedestrian in the study area is 35 years and 34 years for females, while the field results show that the median age of female pedestrians is higher than the average age of men in the Lagos Island CBD. The standard deviation is used to ascertain how dispersed (spread out) female and male pedestrians are in the sampled population from the mean (average). This assists in determining if is it possible to rely on the estimated figures for men and women to provide meaningful representation of the pedestrians' age. Table 54 and 55 provide Average age (mean age) for Males and Females respectively.

Table 54: Average age (mean age) for Males

Occurrence(X)	Frequency (f)	Freq*X	(X-mean)	$(X\text{-mean})^2$	$f^*(X\text{-mean})^2$
21	10	210	-13.542	183.377	1833.767
26	6	156	-8.542	72.96	437.76
31	13	403	-3.542	12.543	163.064
36	5	180	1.458	2.127	10.634
41	3	123	6.458	41.71	125.13
46	4	184	11.458	131.293	525.174
51	2	102	16.458	270.877	541.753
56	2	112	21.458	460.46	920.92
61	2	122	26.458	700.043	1400.087
66	1	66	31.458	989.627	989.627
71	0	0	36.458	1329.21	0
Total	48	1658	-	-	6947.917
Mean	35				
Standard Deviation	12				
Variance	149				

Source: Author's household survey, October 2016©

Table 55: Average age (mean age) for females

Occurrence(X)	Frequency(f)	Freq*X	(X-mean)	(X-mean)2	f*(X-mean)2
21	10	210	-13.365	178.634	1786.335
26	9	234	-8.365	69.98	629.817
31	11	341	-3.365	11.326	124.584
36	6	216	1.635	2.672	16.032
41	6	246	6.635	44.018	264.109
46	3	138	11.635	135.364	406.093
51	2	102	16.635	276.71	553.421
56	3	168	21.635	468.057	1404.17
61	1	61	26.635	709.403	709.403
66	0	0	31.635	1000.749	0
71	1	71	36.635	1342.095	1342.095
Total	52	1787	-	-	7236.058
Mean	34				
Standard Deviation	12				
Variance	141				

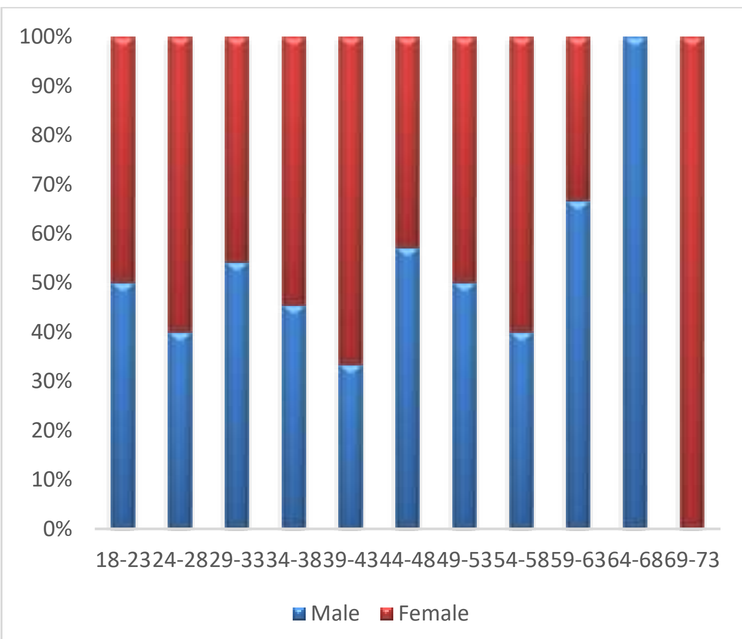
Source: Author's household survey, October 2016©

The more in-depth analysis of the average age of pedestrians in the study area suggests that the calculated arithmetic values in these datasets are tightly bundled together with a small standard deviation (see Tables 54 and 55). The results of the standard deviation for the male and female population sampled in the study region are very revealing; the standard deviation of the pedestrian age is 12 years across the board. Statistically, this indicates that the average age of a pedestrian in the sample is very close to the calculated age. There is not a large spread from the mean of both male and female pedestrians. Thus, a standard deviation of 0 would show that every data point is precisely equal to the mean of the sample.

Age distribution

The age distribution results indicate that 52% of the sampled population is female and 48% male. However, the figure 70 shows clear discrepancies in the distribution of male and female participants in the age groups 64-68 and 69-73.

Figure 70: Age distribution characteristics



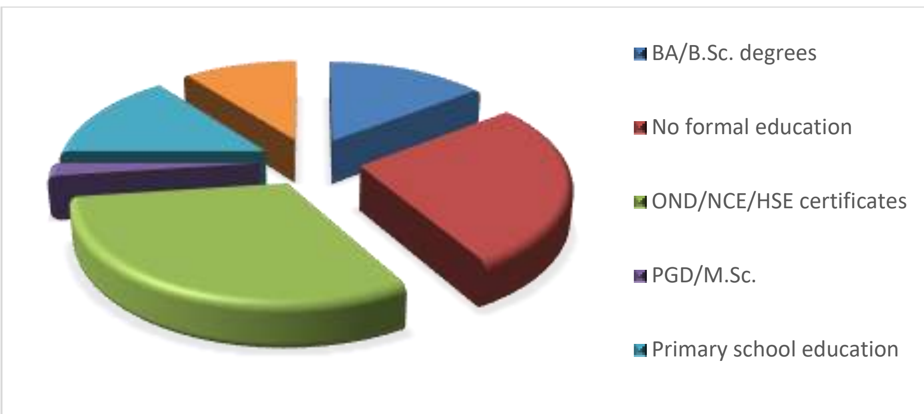
Source: Author's household survey, October 2016

7.2.4: Educational qualifications

Education is a significant predictor when it comes to pedestrian safety. It also shapes economic opportunities and earning potential. However, the positive effects of education on pedestrian safety have not been confirmed; this study aimed to fill this gap in order to assist planners to make informed decisions. The field study analysis in Figure 71 shows that 206 (18%) and 176 (16%)

had primary and secondary school education, respectively. Thus, 49% of the total population sampled had either no formal schooling or did not go beyond secondary school. The independent review led by the author found that around 31% or 350 of the total sample had gone beyond secondary school. 34% of study participants specifically confirming no official enrollment in any formal educational program. Furthermore, 33% of the sample pedestrian population was graduates with at least a National Diploma, with 10% of the female participants falling into this category. Of these, 223 out of 1,123 representing 20% of the total population had OND/NCE/HSE certificates, six, representing 0.5% had completed a PGD/M. Sc and five (0.4% of the total population sampled) had BA/B. Sc. Degrees.

Figure 71: Pedestrians' educational background in Lagos Island CBD



Source: Author's household survey, October 2016©

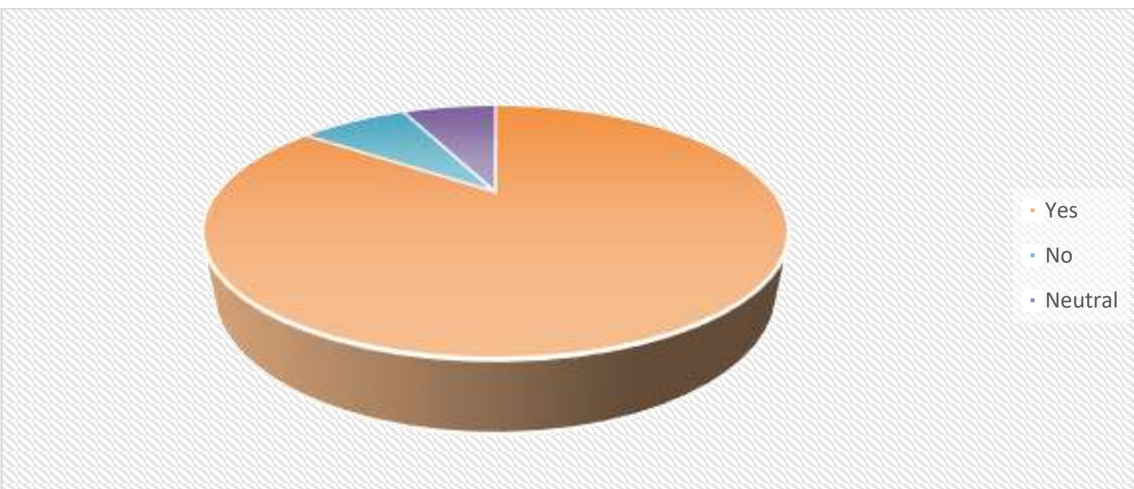
These results suggest that many people with higher levels of education in the study area are not involved in pedestrian activities. The elevated socioeconomic status their education bestows on them enables them to afford automobiles. Furthermore, the results from the field survey suggest that their overbearing attitude towards other road users is a result of such status. The study found that drivers behave badly towards pedestrians on the streets, disrespect other road users, do not stop for pedestrians at crosswalks, and generally exhibit bad behavior on the road. Compounding this problem and as noted earlier, studies on pedestrianization suggest that accidents are more likely to take place in an area where inhabitants have relatively poor educational backgrounds and suffer social and economic deprivation. Previous studies have shown that a population with a high average level of education is likely to experience lower rates of pedestrian accidents. In the Lagos

Island CBD, there are disproportionately higher levels of pedestrian activity among the poorly- or un-educated. The study also found that more male than female pedestrians have a bachelor's degree. Research has shown that 20% and 26% of walkers in the US and Britain is female.(British Heart Foundation Centre 2015, UN-HABITAT Sustainable Urban Development Network (SUD-Net), 2012, Muhlbach, 2012, Steven C. Moore et al., 2012) . In Ghana and Kenya, 9% and 12% educated females engage in walking.(Peprah et al., 2014, Gyamera, 2012, Africa Transport Policy Program, 2015). However, the findings of the current study suggest that educated females are not as invested in walking.

7.2.5: Employment status

Employment status is another major predictor of pedestrian safety. It also affects future environmental sustainability, opportunities, and economic potential.

Figure 72: Employment status in Lagos Island CBD



Source: Author's household survey, October 2016©

Per Figure 72 above, eight-five per cent of the sampled population claimed to be gainfully employed and 8% stated that they were unemployed, with 7% remaining neutral. It is possible that changes to the road network system could affect productivity levels and increase employment rates. This study assumes that employment opportunities increase intra-urban pedestrian mobility. The question is whether the existing road infrastructure in the CBD promotes pedestrian safety.

Employment status and nature of work

Table 56 shows that 338 (44%) of the total population sampled was self-employed, while 105 (14%) worked for private companies. Most of the pedestrians in this group worked in banks, oil companies and other private companies. A hundred and thirteen of the pedestrians in the sample (15%) were civil servants. The remainder (15% or 113 participants) was engage in other formal and informal activities, including as drivers, construction workers and pharmacy attendants. Thus, the majority was engaged in informal sector activities and often lacked specific educational or professional qualifications. It was found that more adult females than adult males were involved in informal sector activities; they thus exhibited more variation in their daily trip frequencies.

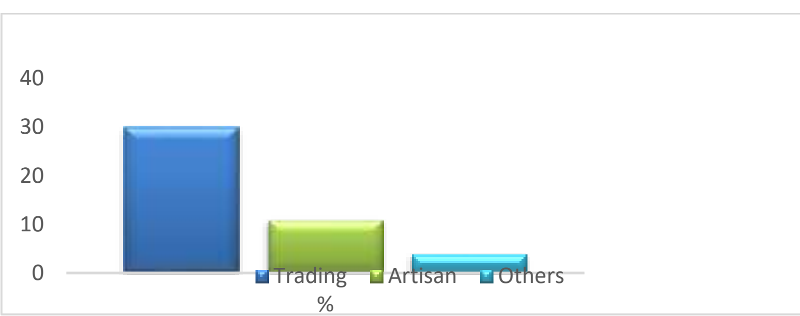
Table 56: Occupation of head of household

Occupation type	%	Frequencies
Civil/public service	15	113
Private multinational company	11	82
Private local company	14	105
Self-employed	45	338
Unemployed	15	113
Total	100	751

Source: Author's household survey, October 2016©

Figure 73 below shows that, of the self-employed participants, 225 (30%) were working in trade, while 83 (11%) of the total sample population were working as artisans. Thirty participants (4%) did not specify their jobs.

Figure 73: Breakdown of self-employment



Source: Author's household survey, October 2016©

Employment status and length of service

Table 57 shows that turning to length of service, 285 of the participants, representing 38% of the total sample population, claimed they had been in gainful employment for an average of 11-15 years. A hundred and fifty, representing 20% and 113 (15%) stated that they had been employed for 6-10 and 16-20 years, respectively. Only 143, representing 19% had been working for an average of 20 years.

Table 57: Length of employment

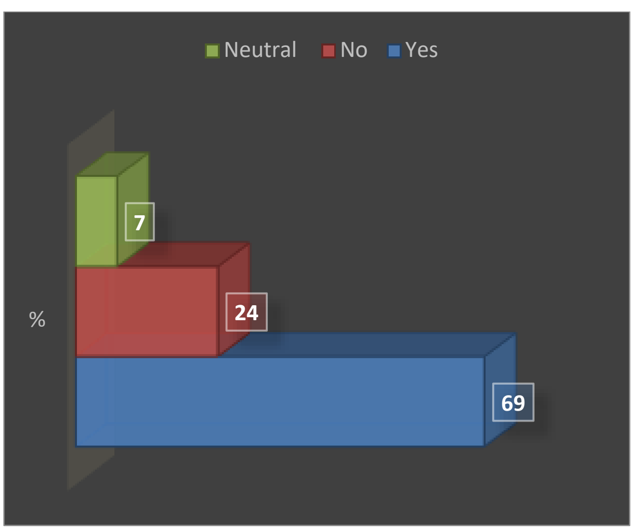
Length of employment	%	Frequencies
1-5	8	60
6-10	20	150
11-15	38	285
16-20	15	113
20-above	19	143
Total	100	751

Source: Author's household survey, October 2016©

Spouse's employment status

The respondents were also asked about their spouses' employment status. Figure 74 below shows that 518 (69%) stated that their spouses were employed and 180 (24%) stated that they were currently unemployed, with 53 (7%) remaining neutral on this issue.

Figure 74: Spouse's employment status



Source: Author's household survey, October 2016©

Employment Status and proximity to place of work

The majority of the participants indicated that they worked in Idumota, Marina, Campus and Apongbon/Abute-ero. Table 58 indicates that 13% of the participants worked in proximity to Marina and 13%, 11.3%, and 10.1% worked in Adeniji Adele, Marina, and the Campus areas.

Table 58: Workplace location

Location	Frequency	%
Apongbon/about-euro	10	6.3
Tinubu Square	1	0.6
Idumota	21	13.2
Balogun	7	4.4
Marina	18	11.3
Idumagbo	8	5.0
Leventis	2	1.3
Carter	1	0.6
Dosumu	9	5.7
Adeniji Adele	20	12.6
Pedro	1	0.6
Campus	16	10.1
Odulami	8	5.0
Nnamdi Azikwe	9	5.7
Ereko	8	5.0
Eko bridge	8	5.0
Broad Street	1	.6
Other	11	6.9
Total	159	100.0

Source: Author's household survey, October 2016©

7.2.6: Per capita income

Studies have shown that per capita income is a predictor of pedestrian safety and that it impacts environmental sustainability, opportunities, and economic potential. It should thus be considered in planning an improved pedestrian system.

Table 59: Residents' income level

Income	Less than 35k /monthly		35K-75K		75K-120K		>120K		Total
Family size	No.	%	No	%	No.	%	No.	%	
1 -4 PPH	7	1	10	1	5	1	2	1	24
5-8 PPH	10	1	20	2	5	1	5	1	40

8-12 PPH	243	22	30	3	12	1	15	1	300
12 and over PPH	623	55	80	7	38	1	18	1	759
Total	593	79	140	13	60	4	40	4	1123

Source: Author's household survey, October 2016© PPH- persons per household

According to Table 59 above, this study confirms that over (593 people) 79% of the entire population sampled earns less than #35,000 Monthly. The reaming (98)13% and (60)8% of the population sampled representing less than quarters of the total population tested is gross income of less 35,000-75,000,75,000-120,000 and more than 120,000 naira, respectively. Thus, almost 80% of the sampled population lives below the poverty line of $1 per day. This amount is equivalent to $112.20 and £89.98 per month and less than $4 and £3 a day. A study by the Lagos State government in 2004 corroborates these findings. According to Table 60, The study also found that in the selected LGAs in the Lagos metropolis, Lagos Island has most residents with very low income, an occupancy rate of close to six people per room and a household size of 11.

Table 60: Household Income Status and density in Selected Local Government Areas in Lagos

Local Government Area	Status by Income	Persons per Room	Number of Households Members
Apapa	High	1.4	4.8
Eti-Osa	High	1.6	5.6
Surulere	Middle	2.0	4.8
Ajeromi-Ifelodun	Low	5.8	5.8
Lagos Island	Low	5.4	10.8
Mushin	Low	8.0	8.0

Source: Lagos State Government/UN-Habitat Nigeria office 2004

Poverty stricken communities are more likely to support a pedestrian system as they cannot afford other modes of transport. The study participants' low-income levels are likely to be due to their high rate of involvement in informal sector activities as well as their relatively low educational qualifications. The results also show that income levels vary significantly with household size.

Per capita income of the household head

Poverty has been linked to pedestrianization in African and other developing countries. Since the family head is most often the breadwinner, their income level was determined. Table 61 below shows that almost 40% of the participants stated that the family head earned less than N35, 000.00 per annum, while 61% claimed that the figure was more than N35, 000. Furthermore, of the 39% of women participants, only 26% earned under N35.000.00 and 13% earned above N35,000.00.

Table 61: Family head's income level

	% Earn below N35,000	Earn more than N35,000	%
Men	14	47	61
Women	26	13	39
Total	40	60	100

Source: Author's household survey, October 2016©

While these results highlight men's dominance as household heads, there is no convincing evidence that female-headed households that engage in pedestrian activities are poorer than male-headed ones. However, the results presented earlier showed that women make shorter trips and more non-work trips than adult males. Furthermore, when children are part of a household, the extent of walking increases for adult females but not for adult males. One-on-one discussions with the respondents also revealed that the division of core domestic responsibilities between men and women has important effects on pedestrian travel behavior.

7.2.8: Place of residence

Finally, place of residence is a significant predictor of pedestrian safety. Table 62 shows that around 86% of the sampled pedestrian population resided in the study area with 14% living in other parts of the Lagos metropolitan area.

Table 62: Population by area

	Frequency	%
Island	968	86.2
Mainland	07	0.6
Outskirts	71	6.3
Other	77	6.9
Total	751	100.0

Source: Author's household survey, October 2016©

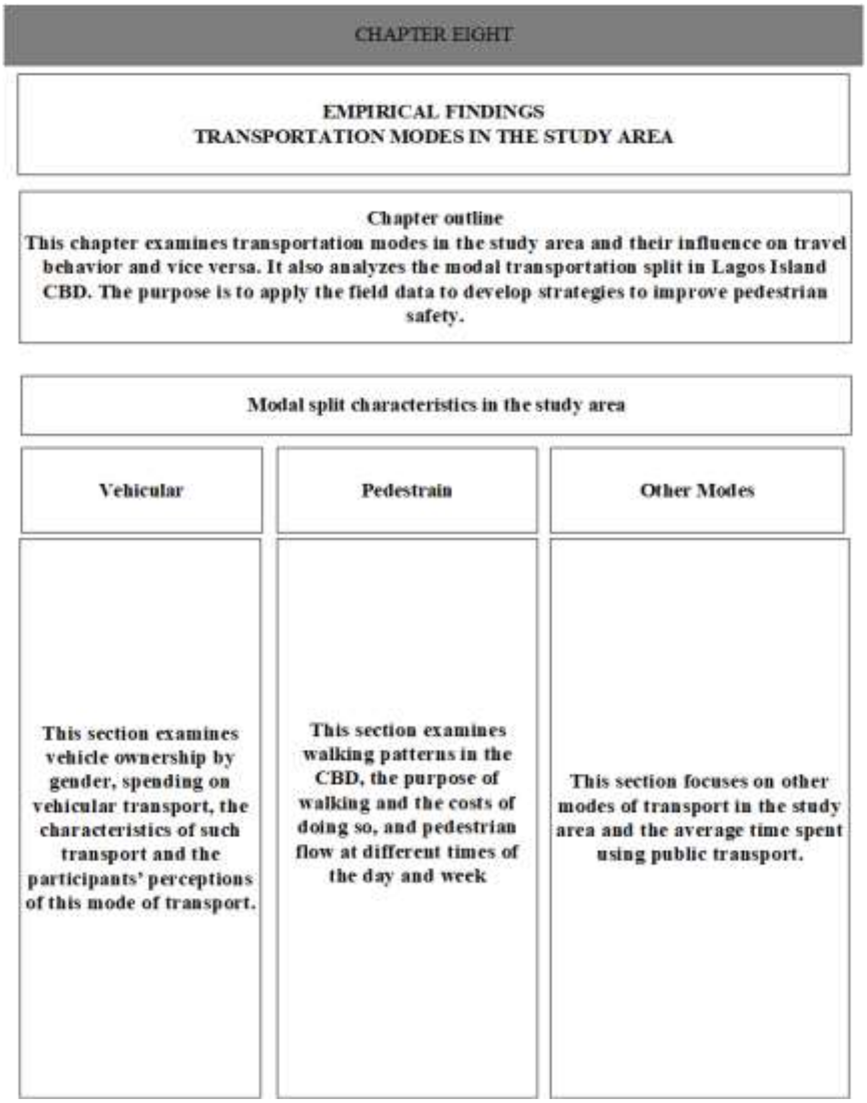
7.3 The Chapter summary:

This chapter is a continuation of the profile on Lagos but with more focus on the socio- economic and demographic characteristics of pedestrians in the study area. Information presented in the form of pictures, maps and other graphic details provides a detailed insight into the interaction between people and the built environment from a transport perspective.

8. CHAPTER EIGHT: EMPIRICAL FINDINGS ON TRANSPORTATION MODES IN THE STUDY AREA

8.1: Chapter outline

Figure 75: Outline of chapter eight



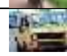
Source: Author's construction, October 2016©

Transportation enables people to move from the point of departure to their destination of choice. This chapter examines transportation modes in the study area and their influence on travel behavior and vice versa. It also analyzes the modal transportation split in Lagos Island CBD. Figure 75 provides outline of chapter 8.

8.2: Transport modes in the study area

Table 63 shows that 55% of the sampled population in Lagos Island CBD uses walking as a mode of transport and 34% use vehicles. Thus, only 11.0% of the sampled population uses other modes of transport.

Table 63: Daily transport modes in the study area

Modal share		%	Frequencies
Walking		55	413
Cars		34	255
Motorcycle - Okada		2	15
Public Buses		7	53
Other		2	15
Total		100	751

Source: Author's Household Survey October 2016©

8.2.1: Vehicular mode

Table 64 shows that only 10 of the 255 participants or 4% in the low-income group spend a disproportionate part of their earnings on transportation. The corresponding figures for the middle-income group are 7% (18 participants) and 10% (26 participants) for the upper-income group. These findings are consistent with other research which found that spending on transportation is a major household expense.

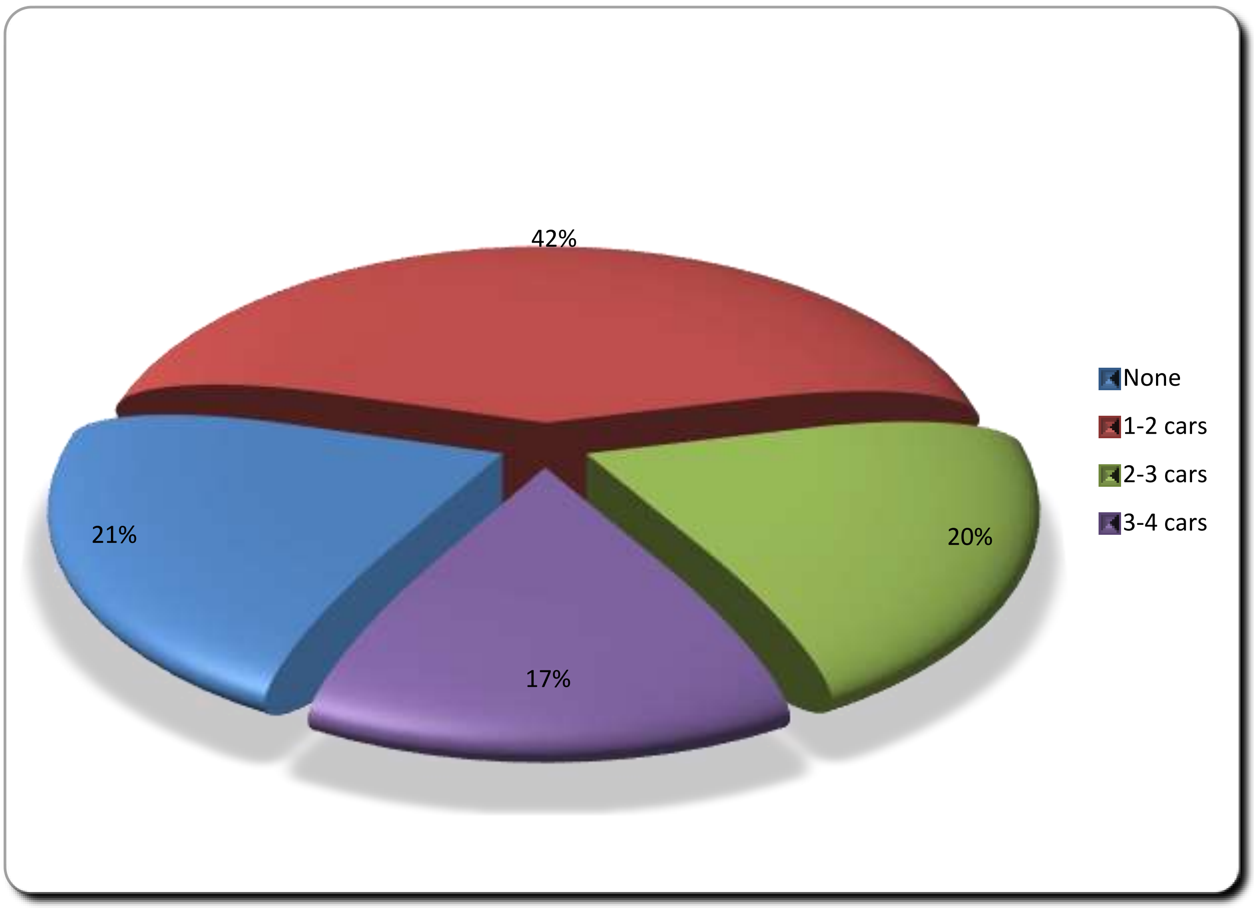
Table 64: Share of household expenses based on income level

Home maintenance	Income level			%	Frequencies
	Low	Medium	Upper		
Private accommodation	17	8	3	29	326
Food	11	9	4	24	270
Transportation	4	7	10	21	236
Clothing	2	4	6	12	135
Medical	0	3	2	5	56
Vacation	0	1	4	5	56
Others	0	1	2	3	34
Utilities	0	0.5	1	1	11
Total	40	24	26	100	255

Source: Author's Household Survey October 2016©

A household’s access to vehicles determines its transport behavior. Figure 76 below shows trends in household vehicular ownership in Lagos Island CBD. The Figure indicates that 94 of the 255 participants representing 37% of the sample, have three or more vehicles. Furthermore, 107 (approximately 42%) and 54 (21%) claimed to own two automobiles and did not own any, respectively. Thus, 89% of the participants were from homes that owned between one and five vehicles, with 21% owning no vehicles. Statistically, the ratio between vehicular ownership and no ownership is four to one.

Figure 76: Share of vehicular ownership

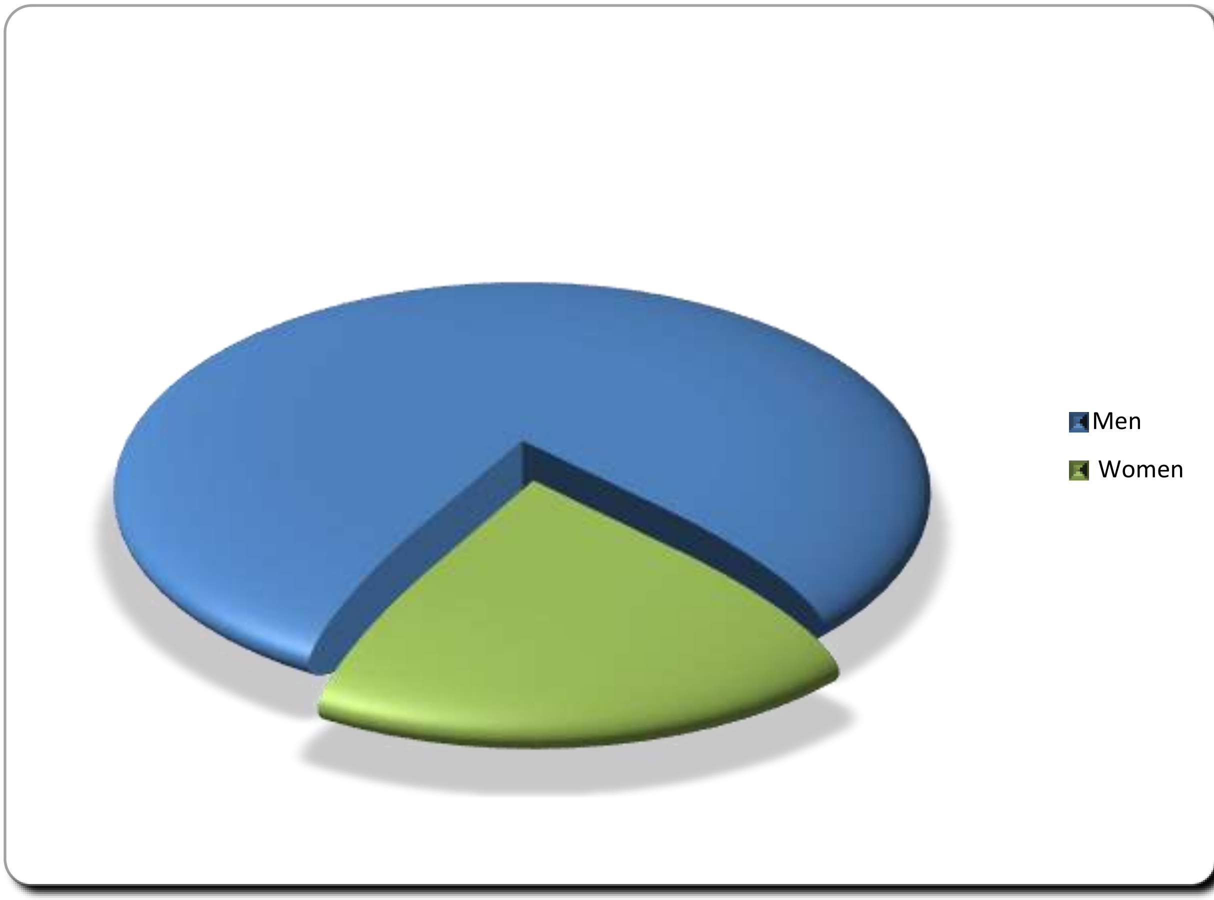


Source: Author’s Household Survey October 2016©

Vehicle ownership and gender

The Figure 77 shows that 79% of the sample population that owned vehicles was male. Thus, men drivers outnumber women in the study area. This finding is consistent with studies around the world.

Figure 77: Vehicle ownership by gender



Source: Author's Household Survey October 2016©

Spending on vehicular travel

Table 65 shows the amount the study participants spent on miles per year of car travel. It indicates that 207 of the 255 participants (81%) spent on average ₦2000 on 11,000 to 20,000 miles per month on petroleum products. Eleven percent, 5% and 3% spent ₦1, 700, ₦850 and ₦2, 500 on 10,000, 5,000 and 20,000 miles, respectively. When compared with the middle- and low-income families' budgets, the results show sharp differences. However, there are other possible explanations.

Table 65: Individual cost of miles per year car travel

Miles per year car travel	%	Frequencies	Naira/Per month		Naira/Per year	
			Naira	Dollar	Naira	Dollar
0000-5000	5	13	₦850	$4.27	₦10,200	$51.24
6000-10000	11	27	₦1,700	$8.54	₦20,400	$102.49
11000-15000	81	207	₦2,100	$10.55	₦25,200	$126.60
16000-20000	3	8	₦2,500	$12.56	₦30,000	$150.72
Total	100	255				

Source: Author's Household Survey October 2016©

Vehicular traffic characteristics

An inbound traffic inventory was undertaken to identify the vehicular peak hour in the study area. A 120 minutes' traffic count survey was conducted during morning and afternoon peak commuter periods on weekdays and weekends. The morning peak period was 8am to 10am and the afternoon period was 4pm to 6pm. The results provide information that can be used to inform a future intra-urban pedestrian system in the study area.

Average weekday morning vehicular travel flow and peak hours

Table 66 shows, that, on a Monday, more than 10,000 cars were counted between 8am and 10am. On the Friday of the same week, this dropped to 9,000 for the same period. Monday and Friday trips made up approximately 30% and 26% of weekly trips to the CBD. Mathematically, comparing the statistical dataset from Table 67 below with the data in Table 60, the 50th percentile of weekday morning peak hours is between 8am and 8.30am. This is the median value or quartile below which 50% of traffic data in the study area falls. Thus, the 85th percentile of vehicular flow happens between the hours of 9am and 9.30am.

Table 66: Weekday flows inbound (mornings) in the study area

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Total
8.00-8.15	2300	1200	1011	980	1800	
8.00-8.30	2930	1850	820	1100	1080	
8.31-8.45	1800	750	630	1200	1532	
8.45-9.00	780	280	620	857	1850	
9.00-9.15	800	320	450	450	853	
9.15-9.30	650	700	235	350	1150	
9.31-9.45	900	650	315	125	576	
9.45-10.00	550	150	299	75	574	

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Total
Total	10710	5900	4380	5137	9415	35542
%	30	17	13	14	26	

Source: Author's Household Survey October 2016©

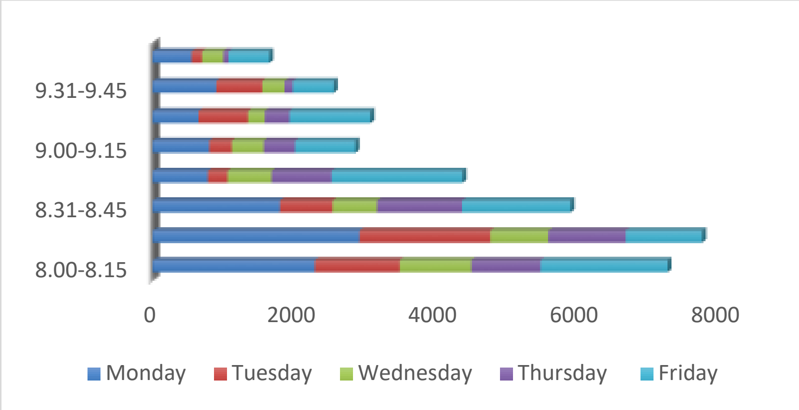
Table 67: Vehicular flow weekday peak period (mornings)

Time	Frequency	%	Cumulative frequency	Percentile
8.00-8.15	2300	21.48	21.48	50th
8.00-8.30	2930	27.36	48.84	
8.31-8.45	1800	16.80	65.64	
8.45-9.00	780	7.28	72.92	
9.00-9.15	800	7.47	80.39	85th
9.15-9.30	650	6.07	86.46	
9.31-9.45	900	08.40	94.86	
9.45-10.00	550	5.14	100	
Total	10710	100.01		

Source: Author's Household Survey October 2016©

Figure 78 provides a more concise evaluation. There are several possible explanations for this result. A review of vehicular flow rate and the traffic pattern in Figure 80 thus concludes that traffic congestion increases progressively throughout the week, with the worst traffic usually recorded on Mondays and Fridays. This highlights the need for investment in the pedestrian system in the study area.

Figure 78: Weekday flows inbound (mornings) in the study area



Source: Author's Household Survey October 2016©

Contrary to expectations, the study found that there are more vehicles on the road on Monday and Friday mornings than any other days of the week. A slightly lower volume was recorded on Tuesday and Thursday mornings of a typical week. Midweek traffic appears to be depressed. Thus, the study shows that the traffic volume varies on weekdays and even over the weekend.

Average weekday afternoon vehicular travel flow and peak hours

An inventory was also taken of average vehicular influx to Lagos Island CBD on weekday afternoons. Tables 68 shows that peak traffic on a typical day shows similar tendencies as the morning peak period, with Mondays and Fridays having significantly higher vehicular flow patterns. Table 68 shows that the 50th percentile peak period is between 4.15pm and 4.45pm; this is the median hour or second quartile below which 50% of traffic data in the study area falls. The 85th percentile peak period is between 4.45pm and 5.00pm daily. Figure 81 provides further analysis of the traffic flow in Lagos Island CBD.

Table 68: Vehicular flow (afternoon) in the study area

	Weekdays (afternoon)				
	Monday	Tuesday	Wednesday	Thursday	Friday
4.00-4.15	2000	1000	500	964	1000
4.15-4.30	2420	1575	587	935	1025
4.30-4.45	1200	600	500	600	855
4.45-5.00	900	1080	200	820	799
5.00-5.15	822	750	350	180	1200
5.15-5.30	618	250	150	60	400
5.31-5.45	630	120	250	70	700
5.45-6.00	188	80	50	48	500
Total	8778	5455	2587	3677	6479

Source: Author's Household Survey October 2016

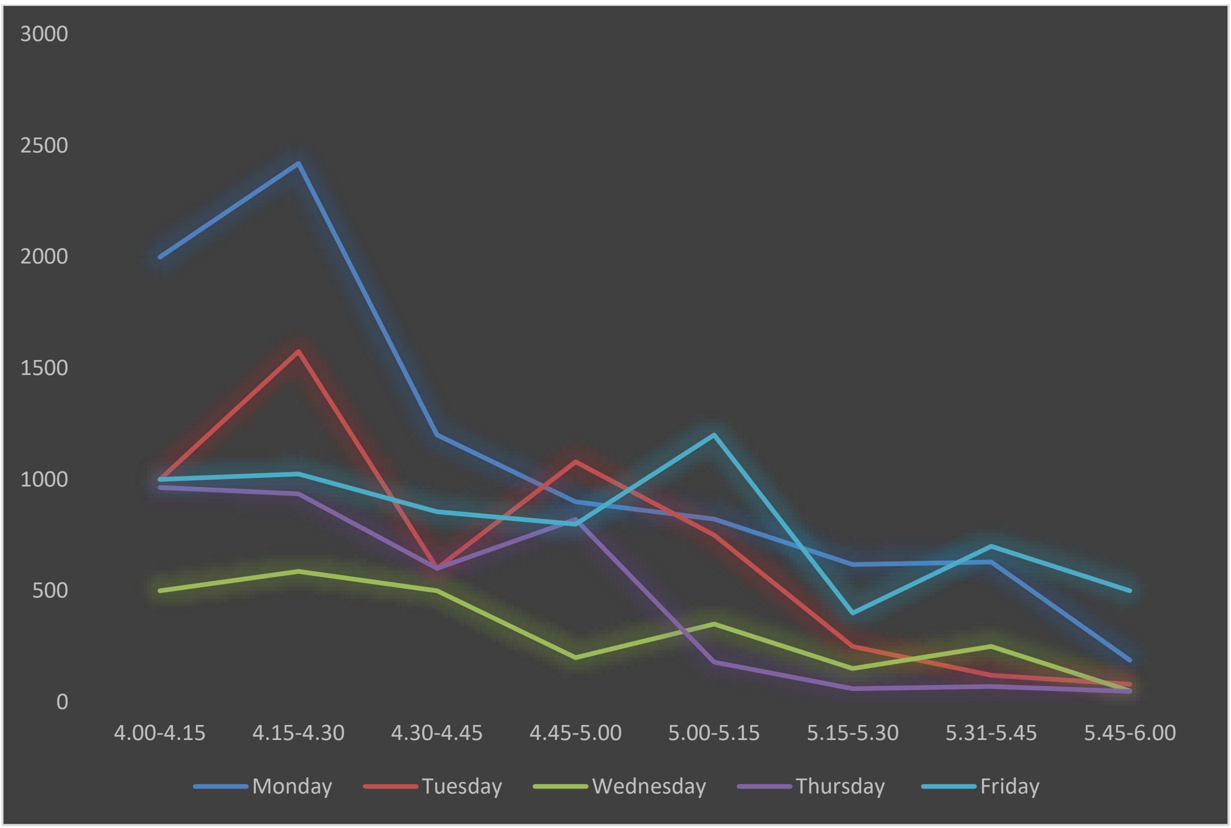
Table 69: Vehicular flow peak period

Time	Frequency	%	Cumulative frequency %	Percentile
4.00-4.15	2000	22.74	17.51	
4.15-4.30	2420	27.56	47.46	50th
4.30-4.45	1200	13.67	66.72	
4.45-5.00	900	10.25	75.48	75th
5.00-5.15	822	9.36	84.84	85th
5.15-5.30	618	7.04	91.88	

Time	Frequency	%	Cumulative frequency %	Percentile
5.31-5.45	630	7.18	99.06	
5.45-6.00	188	2.14	100	
Total	8778	100		

Source: Author's Household Survey October 2016©

Figure 79: Average weekday afternoon vehicular travel flow and peak hours



Source: Author's Household Survey October 2016

In summary, Figure 79 points to excessive vehicular influx to Lagos Island CBD. These findings have major negative socio-economic implications for vehicular /pedestrian travel.

Average weekend morning vehicular travel flow and peak hours

Table 70 shows that there is less influx of vehicles to the Lagos Island CBD on Saturdays and Sundays. However, more vehicles enter the CBD on Sundays. Table 71 further shows that the weekend vehicular flow and density are slightly dissimilar from the regular morning peak period. The morning peak period is between 8.15am and 8.45 am representing the 50th percentile while the 85th percentile is between 9.30am and 10.00am. This suggests that trips should be planned before 9am during the weekend where possible.

Table 70: Vehicular flow weekday (mornings) in the study area

Time	Saturday	Sunday
8.00-8.15	1045	1104
8.16-8.30	1885	285
8.31-8.45	1720	290
8.46-9.00	1050	100
9.00-9.15	750	45
9.16-09.30	875	91
09.31-9.45	890	10
9.46-10.00	680	75
Total	8895	2000

Source: Author's Household Survey October 2016©

Table 71: Vehicular flow inbound peak period (weekend)

Time	Frequency	%	% Cumulative frequency	Percentile
8.00-8.15	1045	11.75	11.75	
8.16-8.30	1885	21.19	32.94	50th
8.31-8.45	1720	19.34	52.28	
8.46-9.00	1050	11.80	64.08	
9.00-9.15	750	8.43	72.51	
9.16-09.30	875	9.84	82.35	85th
09.31-9.45	890	10.00	92.35	
9.46-10.00	680	7.65	100	
Total	8895	100		

Source: Author's Household Survey October 2016©

Table 72: Weekend afternoon vehicular travel flow and peak hours

Time	Saturday	Sunday
4.00-4.15	1200	802
4.16-4.30	1300	750
4.31-4.45	980	354
4.46-5.00	820	354
5.00-5.15	450	180
5.16-5.30	450	330
5.31-5.45	300	80
5.46-6.00	200	100

Total	5700	2950

Source: Author's Household Survey October 2016©

These empirical findings once again highlight excessive vehicular use in the Lagos Island CBD. The discussion now turns to the consequences of this phenomenon.

Consequences of overdependence on vehicular travel

As a follow-up, the respondents were asked to indicate their perceptions of the implications of households and individual's overdependence on vehicular transport.

Table 73: Consequences of heavy vehicular use

Parameters	%	No
The aesthetic quality of the environment is compromised	10	26
Chaotic traffic congestion	25	64
Increasing vehicle- pedestrian collisions	35	89
Health challenges	20	50
Eventually, it causes death	10	26
Total	100	255

Source: Author's Household Survey, October, 2016©

Table 73 shows that 89 of the 255 participants (35%) felt that more vehicles on the road would increase the likelihood of vehicular-pedestrian collisions. Sixty-four (25.0%) were of the opinion that this would cause traffic congestion and a minority (26 out of 255 or 10%) felt that excessive vehicular use would compromise the aesthetic quality of the environment. A small number of those interviewed (26 out of 255 or 10%) stated that too many vehicles could lead to collisions and deaths.

Vehicular-pedestrian collisions

A recurrent theme in the interviews was that more vehicles on the road result in high rates of vehicular-pedestrian accidents.

Health implications

The findings confirm those of other studies that conclude that traffic congestion has numerous negative health implications. The challenges identified by the researcher include but are not limited to high blood pressure, strokes, respiratory complaints, asthma, stress, and cardiovascular and terminal diseases that sometimes result in premature death. It was disturbing to find that most respondents were not aware that breathing street-level fumes for just 30 minutes can have devastating health effects.

Environmental effects

The most significant environmental effect of vehicular use is greenhouse emissions. The greenhouse gas emission of a typically gasoline-powered car is 82 metric ton carbon equivalent, and for a diesel bus it is as high as 480 metric ton carbon equivalent. The International Journal of Learning & Development confirms that walking and cycling result in negligible greenhouse gas emissions. Table 74 below depicts the environmental implications of overdependence on vehicular transport. The empirical findings further indicate that Lagos Islanders are not cognizant of the direct or indirect impacts of vehicular use such as air and environmental pollution, nonrenewable energy consumption and ultimately death. Previous studies have shown that in the developed world, excessive vehicular use is responsible for just over half of carbon monoxide, three-quarters of nitrogen oxide and almost a quarter of hydrocarbons in the atmosphere and that the majority of the population is aware of such.

Table 74:Average greenhouse gas emissions per kilometer

Mode of transportation	Green House Gas Emission/Vehicle/Km (in metric ton carbon equivalent [MTCE])
Pedestrian	Trifling
Bicycle	Negligible
Motor Cycle	36
Tricycle	59
Gasoline Car	82
Diesel Car	146
Gas Mini Bus	235
Diesel Mini Bus	328
Gas Bus	405
Diesel Bus	480
Light Truck	344
Heavy Duty Truck	757
Average Engine Boat	383
Train/Railway Locomotives	396
Average Engine Vessel	430
Heavy Duty Multiple Engine Trawler	1127
Light Double Engine Aircraft	438

Source: International Journal of Learning & Development, 2011

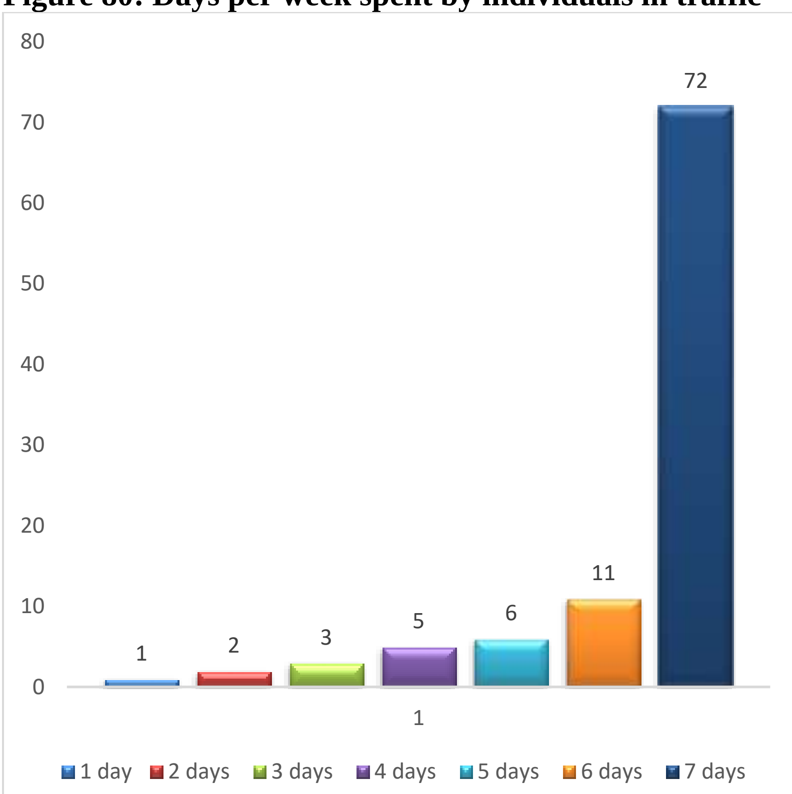
Traffic congestion

The researcher estimated that less than 800,000 people reside within the Island today and this will increase to 1.5 million by 2020. It was also estimated that 120,000 vehicles would use the roadways for 12 hours each day, amounting to around 700,000 per week. The increasing population is not matched by improved infrastructure, resulting in heavy traffic congestion in the CBD. However, the full extent of traffic congestion in the study area remains unknown. To shed light on this important issue, the respondents were asked how many days they spent per week in traffic.

Days per week spent by individuals in traffic

Figure 80 shows that, 72% of the participants felt that there was traffic congestion seven days a week. Eleven per cent and 6% of the participants agreed that traffic congestion occurs five and six days per week, respectively, while 5% opted for four days, 3% for three days, and 2%, and 1% for two days and one day per week, respectively.

Figure 80: Days per week spent by individuals in traffic



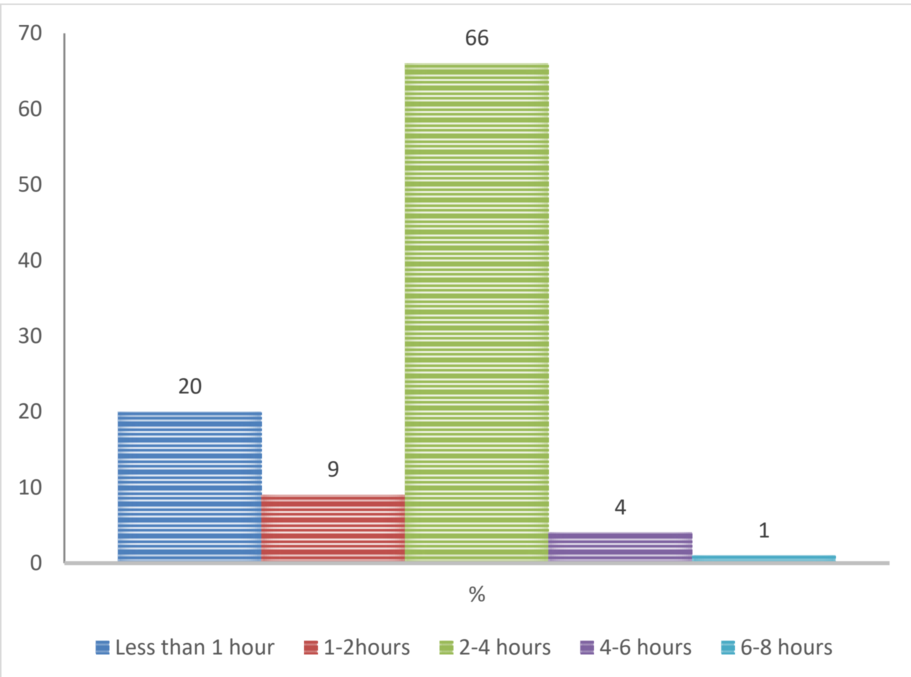
Source: Author's Household Survey October 2016©

The frequency of traffic congestion raises the question how long passengers sit in traffic each day and the cost in wasted time.

Hours spent traveling per person per week in traffic

Figure 81 shows that 20% of the participants claimed that they spent less than an hour in traffic per day, while 9% estimated that this amounted to one to two hours. However, 66% claimed they sit in traffic for between two and four hours.

Figure 81: Time spent in traffic daily and possible time wasted per hour



Source: Author's Household Survey, October 2016©

Assuming that the average Lagos Islander is stuck in traffic for three hours a day, this amounts to 45 hours a year (3 multiplied by 365 days per year divided by 24 hours in a day). This is equivalent to a whole working week. These results highlight the importance of mitigating the effects of vehicular traffic congestion. What are the causes of this undesirable situation?

Leading causes of traffic congestion in Lagos Island CBD

Table 75 sets out the leading causes of traffic congestion in Lagos Island CBD. This information was corroborated by subsequent analysis.

Table 75: Principal causes of traffic congestion

Factors
Accidents
Illegal street trading
Indiscriminate parking
General road infrastructure
Population density and excessive influx of inbound traffic
Road bottlenecks
Bad weather
Land use density
Loading and offloading
Poor law enforcement
Total

Source: Author's Household Survey October 2016©

The main causes of traffic congestion are population density, the excessive flow of vehicles into the study area and inadequate infrastructure to support it. As population density increases, there is more extensive vehicle use (see Plate 13). Indeed, passenger vehicles account for at least 75% of private transport in Lagos State and 8-10% in the study area.

Plate 13:Traffic congestion in Lagos Island CBD

Source: Author's Household Survey, October 2016©

The lack of parking is another factor that causes congestion: Inadequate Parking facilities is another major challenge of Lagos Island CBD for both residents and transients. The number of parking spots in the Lagos Island CBD is not adequate for the number of vehicles (see Plate 14). The survey established that most trips from the Mainland and other parts of the Island (Ikoyi and Victoria Island) are taken by car. The lack of parking results in illegal roadside parking.

Plate 14: Public parking lots in the study area

Source: Author's Household Survey October 2016©

Cost of using the two available parking areas

Table 76 shows the amounts paid for the two available parking areas in the study area. Almost 70% of the sample population claimed they spent ₦200 on two to four hours parking while 15% stated that they paid ₦300 for four to six hours and 12% that an hour's parking costs ₦100. Finally, 5% of the respondents stated that they spent ₦400 on parking for six or more hours. These results are consistent with other studies on parking facilities in Lagos State.

Table 76: Amount paid for parking

Hours	Frequencies	Percentage
Less than 1	100	12
2-4	200	68
4-6	300	15
6-above	400	5
Total	255	100

Source: Author's Household Survey October 2016©

The study participants also identified inadequate road infrastructure as a cause of traffic congestion. Bridges are rickety, and potholes often swallow cars to their axles. There are more than 20,000 km of roads within the study area that carry high volumes of traffic and are mostly unpaved. One interviewee stated that, apart from Third Mainland Bridge constructed during

General Ibrahim Babangida' s rule in early 1990, no new development has taken place to connect the Island to Mainland. A Lagos Island government official added that most of the major roads connecting the Lagos Island CBD were constructed decades ago at a time when the population was much smaller. The researcher's audit revealed that these roadways are grossly inadequate to serve the threshold population, especially given the constant increase in vehicle ownership. Despite advances in commercial trade, millions of people throughout the world still make a living partly or wholly through displaying goods and services on roadways. This is particularly true in Africa and the study area. Informal traders were observed illegally selling everything from vegetables, to clothing and fruit and offering services such as shoe repairs. The traditional heart of commercial activities in Lagos is Eko Idunmota. Plate 15 portrays informal sector operators and those patronizing traders in the Lagos Island CBD. Traders have set up shop in the spaces between buildings and residential areas, on roadways and on pedestrian walkways. Furthermore, shops have been attached to residential buildings without formal planning approval.

Plate 15: Illegal Street trading in the study area

Source: Author's Household Survey October 2016©

The participants agreed, that, illegal street trading causes serious traffic congestion in the study area. A local government official stated that despite serious attempts to rid the roadways of informal operators, they continue to operate on the roads and sidewalks. This is consistent with the findings of studies in other parts of the world. The study also investigated whether increasing the density (i.e., more people per square mile of land) would reduce or increase traffic congestion.

While some studies have addressed this question, it remains unclear how land uses patterns and characteristics in the CBD affect households' travel intensity. Commercial use seems to be the core land use in the study area. Further analysis revealed a large central area of concentrated employment density and a greater degree of mixed residential and commercial use. The author's inventory showed that, higher density residential growth and mixed use are major attractors of traffic. Furthermore, loading and offloading of commodities exacerbate congestion in the CBD (see Plate 16).

Plate 16:Vehicles loading and offloading goods in the study area

Source: Author's Household Survey October 2016©

Economic costs of traffic congestion

In this part of the survey, the respondents were asked to provide information on the economic costs of traffic congestion. Table 77 shows, that, 66% of those who responded to this item stated that if they spent between two and four hours in bumper-to-bumper traffic, this would amount to approximately ₦600 in spent fuel, while 9% felt that the same number of hours in traffic would result in fuel costs of ₦400. Furthermore, 20% reported that if they spent less than an hour in traffic, the average fuel cost is ₦200. In total, the survey collected data from 224 respondents and 5% of those that spent four to eight hours in traffic stated that their average fuel costs were ₦400. Some also noted that being stuck in traffic caused them to be late for work and appointments, adding to the costs of congestion.

Table 77: Time spent in traffic congestion daily and possible time wasted per hour

Time	%	Cost in lost time per hour
Less than 1 hour	20	₦200
1-2hours	9	₦400
2-4 hours	66	₦600
4-6 hours	4	₦800
6-8 hours	1	₦1000
Total	100	

Source: Author's Household Survey, October 2016©

An interviewee stated that these costs did not make sense in an LGA with a per capita income of less than ₦20,000 Naira (less than $50.00) per month. A government official added that the money lost to traffic congestion is alarming, suggesting that time is of the essence in redesigning the Lagos Island CBD for people rather than cars. This consideration motivated the current study on improving pedestrian safety in the study area.

Economic impacts of Vehicular use

Whilst individual financial savings made by walking might initially seem unreal, in both the short and the long run, it will put money in people's pockets. Table 78, shows that 360 of the 413 participants in the survey (83%) spent as much as ₦250 on a single vehicular trip per day.

Table 78: Cost of a single trip (public transport or para-mobility) without walking

Naira	%	Frequencies
₦00-050	1	3
₦51-100	2	5
₦151-200	4	10
₦101-150	10	26
₦201-250	83	211
Total	100	255

Source: Author's Household Survey October 2016©

Furthermore, around 25% of the sampled population spent between ₦50.00 and ₦150.00 on a single vehicular trip per day. Arguably, if this set of respondents were to make an average of four non-walking trips per day, they would spend approximately₦1, 000 a day and almost ₦30, 000 per month. This makes a compelling case for walking more often. A variance and standard deviation test was conducted to verify these results. In a normal distribution, 68% of the population falls between -1 and +1 standard deviation (from the mean), 95% of the population falls between - 2 and +2 standard deviation, and about 99% falls between -3 and +3. Table 79 presents the results where N = 413, M=₦211. 48, SD=36. 15 variances=1307. 14.

Table 79: Cost of a single trip (public transport or para-mobility) without walking

Occurrence (X)	Frequency (f)	Freq*X	(X-men)	(X-mean) 2	f* (X-men) 2
25.5	11	280.5	-185.975	34586.725	380453.98
75.5	23	1736.5	-135.975	18489.219	425252.032
125.5	45	5647.5	-85.975	7391.712	332627.045
175.5	112	19656	-35.975	1294.205	144951.008
225.5	932	210166	14.025	196.699	183323.237
Total ->	1123	237486.5	-	-	1466607.302
Mean	211.475				
SD	36.154				
Variance	1307.137				

Source: Author's Household Survey October 2016©

Thus, while the respondents in the study area were paying a great deal for non-walking trips, based on the standard deviation result, the cost varied quite a bit.

Participants' perceptions of vehicular transportation

The survey participants were asked to state their perceptions of vehicular modes of intra-urban travel in the Lagos Island CBD, especially regarding safety. An overwhelmingly 199 out of 255 participants, representing 78% of the sample, felt that vehicular transportation is the least safe mode. Interestingly, 12% agreed that motorcycles (Okada) are another risky mode of travel while 1%, 2% and 4% felt that tricycles, walking and buses respectively, are the safest modes of travel in the study area (see Table 80). These findings are consistent with those of similar studies.

Table 80: Vehicles are the least safe mode of transport in the study area

Means of travel	%	Frequency
Walk	1	3
Tricycles Keke Marwa and Keke Napep	2	5
Public Buses	4	10
Other modes of transport	3	8
Motorcycle (Okada)	12	31
Cars	78	198
Total	100	255

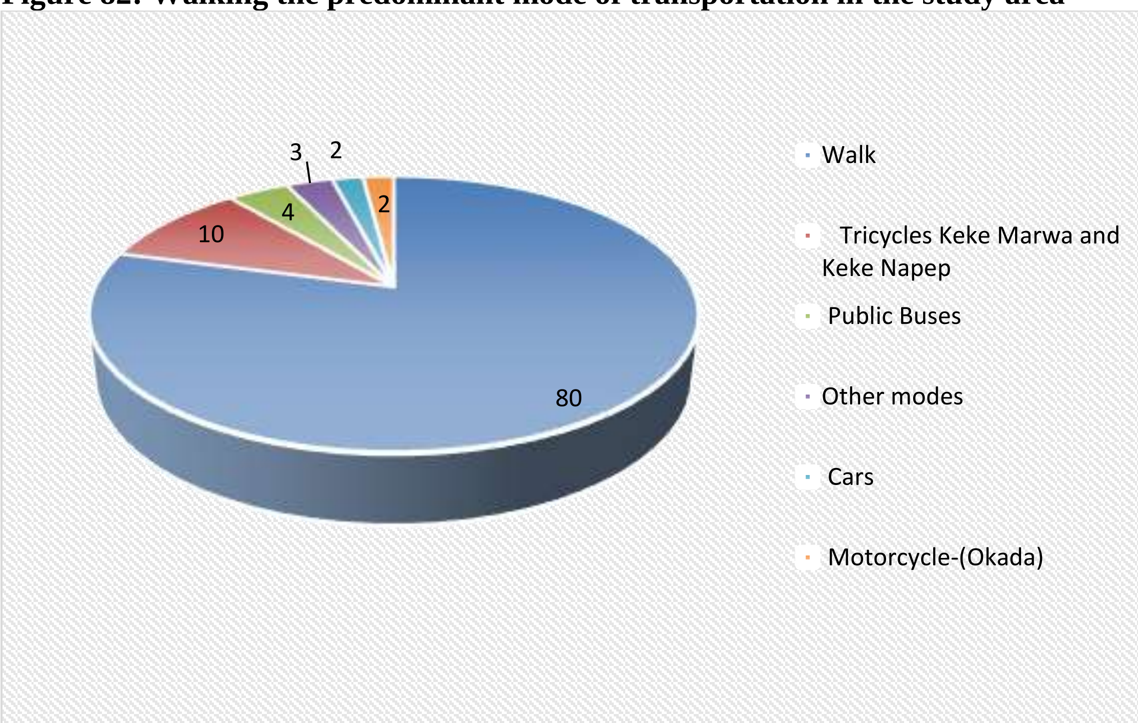
Source: Author's Household Survey October 2016©

8.2.2: Walking mode

Walking patterns in the CBD

According to Figure 82 the study found that 55% of work and no-work intra-urban trips made by the study participants were on foot.

Figure 82: Walking the predominant mode of transportation in the study area

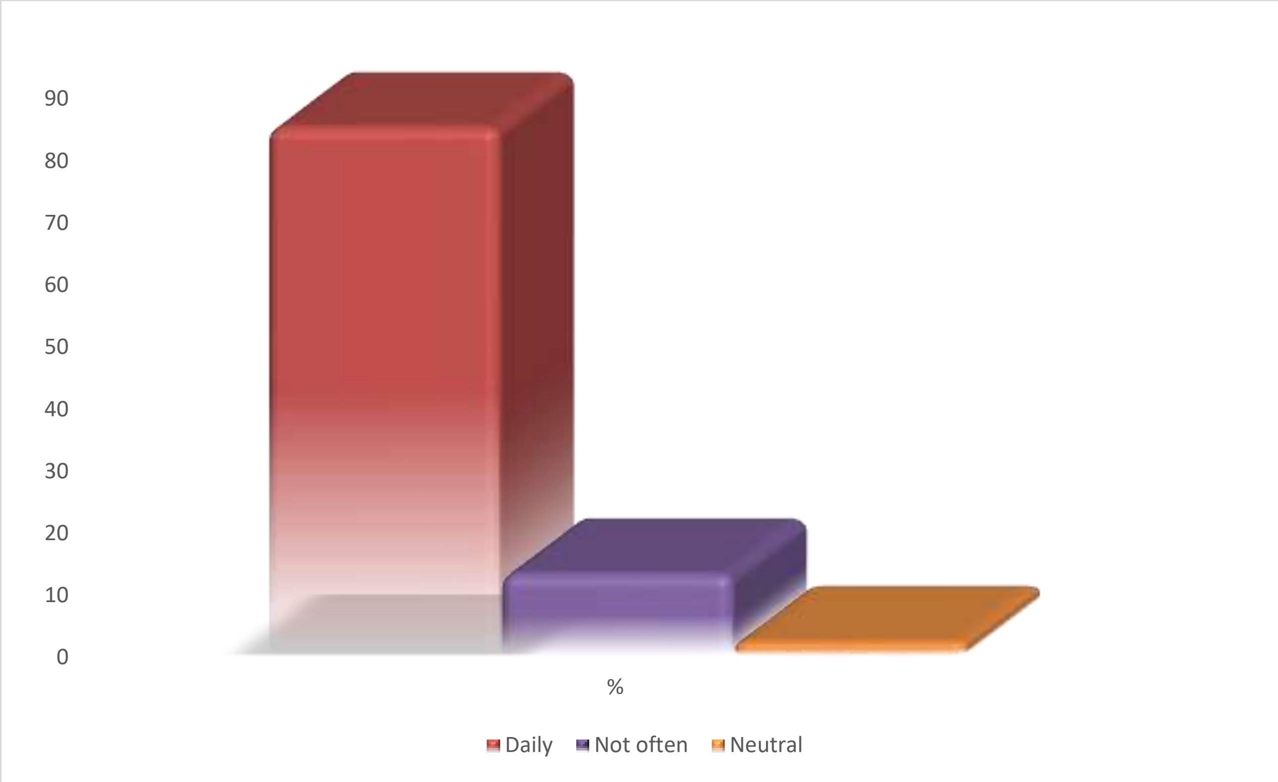


Source: Author's Household Survey October 2016©

Average frequency of walking per day

Walking refers to a journey on foot for different functional purposes. The participants were asked how frequently they walked in the Lagos Island CBD per day. This information can be used to design an eco-friendly pedestrian system.

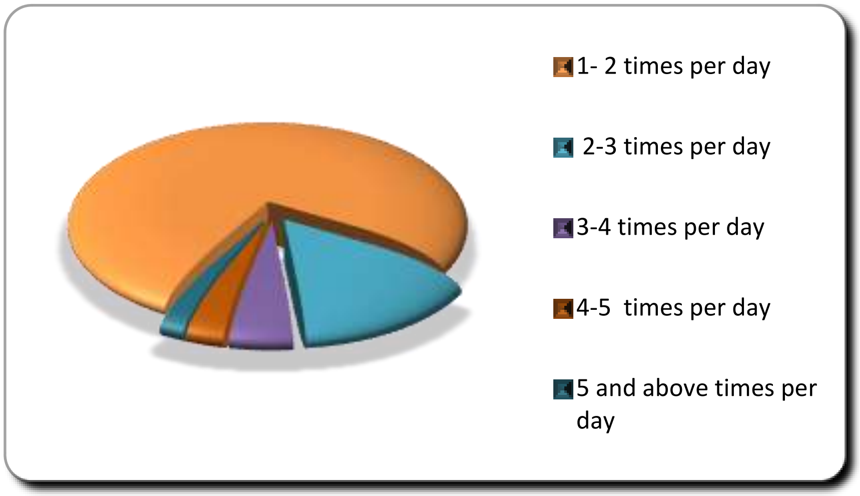
Figure 83: Frequency of daily walking trips



Source: Author's Household Survey October 2016©

According to Figure 83, an overwhelmingly 85% of the sample population reported that they walked frequently daily, while 13% stated that they did not do so. A further 2% remained neutral on this issue. According to Figure 84, Seventy-five per cent of the total sample population walked once to twice per day, 15% did so two to three times a day and 5% made three to four trips on foot per day. Finally, 3% and 2% made four to five and less than one walking trips per day, respectively.

Figure 84: Walking trips per day

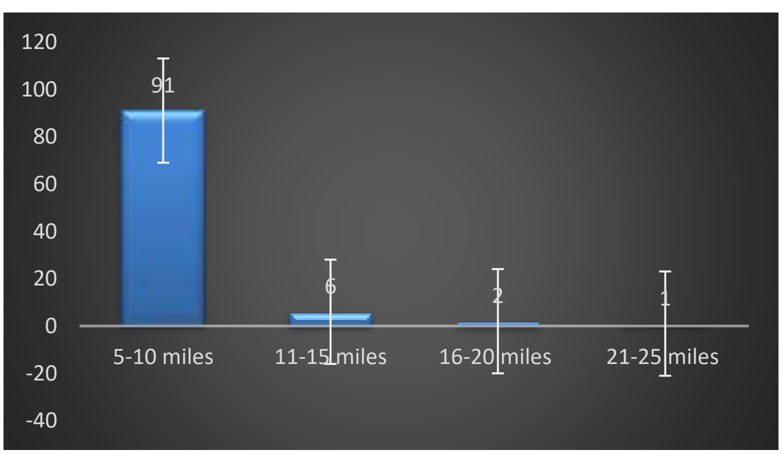


Source: Author's Household Survey October 2016©

Average distance walked per day

Figure 85 illustrates, that, 376 participants (91%) reported that if there were an improved pedestrian system they would be able to walk five to ten miles per day, while 35 (6%) stated, that, such a system would enable them to walk 11-15 miles daily. Only 1% and 2% of the sample felt that, if there was an improved pedestrian system, they could walk more than 16-20 and 21-25 miles, respectively per day. This suggests that improving pedestrian safety in the study area would result in more people taking to walking not only as a hobby but as part of their daily routine.

Figure 85: Distance respondents feel they could walk in a day (regardless of the number of trips)



Source: Author's Household Survey October 2016©

Average walking speed

Walking speed is a predictor of travel patterns and safety. Pedestrian walks at a self-selected slow or relatively fast pace. Some also adopt the pace set by other pedestrians. These rules of walking affected the accuracy of the survey.

Table 81: Pedestrian walking speed

Average Speed- Meters per minute (m/s)	%	Frequencies
0.5-1.0	5	21
1.1-2.0	73	302
2.1-3.0	18	74
3.1-4.0	2	8
4.1-5.0	2	8
Total	100	413

Source: Author's Household Survey October 2016©

Table 81 above shows, that 302 of the 413 participants, representing 73% of the sample population, favored a walking speed of 1-2 meters per second (m/s). However, 74 participants (18%) stated that they walked at a speed of 2-3 m/s, while 4% opted for 3-5m/s. The balance (5%) favored 0.5m/s to 1m/s. The survey also revealed gender differences in relation to walking speed (see Figure 86 below).

Figure 86: Walking speed by gender

Source: Author's Household Survey October 2016©

As expected and given the broad age range of the dataset, men walk faster than their women counterparts. The figure shows that 42% of the male and 33% of the female participants favored a walking speed of 1.55 m/s. However, the percentages were the same at 1% for the highest walking speed of 3.55m/s. Table 82 shows the mean walking speed by gender. The average walking speed for women was 1.74 m/s while that for men was 1.72m/s.

Table 82: Walking speed by gender

Walking speed	Male	Female
0.75	12	8
1.55	173	136
2.55	41	33
3.55	4	4
Mean	1.7213	1.74116
Standard Deviation	0.50	0.51
Variance	0.25	0.26

Source: Author's Household Survey October 2016©

Thus, a slower walking speed is not limited to women. The extent of this association may be affected by different factors during different periods of the survey. Thus, the standard deviation is computed and compared with the mean walking speed.

Table 83: Standard deviation walking speed of pedestrians

Occurrence(X)	Frequency(f)	Freq*X	(X-mean)	(X-mean)2	f*(X-mean)2
0.75	20	42	-1.042	1.087	60.848
1.55	309	1269.45	-0.242	0.059	48.117
2.55	74	515.1	0.758	0.574	115.944
3.55	8	81.65	1.758	3.089	71.052
Total ->	411	2012.85	-	-	470.862
Mean	1.73				
Standard Deviation	0.50				
Variance	0.27				

Source: Author's Household Survey October 2016©

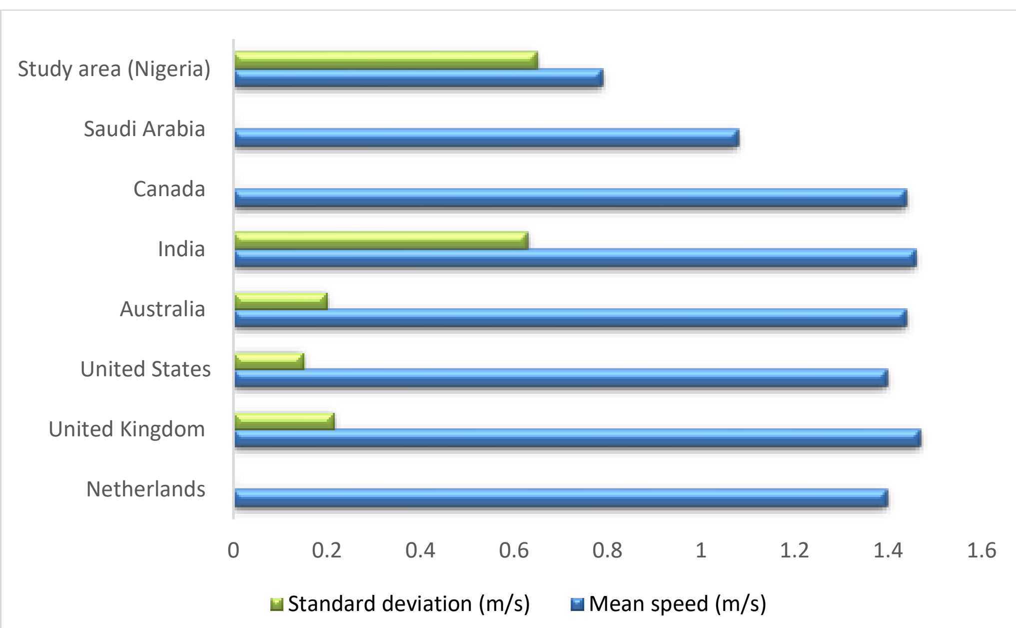
Table 83 above reveals that the standard deviation results are closely clustered around the mean. This implies a mathematically dependable dataset. The mean (average) walking speed in the study area is 1.73 m/s with standard deviation of 0.50 and variance of 0.27. Given the sample size, mean and standard deviation, for a chosen confidence level this empirical estimate is used to determine the confidence interval (or accuracy) of the mean. With a score of 1.79, standard deviation of 0.64 and confidence level of 95% and 99%, the corresponding confidence interval is ± 0.04 and ± 0.05. These scores cluster close to the average. At 95% and 99% confidence level, the population means falls within the range of 1.75 to 1.83 and 1.74 to 1.85. However, based on the small standard deviation result, it appears as if walking speed varied quite a bit. The comparative analysis in Table 84 and Figure 89 below show that the observed mean flow of walking in the study area is slower than that of other nations such as USA, United Kingdom, and Australia.

Table 84: Pedestrian speed in selected countries

Mean speed (m/s)	Standard deviation (m/s)	Country
1.40	0.00	Netherlands
1.47	0.215	United Kingdom
1.4	0.15	United States
1.44	0.20	Australia
1.46	0.63	India
1.44	0.00	Canada
1.08	0.00	Saudi Arabia
0.79	0.65	Study area (Nigeria)

Sources: Winnie Daamen and Winnie Daamen, Free Speed Distributions for Pedestrian Traffic [http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.371.4421&rep=rep1&ty and](http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.371.4421&rep=rep1&ty) Author's field survey, October 2016

Figure 87: Pedestrian speed in selected countries and study area

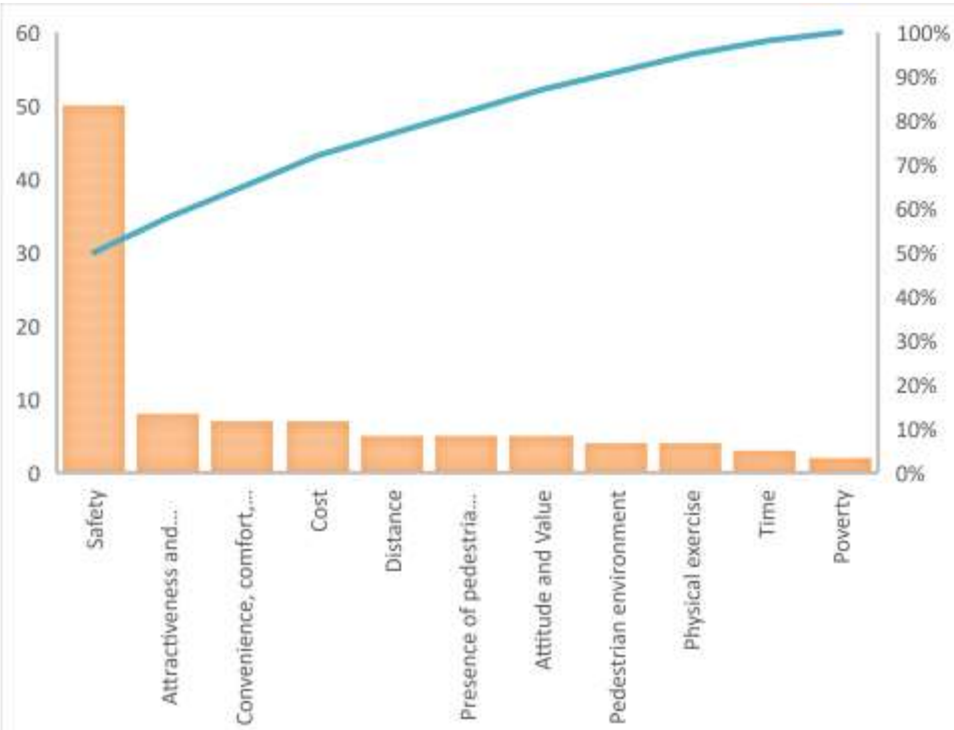


Source: Author's field survey, October 2016©

The reasons for supporting frequent daily walking in the study area

Why do so many respondents support a pedestrian system in the study area? Per Figure 88 below Two hundred and six participants (50% of the sample population) felt that it is safer for children and older persons to walk, and 5% believed that pedestrian facilities such as traffic signals, pedestrian crossings and sidewalks encourage people to walk.

Figure 88: Reasons for frequent daily walking



Source: Author's field survey, October 2016©

A handful of participants (7%) cited attractiveness and the aesthetic quality of the Lagos Island CBD as reasons for walking. Figure 90 shows attractive views of the Lagos Island CBD. Furthermore, 7% pointed to convenience, comfort, reliability, time, or ease of access to support their decision to walk. Five per cent stated that they enjoyed walking if the distance was not too far, while cost was the main consideration for 7%. Three per cent of the survey participants cited time constraints and an equal number felt that walking is a good form of exercise. Finally, 2% noted that the family situation might dictate the need to walk and 8% felt that the pedestrian environment may affect the decision to walk**.** The weather is also a major factor in the decision to walk. Around 10% of the participants stated that heavy rain prevents pedestrians form walking and 73% said that hot sun has the same effect. Not surprisingly, the decision to walk appears to be determined by pedestrian facilities, weather conditions, safety and an aesthetically pleasant environment. When these factors are not favorable they are powerful disincentives to walk, particularly for women and children. Thus, a government official stated that features such as greenery, landscaping, aesthetically pleasing views, architectural diversity, preservation of historical places, and a concentration of activities will make the pedestrian system more attractive. In summary, if the environment were to resemble the views in certain streets in Lagos Island, more people will be likely to walk.

The reason for not walking frequently in the study area

Table 85 presents the study participants' views on what makes it hard to walk in the Lagos Island CBD.

Table 85: What makes it hard to walk: community members' perspectives

Problems	Pedestrian facilities	%	No
Pedestrian infrastructure and design issues	Sidewalks: Inadequate or non-existent sidewalks Median does not go to the street, sidewalk obstructions Poor quality walking, lack of signage and continuous pedestrian routes	13	54
	Zebra Crossing: No crossings across major streets, crossings not visible		
	Road system: Roads too busy/too much traffic, potholes, open/badly located drain, unprotected culverts; missing pipes, poor quality lighting, speeding traffic, lack of rest areas and seating, and lack of shade and protection from inclement conditions.		
	Footbridges: Inadequate pedestrian footbridges and footbridges too far from bus stops Dark in the informal areas; fear of being attacked		
Personal safety	Fear of being run over by a car, too many dark spots	55	226
Personal security	No adequate security for pedestrians	15	62
Physical environmental issues	Higher exposure to air pollution, which affects health and visibility Informal operators create unsanitary conditions No enabling environment for walking	8	33
Potential social deterrents and stigmatization	Pedestrians directly associated with poverty	5	21
Neutral		4	17
Total		100	413

Source: Author's Household Survey October 2016©

Around 13% of the participants that answered this question reported that pedestrian infrastructure and design issues are major reasons for not walking frequently. Fifteen per cent cited security issues and 55% stated that they did not enjoy walking because of road conditions. Furthermore, 8% said that there is no enabling environment for walking in the study region and a further 8% cited weather and climatic conditions. Only 5% of the sample cited social perceptions as deterrents to walking and 4% remained neutral on this issue.

8.2.2.1.6: The purpose and reasons for walking

Walking can be undertaken for the purpose of getting to work or to the shops, or for social, recreational or health reasons. Just over half (56%) of the participants confirmed that they walked to work and 22% stated that they walk in the CBD for shopping purposes. Plate 17 below provides snapshot of shoppers walking at Balogun Market in the study area.

Plate 17:Shoppers walking at Balogun Market in Lagos Island CBD

Source: **https://www.linkedin.com/pulse/e-commerce-deadlong-live-conversational-commerce-olayinka-oluwakuse**

In terms of social activities, approximately 5% of the sample walked to socialize with neighbors and acquaintances. Four per cent felt that walking instead of driving would help to reduce environmental pollution and improve living conditions and another 4% walked to educational institutions. Finally, 3% of the participants indicated that walking promotes a healthy lifestyle. Thus, the results suggest that more than half of adults in Lagos Island walk for functional purposes.

Table 86: Purpose of the Trip

Purpose and reason for walking	%	Frequencies
Economic: Save money	3	12
Educational: Going to school to learn	4	17
Environmental: Preserving the environmental, going green	4	17
Health: Heart, weight loss, reduce blood sugar, promote mental activity	3	12
Recreational: Admire the scenery	3	12
Shopping: Buying for personal and family consumption	22	91
Social: Great way to meet neighbors and friends	5	21
Work: Source of livelihood for individual and family	56	231
Total	100	413

Source: Author's Household Survey October 2016©

It is important to note that these field results in Table 86 do not enable scientific predictions to be made as they are based on personal beliefs and feedback from the respondents. Furthermore, the results do not demonstrate that work, and social, recreational, health or shopping have a significant acceptable relationship with improving the pedestrian system.

The relationship between walking as a built environmental activity and functional walking purposes

In light of the above observations, a key question for this study is whether there is an association between aspects of the built environment and functional walking purposes.

Table 87: Percentage of all respondents citing cost as the main factor in deciding to walk

	Walking	Economics	Education	Environ mental	Healthy	Recreati onal	Shopping	Social	Work
Neutral	3	3	3	3	4	3	3	3.5	3.5
Somewhat likely	3	3	5	5	5	4	6	4	4
Rather unlikely	4	3	4	4	4	5	4	5	5
Very likely	86	87	79	75	82	15	82	14.5	14.5
Very unlikely	4	4	9	13	5	73	5	73	73
Total	100	100	100	100	100	100	100	100	100
Mean		20							20
R		0.9999							0.9982
R		0.9998							0.9965

Source: Author's Household Survey October 2016©

The empirical analysis in Table 87 above shows that, approximately 87% of the participants agreed that people walk for economic, social, health, shopping environmental and health purposes. Around 4% of the sample cited different purposes of walking. Three per cent felt that it was likely (at some level, or probably) and somewhat improbable (unlikely or doubtful), respectively that the functional purposes of walking are essential factors in the pedestrian system. Furthermore, 3% of the sample was neutral regarding this issue. It can thus be concluded that 87% of the total sample concurred that it is very likely that walking is the cheapest form of conveyance. Thus, most respondents and the simulation results verify that there is a possibility or that it is very likely that walking can produce significant savings, promote good health, offer a platform for socialization and sustain the environment. Per Table 94, the age of the study participants ranged from 18 to 75 years with a mean of 33 (standard deviation 9.9). Forty-five per cent of the participants were male and 55% female. From the detailed empirical results in Table 5, the standard and hypervalent determination (r) equal 0.9999 with a degree of freedom of 413 (r (413) =0. 9998).

Scientific associations between the built environment and functional walking purposes

To validate and examine the synergies, scientific simulation was conducted to determine the associations between the built environment and functional walking purposes. Quantitatively, this study uses standard intellectual and empirical procedures- a Pearson's correlation coefficient across the board to determine the relationship between walking as a built environmental activity and these functional walking purposes. The validity of the Pearson correlation calculations in this study are based on four assumptions:

1. The datasets for both walking as a built environmental activity and walking purposes are at continuous (scale/interval/ratio) level;
2. The dataset values for both walking as a built environmental activity and walking purposes are independent of each other;
3. A linear correlation p is assumed when calculating Pearson's coefficient of correlation;
4. The field observations in Lagos Island CBD are random samples from a normal or symmetric distribution system. The farther the value is to zero (0 and +1), the stronger the relationship.

Thus, a hypothesis is set up (see Table 88) [using walking dataset as a built environment feature] and measuring [another functional purpose dataset] (HI: $W \neq E$). The hypothesis is set up in such a way that if there is no direct connection between walking and another walking purpose, we would retain the null hypothesis - HO. The purpose of hypothesis testing includes clarifying, refuting and defining the parallel relationship between walking as a built environmental activity and the functional walking purposes in creating an improved pedestrian system. The import of this analysis is to consider the possibility of a linear relationship or otherwise between the built environment and functional walking purposes.

Table 88: Setting up scientific hypothesis

HO (null hypothesis): (HO: W=E)	There is a positive linear relationship between walking as a built environmental activity and these functional walking purposes
HI: Alternative hypothesis):	There is a negative linear relationship between walking as a built environmental activity and these functional walking purposes

Source: Author's construction (2016) ©

The results of the empirical hypothesis:

The results of the empirical hypothesis in Table 89 and 90 alongside the subsequent Figure 91show that across the board there is a perfect relationship between the built environment and functional walking purposes. The statistical significance level p-value (0.00001) is significantly different at ($p < 0.01$, 0.05 and 0.10). With this positive statistical result, the null hypothesis (HO: W=E) is accepted and the alternative hypothesis (HI: W≠E) is rejected. It can be hypothetically concluded that there is a strong positive or a complete correlation between the built environment and functional walking purposes.

Table 89: Results of detailed analysis and empirical effects

Analysis	Economic	Education	Education	Environment	Health	Recreational	Shopping	social	work
Correlating percentage	90%	70%	70%	70%	80%	70%	88%	80%	80%
The probability that walking and economic factors are positively related	95.83%	88.33%	88.33%	88.33%	93.33%	88.33%	74.17%	93.33 %	93.33%
The likelihood that walking and economic factors are not positively related	4.17%	11.67%	11.67%	11.67%	6.67%	11.67%	25.83%	6.67%	6.67%
Data pairs count	5	5	5	5	5	5	5	5	5
The chance that walking and economic factors are somehow related	91.67%	76.67%	76.67%	76.67%	86.67%	76.67%	48.33%	86.67 %	86.67%
The probability that walking and economic factors are not linked at all	8.33%	23.33%	23.33%	23.33%	13.33%	23.33%	51.67%	13.33 %	13.33%
Likely (90% chance) estimate of the real correlation (experienced 90%) interval	from 29.96% to 98.98%	from -28.75% to 96.61%	from -28.75% to 96.61%	From -28.75% to 96.61%	from -6.44% to 97.85%	From -28.75% to 96.61%	From -62.88% to 91.96%	From -6.44% to 97.85 %	From -6.44% to 97.85%
Very likely (95% chance) assessment of the actual relationship (experienced 90%) interval	from 8.61% to 99.34%	from -47.66% to 97.82%	from -47.66% to 97.82%	From -47.66% to 97.82%	from -27.96% to 98.62%	From -47.66% to 97.82%	From -74.53% to 94.78%	From -27.96 % to 98.62 %	From -27.96% to 98.62%
Sure (99% chance) assessment of the real relationship (experienced 90%) interval	from -33.56% to 99.72%	from -74.16% to 99.08%	from -74.16% to 99.08%	From -74.16% to 99.08%	from -61.86% to 99.42%	From -74.16% to 99.08%	From -88.49% to 97.78%	From -61.86 % to 99.42 %	From -61.86% to 99.42%

Analysis	Economic	Education	Education	Environment	Health	Recreational	Shopping	social	work
Completely sure (99.9% probability) estimate of the real correlation (experienced 90%) interval	from -69.34% to 99.9%	from -89.75% to 99.66%	from -89.75% to 99.66%	From -89.75% to 99.66%	from -84.2% to 99.79%	From -89.75% to 99.66%	From -95.65% to 99.19%	From -84.2% to 99.79 %	From -84.2% to 99.79%
Spearman correlation coefficient	0.9	0.7	0.7	0.7	0.8	0.7	0.4	0.8	0.8
Spearman correlation coefficient squared	0.81	0.49	0.49	0.49	0.64	0.49	0.16	0.64	0.64
Spearman correlation significance (p-value) one-tail	0.0417	0.1167	0.1167	0.1167	0.0667	0.1167	0.2583	0.0667	0.0667
Spearman correlation significance (p-value) two-tail	0.0833	0.2333	0.2333	0.2333	0.1333	0.2333	0.5167	0.1333	0.1333
Likely (90% probability) estimate of the real correlation (experienced 0.9) interval	from 0.2996 to 0.9898	from -0.2875 to 0.9661	from -0.2875 to 0.9661	From -0.2875 to 0.9661	from -0.0644 to 0.9785	From -0.2875 to 0.9661	From -0.6288 to 0.9196	From -0.0644 to 0.9785	From -0.0644 to 0.9785
Very likely (95% probability) estimate of the real correlation (experienced 0.9) interval	from 0.0861 to 0.9934	from -0.4766 to 0.9782	from -0.4766 to 0.9782	From -0.4766 to 0.9782	from -0.2796 to 0.9862	From -0.4766 to 0.9782	From -0.7453 to 0.9478	From -0.2796 to 0.9862	From -0.2796 to 0.9862
Sure (99% probability) estimate of the real correlation (experienced 0.9) interval	from -0.3356 to 0.9972	from -0.7416 to 0.9908	from -0.7416 to 0.9908	From -0.7416 to 0.9908	from -0.6186 to 0.9942	From -0.7416 to 0.9908	From -0.8849 to 0.9778	From -0.6186 to 0.9942	From -0.6186 to 0.9942
Completely sure (99.9% probability) estimate of the real correlation (experienced 0.9) interval	from -0.6934 to 0.999	from -0.8975 to 0.9966	from -0.8975 to 0.9966	From -0.8975 to 0.9966	from -0.842 to 0.9979	From -0.8975 to 0.9966	From -0.9565 to 0.9919	From -0.842 to 0.9979	From -0.842 to 0.9979
Pearson correlation coefficient	0.9999	0.9982	0.9982	0.991	-0.2269	0.9998	0.9993	0.9993	0.9993
Pearson correlation coefficient squared	0.9997	0.9965	0.9965	0.9821	0.0515	0.9997	0.9986	0.9987	0.9987

Analysis	Economic	Education	Education	Environment	Health	Recreational	Shopping	social	work
Pearson correlation significance (p-value) one-tail	0	0	0	0.0005	0.6432	0	0	0	0
Pearson correlation significance (p-value) two-tail	0	0	0	0.001	0.7136	0	0	0	0

Source: Author's Household Survey October 2016

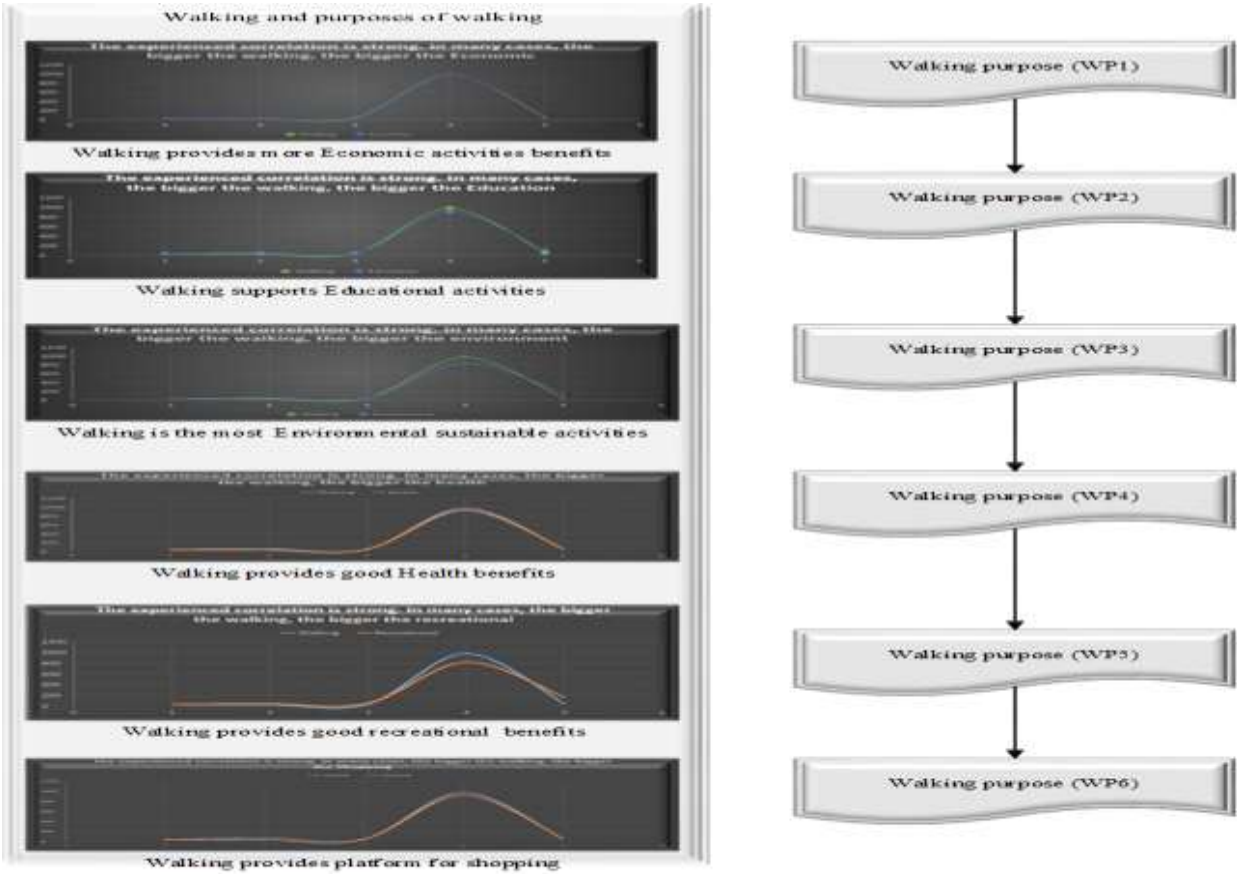
Table 90: P value from Pearson (r) and significance level

P Value from Pearson (R)	Significance Level @0. 01	Significance Level @0. 05	Significance Level@0. 10
Walking and purpose of walking	The P-Value is < 0.00001. The	P-Value is < 0.00001. The result is significant at p < 0.05. Calculate	The P-Value is < 0.00001. The result is significant at p < 0.10.

Source: Author's Household Survey October 2016

This finding provides support for the key argument and unequivocally demonstrates that there is a statistically positive significant relationship between walking mode and functional purpose robustness. The cited figures show that walking and functional purposes move in the same way. This hypothesis result implies that the built environment and functional walking purposes are active in the same way. Figure 89 shows this unambiguously perfect relationship.

Figure 89: Relationship between walking and purpose of walking



Source: Author's Household Survey October 2016

Empirical findings and implications for pedestrian safety.

The findings of the theoretical analysis are entirely convincing, and it can be concluded that there is a direct relationship between walking and the functional purpose. The most significant contribution is that the walking mode will automatically support shopping, social purposes and education; promote significant savings (economic) and increase life expectancy and promote healthier lifestyles (health). The hypothesis results show that a pedestrian system will also improve air quality and reduce CO2 emissions (global warming). It will promote a more human-scaled street for walkers in Lagos Island. The study thus confirms that walking as a feature of the built environment predicts the functional purpose. Hence, this study corroborates the extensive literature and rigorous hypothetical research in urban planning and public health that predicts associations between walking as a built environmental feature and functional walking. An article in the journal *PLoS Medicine* reported on a study that concluded that 150 minutes of brisk walking a week can add 3.4 years to one's lifespan. Furthermore, walking for 15 minutes after a meal improves digestion, boosts health and evens out blood sugar levels. The study found that 30 minutes walking a day increases cardiovascular fitness, strengthens bones, reduces extra body fat, improves blood pressure and cholesterol and promotes muscle power and survival. It also reduces the risk of heart disease, type2 diabetes, osteoporosis and some cancers.(Frank and Engelke, 2002, Muhlbach, 2012, Mills, 2013, Steven C. Moore et al., 2012)

Computing vehicular and walking costs

A comparative analysis was undertaken of the cost of vehicular commuting and walking. While, regardless of the distance travelled, walking comes at no cost, private or public vehicular travel incurs substantial costs (see Table 91).

Table 91: Cost of walking and using motorized transport for a typical trip

Mile	Walking	Assumed vehicular expense (#)	Dollar equivalent
01-05	0	₦1000	$3.33
06-10	0	₦2000	$6.67
11-15	0	₦3000	$10.00
16-20	0	₦4000	$13.33

Source: Author's Household Survey October 2016©

It is also necessary to pose the fundamental question of why people walk rather than commuting by means of a vehicle or other modes. This is an important consideration in planning improvements to the pedestrian system.

Walking patterns in selected CBDs in Lagos

The large majority of the sample population in the study area was in favor of walking. Table 92 shows that this is also true of other CBDs in the Lagos metropolitan area.

Table 92: Comparative analysis of walking and other modes of commuting in the Lagos Island CBD and other CBDs in Lagos

Modes of travel	Study area	Yaba	Oshodi	Ikeja
Walk	80	75	79	70
Tricycles Keke Marwa and Keke Napep	10	12	10	3
Public Buses	4	5	7	5
Other modes	2.5	2	4	1
Cars	2	3	3	20
Motorcycle (Okada)	1.5	3	3	1
Total	100	100	110	100

Source: Author's Household Survey October 2016©

The overwhelming majority of respondents (70%, 75% and 79%) of the population sampled in three leading CBDs, Ikeja, Yaba, and Oshodi, respectively supported walking. However, slightly more participants in the study area expressed a preference for this mode of travel.

Participants' perceptions of the walking mode

Table 93 indicates that, 80% of the sampled population felt that walking is the safest transportation mode, while 10% were of the opinion that a tricycle (Keke Marwa) is the safest. On the other hand, and 1%, 3% and 4% of the sample suggested that motorcycles, vehicles, and public buses, respectively, are the least safe ways to travel in the Lagos Island CBD.

Table 93: Percentage of all respondents citing walking as the safest mode of transportation

	%	Frequencies
Neutral	3	12
Somewhat	3	12
Rather unlikely	4	17
Very likely	86	355
Very unlikely	4	17
Total	100	413

Source: Author's Household Survey October 2016©

An overwhelming majority (355 participants, representing 86% of the sample) concurred that it is very likely that walking is the most dependable mode. Only 4% disagreed with this view. In contrast, 3% and 4% of the participants felt that it is somewhat likely and somewhat unlikely respectively, that walking is the most secure mode of travel and three remained neutral on this issue (see Plate 18)

Plate 18:The safest mode of transportation in the study area

Source: Author's field survey, October 2016©

Pedestrian flow

The field census was restricted to two-hour peak periods in the morning (8am-10am) and the afternoon (4pm-6 pm) throughout the week. Tables 94 and 95 provide the pedestrian flow rate on a typical weekday morning and afternoon in Lagos Island CBD. While the data may not necessarily be accurate, it is a reflection of the influx of pedestrians in the CBD on weekdays and illustrates the need to improve the pedestrian system.

Table 94: Typical pedestrian flow (morning) in the study area

Time	Weekdays (morning)							
	Mon	Tue	Wed	Thurs	Fri	Sat	Sun	Total
8.00-8.15	2700	2400	1120	2100	2000	3045	300	13665
8.00-8.30	3300	1400	1000	2100	3800	4000	585	16185
8.31-8.45	2800	1000	1000	1000	2200	2000	390	10390
8.45-9.00	1000	500	800	857	2000	1500	200	40240
9.00-9.15	1000	500	1000	450	1000	1005	100	5055
9.15-9.30	1200	1000	300	350	1150	1000	95	5095
9.31-9.45	1500	750	500	125	576	1000	30	4481
9.45-10.00	1000	250	400	75	574	750	75	3124
Total	14500	7800	6120	7057	13300	14300	1775	98235

Source: Author's Household Survey October 2016©

Table 95: Typical pedestrian flow (afternoon) in the study area

Time	Weekdays (Afternoon)							
	Mon	Tues	Wed	Thurs	Fri	Sat	Sun	TOTAL
4.00-4.15	2000	1000	1000	1064	1900	2500	802	10266
4.15-4.30	3420	2575	1087	1500	3025	3000	1000	15607
4.30-4.45	2200	600	800	600	1855	1500	554	8109
4.45-5.00	1000	1200	400	1200	1000	1000	554	6354
5.00-5.15	1000	750	450	620	1220	450	300	4790
5.15-5.30	800	250	250	180	400	450	430	2760
5.31-5.45	700	120	450	280	700	300	80	2630
5.45-6.00	300	80	150	120	500	200	100	1450
Total	11420	6575	4587	5564	10600	9400	3820	51966

Source: Author's Household Survey October 2016©

Pedestrian travel patterns in Lagos Island from Monday to Friday are relatively consistent. Interestingly, the results suggest that there is a relatively higher influx of pedestrians on Mondays and Fridays than other days in the working week. Table 88 also shows that afternoon weekday pedestrian peak flows are unique. The peak is bent and dispersed over the same period as the morning point (see Plate 19). The afternoon peak results also illustrate fluctuations in pedestrian flow on weekday afternoons. A comparative analysis of pedestrians in the CBD on weekdays and weekends reveals significant differences, confirming variations in the pattern.

Plate 19:Pedestrian density on a typical weekday

Source: Author's Household Survey October 2016©

Pedestrian densities are overwhelmingly higher on weekdays than on the weekend. Seasonal variations are also more likely on the weekends than on work days. It was observed that streets in the inner CBD were usually quiet on weekends and sometimes empty on Sundays.

Table 96: Pedestrian density on weekdays and weekends

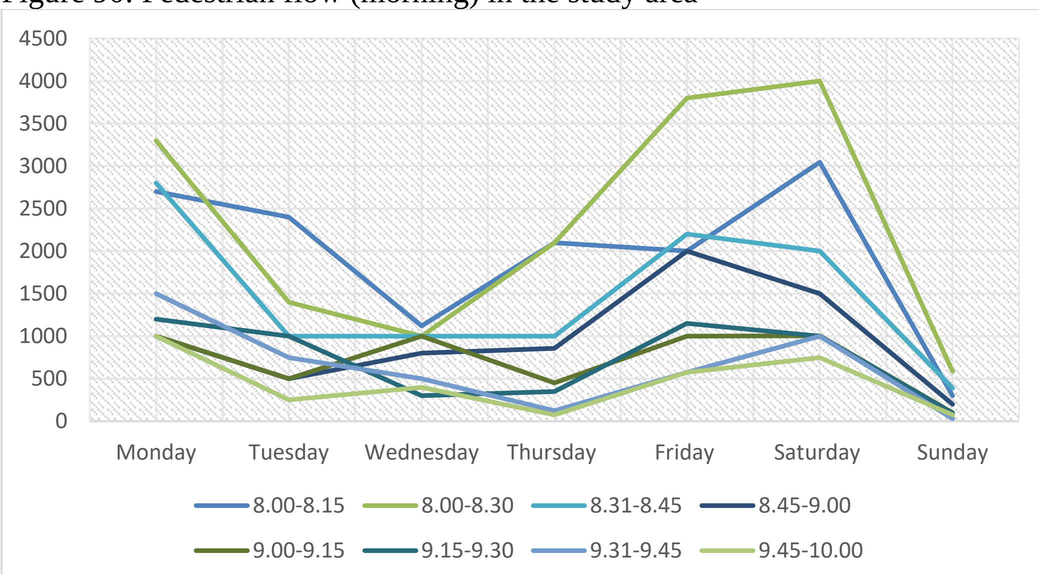
Day	8-10	4-6	Total	Percentage
Monday	14500	11420	25920	22.18
Tuesday	7800	6575	14375	12.3
Wednesday	6120	4587	10707	9.1
Thursday	7057	5564	12621	10.8
Friday	13330	10600	23930	20.47

Day	8-10	4-6	Total	Percentage
Saturday	14300	9400	23700	20.28
Sunday	1775	3820	5595	4.788
Total	58882	47966	116848	99.918

Source: Author's Household Survey October 2016©

Figure 90 shows that there is a relatively higher influx of pedestrians in the study area on Mondays and Fridays. It reveals that, between Saturday and Sunday there is an eightfold decrease in the number of pedestrians travelling to the CBD.

Figure 90: Pedestrian flow (morning) in the study area



Source: Author's Household Survey October 2016©

Considering these empirical findings, a 50th and 85th percentile of pedestrian access/egress was calculated based upon 15-minute peak demand intervals (see Table 97).

Table 97: Pedestrian morning flow on weekdays

Time	Frequency of the pedestrian flow	Cumulative frequency	Increasing frequency	Percentile
8.00-8.15	2700	18.62	18.62	
8.00-8.30	3300	22.76	41.38	50th
8.31-8.45	2800	19.30	60.68	
8.45-9.00	1000	6.90	67.58	
9.00-9.15	1000	6.90	74.48	
9.15-9.30	1200	8.28	82.76	85th
9.31-9.45	1500	10.34	93.1	
9.45-10.00	1000	6.90	100	
Total	14500	100		

Source: Author's Household Survey October 2016©

In the morning, the peak period is between 8.30am and 8.45am. The results show that more than 50% percentile of the pedestrian flow occurs during this period and 85% percentile is recorded between 9.15am and 9.45am. Thus, at the 85% percentile, there is higher pedestrian circulation on the roadways in the study area between 9.15am and 9.45am. Table 98 illustrates pedestrian circulation during the afternoons in Lagos Island CBD. Between 4pm and 6pm, the peak period is from 4.30pm to 5.30pm.

Table 98: Pedestrian afternoon weekday flow

	Frequency of the pedestrian flow	Cumulative frequency	Increasing frequency percentage	Percentile
4.00-4.15	2000	17.51	17.51	
4.15-4.30	3420	29.95	47.46	50th
4.30-4.45	2200	19.26	66.72	
4.45-5.00	1000	08.76	75.48	
5.00-5.15	1000	08.76	84.24	85th
5.15-5.30	800	7.00	91.24	
5.31-5.45	700	6.13	97.37	
5.45-6.00	300	2.63	100	
Total	11420	100		

Source: Author's Household Survey October 2016©

The results show that more than 50% percentile of the pedestrian flow is between 4.15pm and 4.30pm and 85% percentile is between 5.00pm and 5.30pm. Thus, at that the 85% percentile, more pedestrians use the roadways in the study area between 5.00pm and 5.30pm. The survey also revealed a significant fall in pedestrian density between 5.15pm and 6pm. This suggests that there are variations in pedestrian density during the peak periods. More pedestrians are walking in the CBD from 4.00pm to 4.45pm in the afternoon.

8.2.2.4: Arithmetic mean with statistical harmonic mean flow of pedestrians

The arithmetic mean was compared with the harmonic mean. Table 99 indicates the sureness of the result. On a typical weekday morning and afternoon, the aggregate arithmetic and harmonic mean of pedestrian flow is 8,500 and 6,949 for every two-hour period, respectively. Hypothetically, the total arithmetic mean of pedestrian flow provides convincing evidence that on a typical weekday, the aggregate arithmetic and harmonic mean of pedestrian flow to the CBD between 8am and 10am is 8,561 and 7,988 and between 4pm and 6pm is 6949 and 6419. On a typical weekend, the average number of pedestrians coming to the CBD between 8am and 10am is 8,038 and 3,158 and between 4pm and 6pm is 6,610 and 5,432. Thus, the aggregate arithmetic means of pedestrian flow in the study area is greater than or equal to the harmonic mean. These results show consistency and confirm a significant relationship between the average mean and harmonic mean.

Table 99: Statistical results of aggregate arithmetic and harmonic mean of pedestrian flow

	Arithmetic Mean	Median	Harmonic Mean	variance	SD
Monday-Friday 8-10	8561.4	7800	7987.566134	6.309340	2511.839931
Monday-Friday 4-6	6949.2	6575	6419.012648	4.237757	2058.581395
Weekend 8-10	8037.5	8037.5	3158.009	3.921891	6262.5
Weekend 4-6	6610	6610	5432.375185	7784100	2790

Source: Author's Household Survey October 2016©

The study thus confirmed that on average 8,500 people come to CBD at two-hour intervals, resulting in a significant daily influx of pedestrians in the study area. It can be projected that during a 12-hour period in a 24-hour day, 51,500 individuals will come to the CBD. Mathematically, this produces an exponential value of 100,000 people visiting the CBD during business hours between 8am and 6pm each day. Increased pedestrian flow or density implies a growth in the number of shoppers and a concomitant increase in income for the Lagos Island local government. However, to sustain this trend, there is a need to improve the pedestrian system.

Table 100: Comparing Pedestrian density, afternoon weekend and afternoon weekdays

Time	Pedestrians density (afternoon weekend)	Pedestrians density (afternoon weekdays)
4.00-4.15	2500	2000
4.16-4.30	3000	3420
4.31-4.45	1500	2200
4.46-5.00	1000	1000
5.00-5.15	450	1000
5.16-5.30	450	800
5.31-5.45	300	700
5.46-6.00	200	300

Source: Author's Household Survey October 2016©

The study also analyzed the relationship between the aggregate arithmetic and harmonic mean of pedestrian flow on weekdays and weekends (see Table 100). However, Table 101 sets out the statistical Spearman correlation coefficient between the aggregate arithmetic and harmonic mean of pedestrian flow during these times. The Spearman correlation coefficient is 0.978 and the Spearman correlation significance (p-value) one-tail and Spearman correlation significance (p-value) two-tail are 0.0001 and 0.0002, respectively. The probability that pedestrian density on weekday afternoons and on weekend afternoons is positively related is 99.99%. The likelihood that pedestrian density on weekday afternoons and weekend afternoons is not positively related is 0.01%. The empirical analysis thus found that there is a significant relationship between pedestrian flow on weekdays and weekends. It can be projected that the larger the pedestrian density on weekday afternoons, the more important is pedestrian density on weekend afternoons. This result indicates strong positive correlation, which means that high pedestrian flow on weekday mornings has a perfect relationship with pedestrian flow on weekend mornings (and vice versa).

Table 101: Statistical Spearman correlation coefficient between pedestrian flow on weekdays and weekends

Mature correlation percentage	95.78%
Spearman correlation coefficient	0.9578
Spearman correlation coefficient squared	0.9174
Spearman correlation significance (p-value) one-tail	0.0001
Spearman correlation significance (p-value) two-tail	0.0002
Likely (90% probability) estimate of the real correlation (experienced 0.9578) interval	from 0.8285 to 0.9902
Very likely (95% probability) estimate of the real correlation (experienced 0.9578) interval	from 0.7788 to 0.9926
Sure (99% probability) estimate of the real correlation (experienced 0.9578) interval	from 0.6452 to 0.9957
Completely sure (99.9% probability) estimate of the real correlation (experienced 0.9578) interval	from 0.4198 to 0.9977
Pearson correlation coefficient	0.9357
Pearson correlation coefficient squared	0.8756
Pearson correlation significance (p-value) one-tail	0.0003
Pearson correlation significance (p-value) two-tail	0.0006
Likely (90% probability) lower estimate of the real correlation (experienced 0.9357) is at least	min 0.8108
Very likely (95% probability) lower estimate of the real correlation (experienced 0.9357) is at least	min 0.7474
Sure (99% probability) lower estimate of the real correlation (experienced 0.9357) is at least	min 0.5798

Completely sure (99.9% probability) lower estimate of the real correlation (experienced 0.9357) is at least	min 0.31
Likely (90% probability) upper estimate of the real correlation (experienced 0.9357) is below	max 0.9791
Very likely (95% probability) upper estimate of the real correlation (experienced 0.9357) is below	max 0.9849
Sure (99% probability) upper estimate of the real correlation (experienced 0.9357) is below	max 0.9917
Completely sure (99.9% probability) upper estimate of the real correlation (experienced 0.9357) is below	max 0.9958
Likely (90% probability) estimate of the real correlation (experienced 0.9357) interval	from 0.7474 to 0.9849
Very likely (95% probability) estimate of the real correlation (experienced 0.9357) interval	from 0.6783 to 0.9886
Sure (99% probability) estimate of the real correlation (experienced 0.9357) interval	from 0.501 to 0.9934
Completely sure (99.9% probability) estimate of the real correlation (experienced 0.9357) interval	from 0.227 to 0.9965

Source: Author's Household Survey October 2016©

Effects of weather on the pedestrian system

Plate 20:Typical street with pedestrians after torrential rains in the study area

Source: Author's Household Survey October 2016©

Studies have identified the weather as an important factor in efforts to improve the intra-urban pedestrian system in the study region (see Plate 20 above). The study participants were asked how the weather affects their decision to walk.

Table 102: Climatic conditions that cause pedestrians to walk

	Percent	Frequencies
Fog	4	17
Light Rain	10	41
Very sunny	13	53
Partly sunny	73	302
Total	100	413

Source: Author's Household Survey October 2016©

Per Table 102, Three hundred and two of the 413 participants representing 10% of the total sampled population said that torrential rains prevented them from walking. A third stated that they do not walk when temperatures are above normal and 165 (40%) reported they would not walk when the temperature falls below normal. These results confirm that there are substantially more pedestrians on the streets when the weather is partly sunny (near the coast, temperatures rarely exceed 32 degrees Celsius (90-degree Fahrenheit)) than when it was misty with light rainfall (average rainfall along coast is about 180cm (70in)). Only 17 (4%) stated that foggy weather discourages them from walking. Thus, only 53 of 413 participants representing 13% of the total sample population identified harsh weather as a reason for not walking. It is concluded that precipitation is a bigger impediment to walking. The study also found that the weather is a greater deterrent for scheduled journeys, such as commuting to work, then for discretionary trips.

8.2.3: Other modes

Aside from walking and the vehicular mode of commuting, modes of conveyance in the study area include public buses, tricycles, and bicycles. This study found that 83 (11%) of the participants travelled to the CBD area using these modes. Plate 21 illustrates one of these modes of transportation in the study area.

Plate 21:Other modes of transportation

Source: Author's Household Survey October 2016©

Average daily use of public modes of transportation among the sample population

Table 103 shows that, 74% of the participants confirmed that they use public modes of transportation once or twice a day to reach the CBD, while 18% stated that they used such modes two to four times a day. Six per cent and 2% of the sample population used public transport four to six and six to eight times per day, respectively.

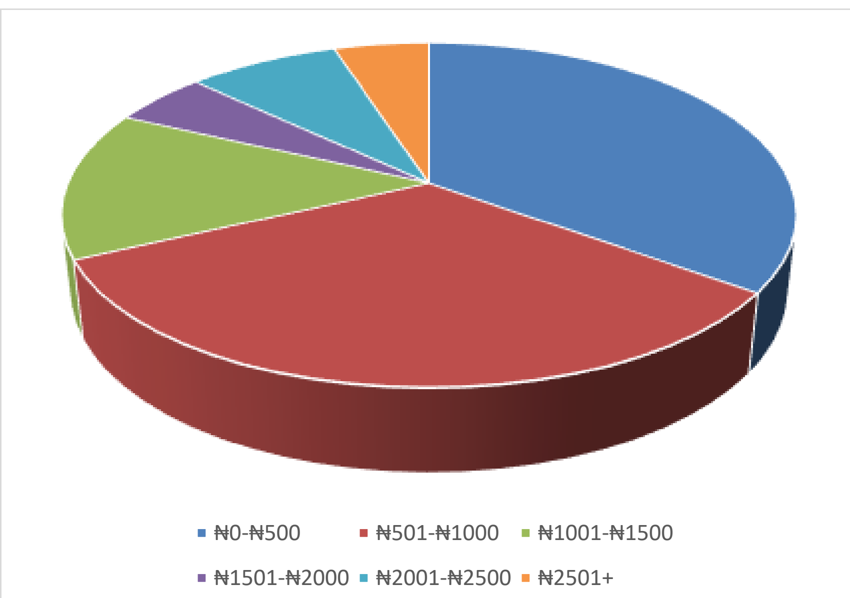
Table 103: Use of public transportation among the sampled population

No. of times/per day	%	frequencies'
01-02 times	74	61
02-04 times	18	15
04-06 times	6	5
06-08 times	2	2
Total	100	83

Source: Author's Household Survey October 2016©

Average daily expenditure per trip on public transportation:

Figure 91: Daily expenditure per trip on public transportation in Lagos Island



Source: Author's Household Survey October 2016©

Graphical analysis in Figure 91 and complementary Table 104 show that 35% of the participants spent between ₦0 and ₦500 ($0 - $2.50) per trip on public transportation; 33% spent between

₦500 to ₦1000 ($2.50 - $5.00) per trip and 14% paid ₦1000 to ₦1500 per trip. Per Table 104 The latter group sometimes uses more than one form of public transportation to reach their destination.

Table 104: Daily expenditure per trip on public transportation in Lagos Island

Naira	%	Frequencies
₦0-₦500	35	29
₦501-₦1000	33	27
₦1001-₦1500	14	12
₦1501-₦2000	5	4
₦2001-₦2500	8	7
₦2501+	5	4
Total	100	83

Source: Author's Household Survey October 2016©

Average time spent using public transport

Table 105 below shows the average time the participants spent on public transport. The majority (80%) spent between 31 and 60 minutes; 10% completed their trips in 30 minutes; and 7% and 3% spent between 61 and 90 and 91 and 120 minutes on public transport, respectively. The average time spent on public transport is thus 46 minutes. The is not onerous considering that the average vehicle owner will sit in traffic for close to two hours for a single trip from the Mainland to the Island during the peak period.

Table 105: Time taken to get to the nearest point in the CBD using public transportation

Time spent on a trip	%	No
0- 30 Minutes	10	8
31-60 Minutes	80	66
61-90 Minutes	7	6
91-120 Minutes	3	2
Total	100	83

Source: Author's Household Survey October 2016©

Parameters used to rate other modes of transportation

Table 106 shows that 55% of the participants took the safety of public transport into account; 14% considered the price; 10% stated that they would examine the state of the vehicle and 5% took convenience, punctuality, and waiting time into account, respectively.

Table 106: Rating parameters of current public transportation

Rating parameters	%	Frequencies
Quality of vehicles	10	8
Safety	55	46
Convenience	5	4
Punctuality	5	4
Waiting/ time	5	4
Government	6	5
Price/cost	14	12
Total	100	83

Source: Author's Household Survey October 2016©

The participants in the study area were also asked to rate different aspects of current public transportation. Table 107 reveals that the overwhelming majority was not satisfied with the quality of vehicles, and the safety, convenience, punctuality, waiting time and price of public transportation, with just 4% reporting that they were satisfied.

Table 107: Rating of current public transportation

Rating	Quality of vehicles	Safety	Convenience	Punctuality	Waiting time	Government	Price
Excellent	0	0	0	0	0	0	0
very good	0	0	1	0	0	0	0
average	10	2	5	3	5	5	5
good	10	3	12	13	13	10	5
poor	80	95	82	84	82	85	90
total	100	100	100	100	100	100	100

Source: Author's household survey October 2016©

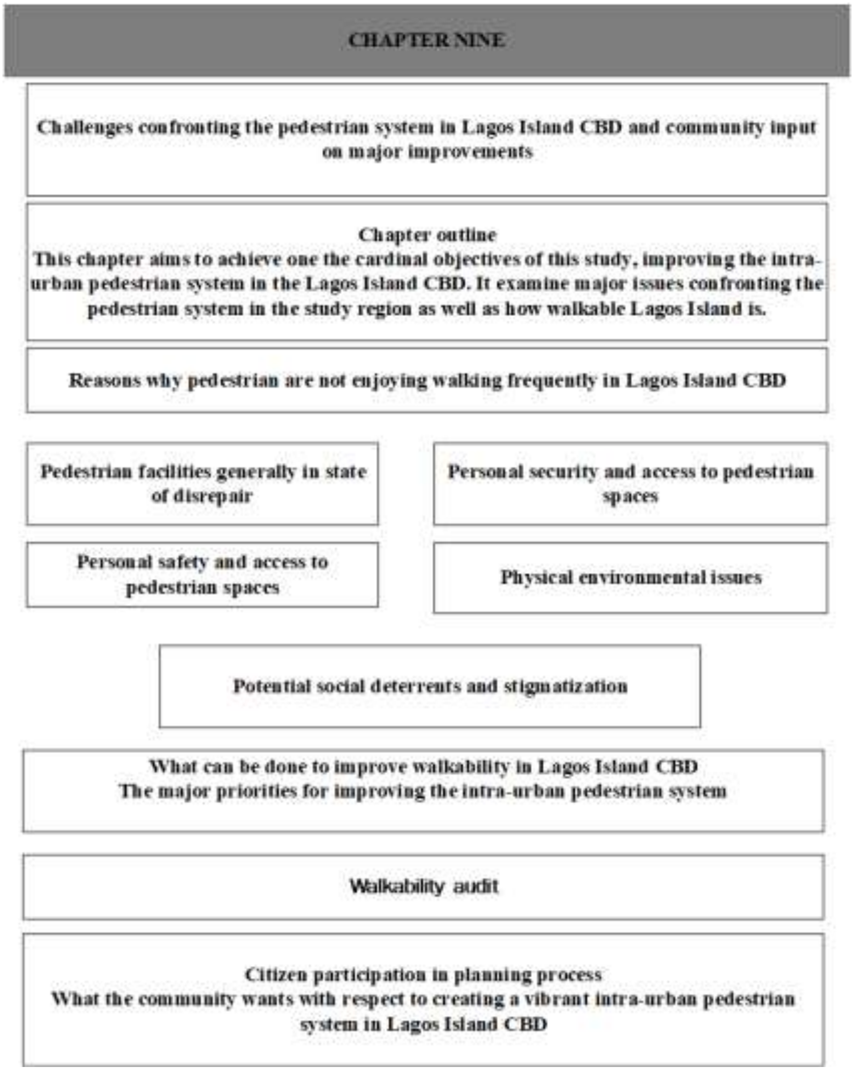
8.3 The Chapter Summary:

This chapter is a continuation of data analysis but with a focus on socio-economic characteristics and its implication on mobility. The introduction of other forms of data presentation in the form of graphs, charts and tables ushers in an enjoyable and exciting perspective to the reader. But more so, overwhelming vivid evidence further substantiates the analytical insight of the study area

9. CHAPTER NINE: EMPIRICAL FINDINGS - CHALLENGES CONFRONTING THE PEDESTRIAN SYSTEM IN LAGOS ISLAND CBD AND COMMUNITY INPUT ON MAJOR IMPROVEMENTS

9.1: Chapter outline

Figure 92: Outline of chapter 9



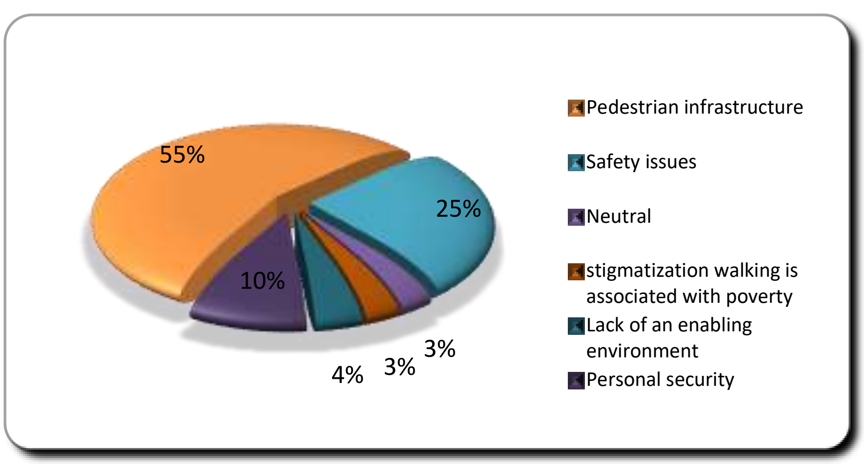
Source: Author's Construction, October 2016©

Previous chapters noted that, Lagos Island CBD is one of the most densely populated regions (this study estimated a population density of 325 people per square kilometer) in the Lagos urban environment with a high real-time transient pedestrian flow. Figure 92 outlines the structure of Chapter 9. Like other commercial nerve centers throughout the world, Lagos Island CBD aspires to support an environmentally friendly pedestrian system and develop high quality supporting infrastructure that is reliable, secure, and resilient in order to enhance the functioning and growth of this prime area. This chapter aims to achieve one the cardinal objectives of this study, improving the intra-urban pedestrian system in the Lagos Island CBD. It examines the major issues confronting the pedestrian system in the study region as well as how walkable Lagos Island CBD is. It also provides a unique opportunity for citizen participation in decision-making, especially in terms of the best strategies and preferences for building a sustainable intra-urban pedestrian system

9.2: Reasons why pedestrians do not enjoy walking frequently in Lagos Island CBD

An important question posed to the study respondents was why pedestrians do not enjoy walking frequently in the Lagos Island CBD. Creating pedestrian-friendly communities and addressing pedestrians' needs are part of every urban planning effort. However, reliable data are required to decide on the best options for architecture and streetscape design and an improved pedestrian system. Figure 93 shows that, with a marginal error of (±) 5%, 55% of the respondents that answered this question pointed to the poor state of pedestrian infrastructure. Around 25% cited safety issues, while 10% said that fears for their personal security prevented them from walking and only 4% identified the lack of an enabling environment. Finally, 3% of the respondents remained neutral on this issue and the same percentage pointed to stigmatization whereby walking is associated with poverty.

Figure 93: Participants' responses relating to problems with the intra-urban pedestrian system in Lagos Island CBD



Source: Author's household survey, October 2016©

These intra-urban pedestrian challenges are not peculiar to the Lagos Island CBD. The fact that the majority of the participants cited the lack of pedestrian infrastructure highlights the need to address this issue. The following sections discuss each of the issues raised in more detail.

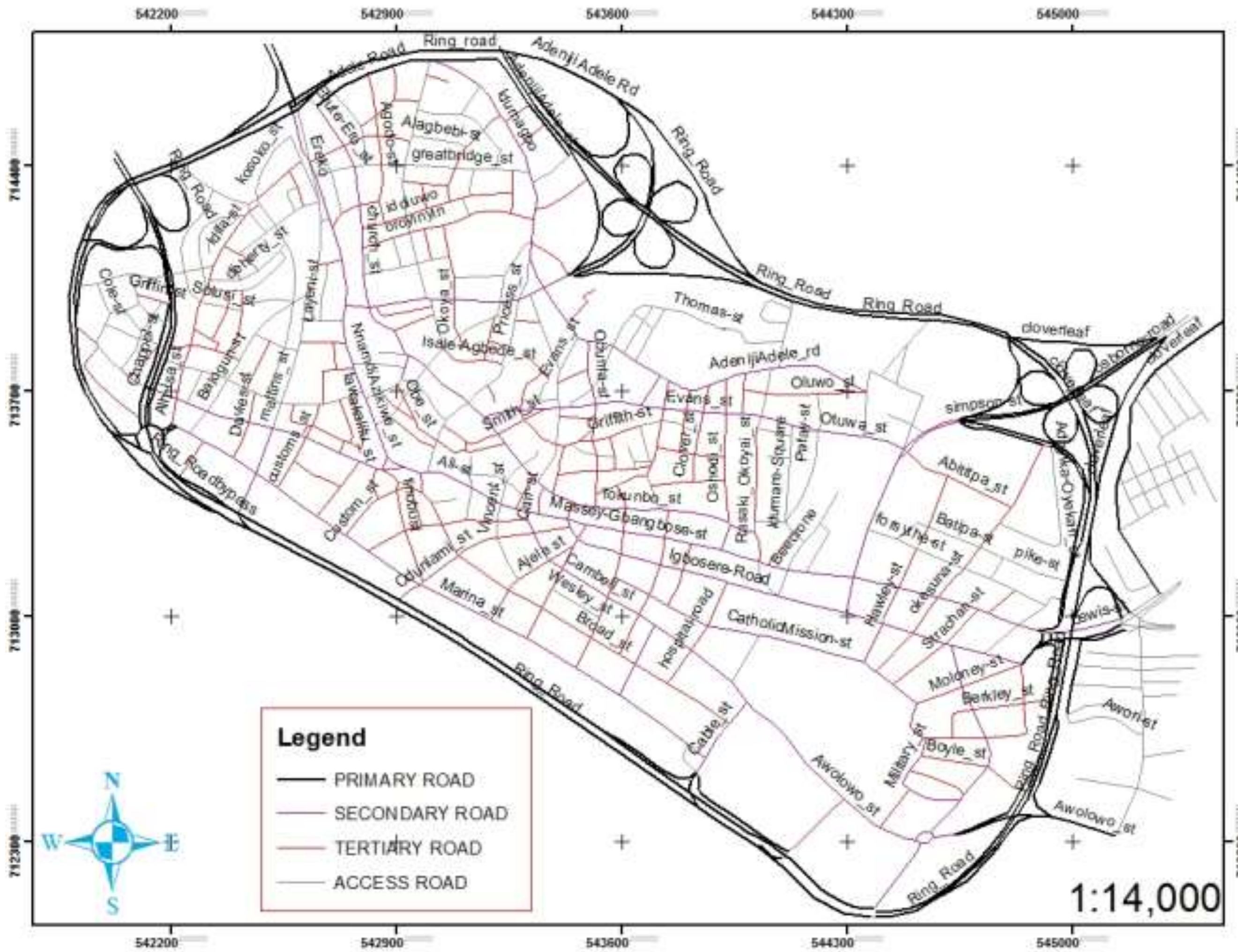
9.2.1: Pedestrian facilities generally in a state of disrepair

Five major pedestrian facilities in the Lagos Island CBD were identified for close evaluation, namely, footbridges, walkways, roads, pedestrian signage, and crosswalks.

9.2.1.1 Road systems

In the Lagos Island CBD, the road system is, by default, arguably one of the major pedestrian facilities. The transport network is road based with 90% of total passengers and goods moved through roadways. The number of road-related trips by all modes (including walking) was hypothetically estimated at three million per day (researcher's estimates based on field results) with walking trips accounting for 45% of total travel. Figure 94 shows the categorization of roadways in the Lagos Island CBD. There are two spiral ring roads with a high level of accessibility to several parts of the Lagos Metropolitan area including the Mainland and other sections of the Island (Victoria Island). The geographical and spatial location of the streets demonstrates a radio-centric internal road pattern with a high level of accessibility to vehicular services. The CBD roadways extend from Carter Bridge to the western parts of the CBD through Adeniji Adele Road, the Marina (inner and outer) and to Tafawa Balewa Square. They continue to Broad Street and stretch to Idumagbo Avenue, and Ereko, Martins, and Balogun Streets back to Idumota and Carter Bridge. These roads are dedicated to vehicular use with little regard for pedestrians and other non-motorized transport

Figure 94: Categorization of roadways in the Lagos Island CBD



Source: Author’s household survey, October 2016©

The road inventories shown above demonstrate that the Lagos Island CBD generates large volumes of vehicular activities that traverse all its nooks and crannies. Despite the potential of the roadway system to stimulate local economic development, its dedication to vehicular use is a serious challenge that inhibits development, especially regarding pedestrian safety. Plate 22 illustrates the typical conflicts between vehicles and pedestrians.

Plate 22:A typical busy roadway in the study area and pedestrians navigating the road

Source: Author's household survey, October 2016©

Table 108 below presents a detailed breakdown of the field inventories of existing road facilities. While major arterial roads are devoted to vehicular activities, the major struggle for roadways among vulnerable pedestrians and NMT is concentrated in the collector and local streets. Road connectivity in the Lagos Island CBD exacerbates conflict between pedestrian and vehicular use. This is negatively impacting the development of Lagos Island as well as the living and working conditions of the population, particularly pedestrian and NMT users.

Table 108: Selected roads and categories in the study area

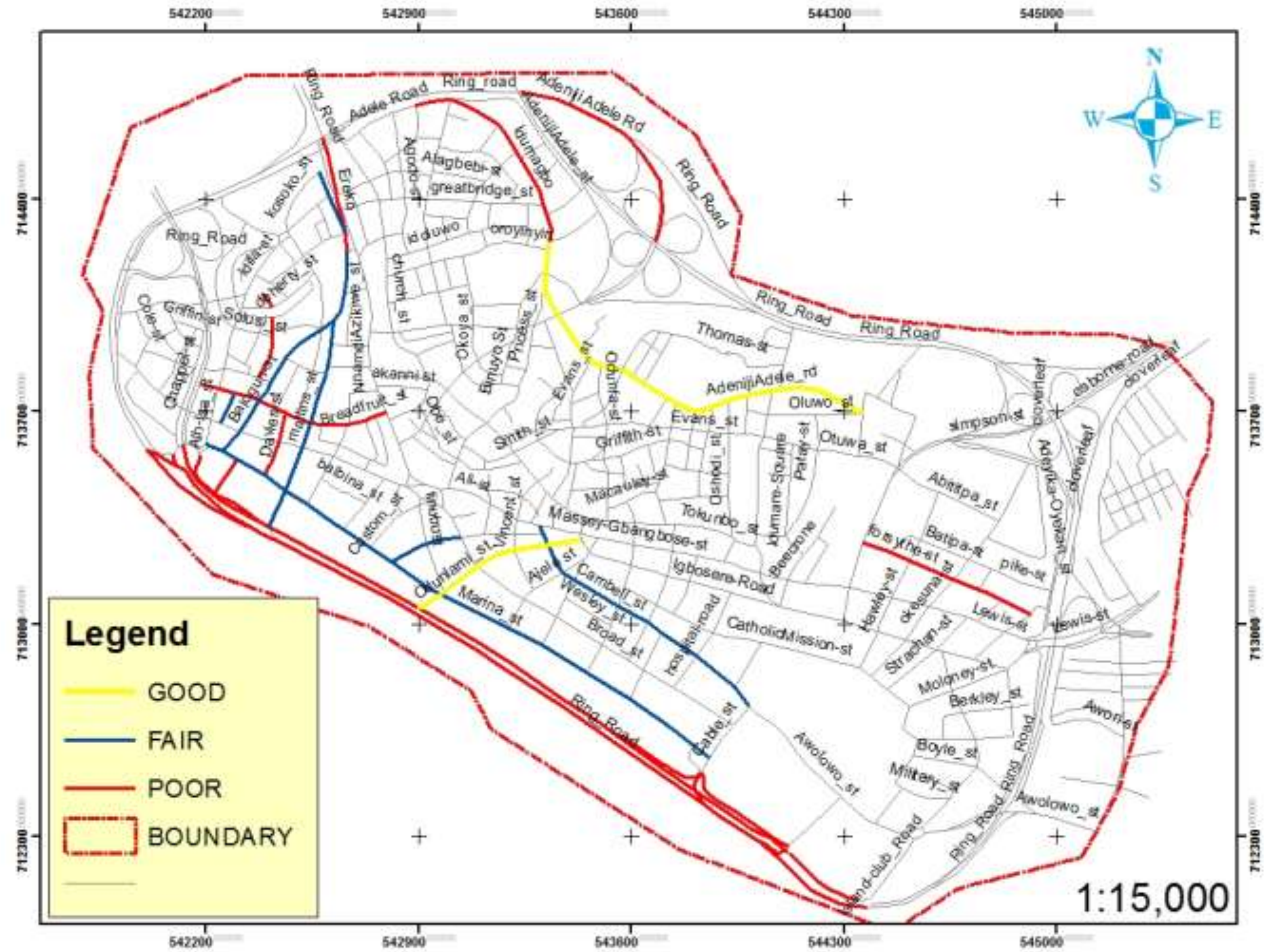
Functional Classification	Streets	Motorization	NMT	others
Arterial Street	New Cowry Bridge Marina/Carter bridge	X X		
Collector Street	Inner Marina Broad Street Nnamdi Azikwe Street King George V Road	X X X	X X X	X X X
Local Street	Idumagbo Avenue Outer Marina	X X X X	X X X	X X X X

Functional Classification	**Streets**	**Motorization**	**NMT**	**others**
	Adeniji Adele Street Martins Street Balogun Street Odulami Street Ereko Street New Balogun Street Campbell Street Breadfruit Street Abibu Oki Street Davies Street Kakawa Street Force Road Oloto/Fosbery Road	X X X X X X X X X X X	X X X X X X X X X X X X	X X X X X X X X X X X

Source: Author's household survey, October 2016©

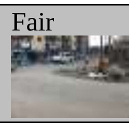
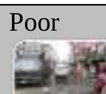
A multipronged inventory of selected highway systems was conducted to determine roadworthiness and the level of streetscape sustainability. The data was analyzed to determine the types of roadways within the CBD that are not pedestrian friendly (see the figure 95). In addition to the figure 95, Table 109 indicates that more than 86% of these selected roads within the CBD were ranked below average. In nearly all cases, they are unsafe for both vehicles and pedestrians and only 12% of the road network is considered safe. The majority of the roadways in the study area are in a dire state of disrepair, with pot-holes, peel-offs, and uneven surfaces. The field inventories show low to moderate rankings and the roadways can be described as poor, unregulated, chaotic, inefficient, low quality and dangerous.

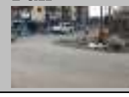
Figure 95: Condition of selected road network systems in the study area



Source: Author's household survey, October 2016©

Table 109: Condition of selected road network systems in the study area

Selected roads	Good 	Fair 	Poor 
Abibu Oki Street	●		
Adeniji Adele Street			●
Balogun Street		❖	
Breadfruit Street			●
Campbell Street		❖	
Davies Street			●
Ereko Street			●
Force Road			

Selected roads	Good 	Fair 	Poor 
Idumagbo Avenue			●
Kakawa Street		❖	
Marina		❖	
Market Street		❖	
Martins Street		❖	
New Balogun Street			●
Odulami Street	●		
Oloto/Fosbery Road			●
Outer Marina			●
%	12	35	53

Source: Author's household survey, October 2016©

The poor state of the road hierarchies means that they cannot support a pedestrian system. Furthermore, there is a high level of disconnection along the entire road network within the CBD. The highway system also shows a lack of cohesiveness and orderliness as motorists struggle to find parking. The poor state and inefficiency of the road network are primarily responsible for traffic congestion as well as pedestrians' inability to navigate the road (see Plate 23).

Plate 23:Pedestrians struggling with vehicular transport

Tinubu square area

Adeniji Adele Area

Adeniji Adele Area

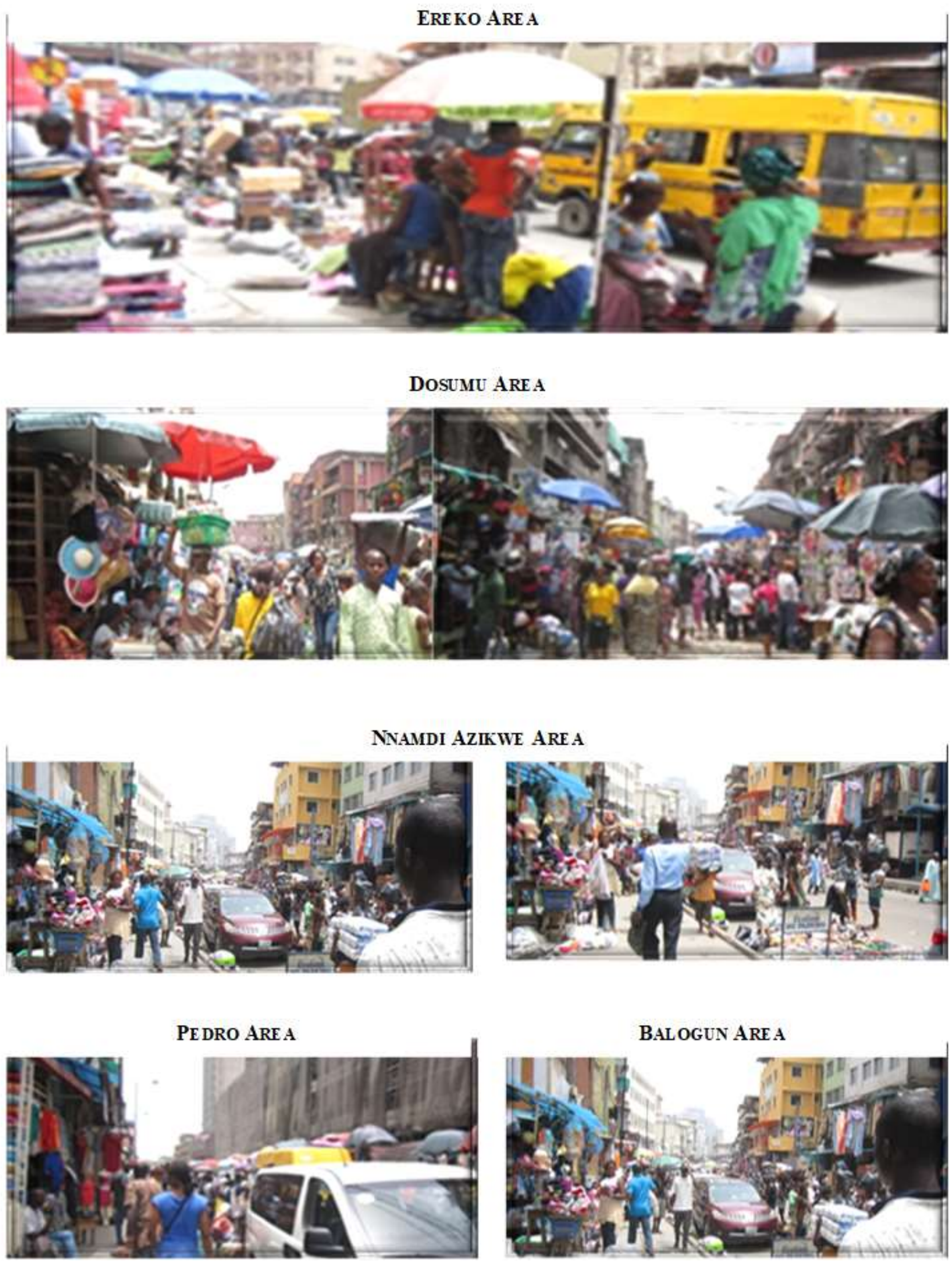
Campos Area

Odunlami Area

Source: Author’s household survey, October 2016©

Rapid growth in ownership of private vehicles, combined with reliance on other transport modes including "Danfo," Taxis, "Okada," and Keke Marwa" have resulted in extreme traffic congestion throughout the Lagos Island CBD. About 200 km of roads in Lagos Island CBD are frequently congested, with hypothetically more than 300,000 vehicles using them on a daily basis. The more than 500,000 people that pass through the CBD add to the congestion. Using the tactical urbanism approach, the study found that many road spaces in the CBD have become parking lots. Moreover, unregulated informal traders openly display goods on roadways. Plate 24 shows typical encroachment of roads by unauthorized users such as street hawkers.

Plate 24:Encroachment of roadways by unauthorized users such as street hawkers



Source: Author's household survey, October 2016©

This hampers the free flow of traffic and negatively affects economic development and the quality of life. It also results in significant safety and security concerns among pedestrians as well as raising health issues due to the level of pollution.

9.2.1.2 Footbridges

Footbridges promote pedestrian travel and safety. The inventory of existing footbridges in the study area identified three areas with pedestrian footbridges, Apongbon, the CMS bus stop, and Iddo, Idumota (see Table 110).

Table 110: Location of footbridges

Location of footbridges	Construction materials	Condition	Year	Picture
Apongbon	Concrete	Very Good	2000	
CMS	Concrete	Very good	2004	
Iddo	Concrete	Good	2001	

Source: Author's household survey, October 2016©

The number of footbridges is not in keeping with the population threshold. It was estimated that 800,000 people inhabit the study area that is served by just three pedestrian bridges. This equates to 266,000 people per footbridge. This once again points to the need to improve the pedestrian environment in the study area. Without sufficient footbridges, safety, accessibility, and walkability are compromised. The study also revealed underutilization of the existing pedestrian footbridges (see Plate 25). Asked why this was the case, the respondents cited their distance from the nearest bus stop and other land uses, the activities of informal sector operators, safety and security issues, and a lack of sufficient lighting.

Plate 25:Pedestrian bridge located at CMS and pedestrians seen not using the pedestrian footbridge at Apongbon

Source: Author's household survey, October 2016©

The authorities are of the view that taxpayers' money should not be spent on extending facilities that will not be used. However, a government official that was interviewed felt that the government should embark on aggressive efforts to sensitize residents on this issue.

9.2.1.3 Sidewalks

Sidewalks play a central part in enabling community members to walk safely. Studies demonstrate that the availability of sidewalks influences routes choices in the CBD. The field inventory indicated a dearth of dedicated sidewalks in the study area. No pedestrian sidewalks were found in the central areas of the CBD. In areas within the CBD originally designed for cars, sidewalks are often missing. Plate 26 illustrates the lack of dedicated sidewalks on selected roadways.

Plate 26:The lack of sidewalks on roadways in the study area and roads in typical poor condition with the footpaths ending abruptly

Idumagbo Area

Olusi

Broad Street

Broad Street

Source: Author's household survey, October 2016©

The study also found that, where sidewalks are available, they often end abruptly (see Plate 27 below).

Plate 27:Sidewalk ending abruptly in the study area

Source: Author's household survey, October 2016©

Furthermore, the sidewalks in the CBD are in a sorry state (see Plate 28 below), suggesting poor management and maintenance.

Plate 28:The sorry state of sidewalks in the CBD

Source: Author's household survey, October 2016©

The field inventory also found that sidewalks are used for purposes other than that for which they were designed, with street traders and other informal sector operators setting up shop on sidewalks throughout the area (see Plate 29).

Plate 29:Street traders and other informal sector operators displaying their goods on the sidewalks

Source: Author's household survey, October 2016©

The synthesis of the field inventories generated by this study provides substantial evidence that the state of pedestrian sideways in the study area is not satisfactory, calling for urgent action to be taken.

9.2.1.4 Crosswalks

Plate 30: Crosswalk in Marina, Lagos Island CBD

Source: Author’s household survey, October 2016©

Studies have found that improved crosswalks can have a positive impact on commercial activities. Creating a workable community starts with the built environment. Although there are some crosswalks in the study area (see Plate 30) however they are not sufficient to support walking as a paramount facet of a CBD and economic activities. The study found that most streets in the Lagos Island CBD have no sufficient crosswalks. This results in a high level of jaywalking (see Figures Plate 31 and 32).

Plate 31: Pedestrians dashing across the road

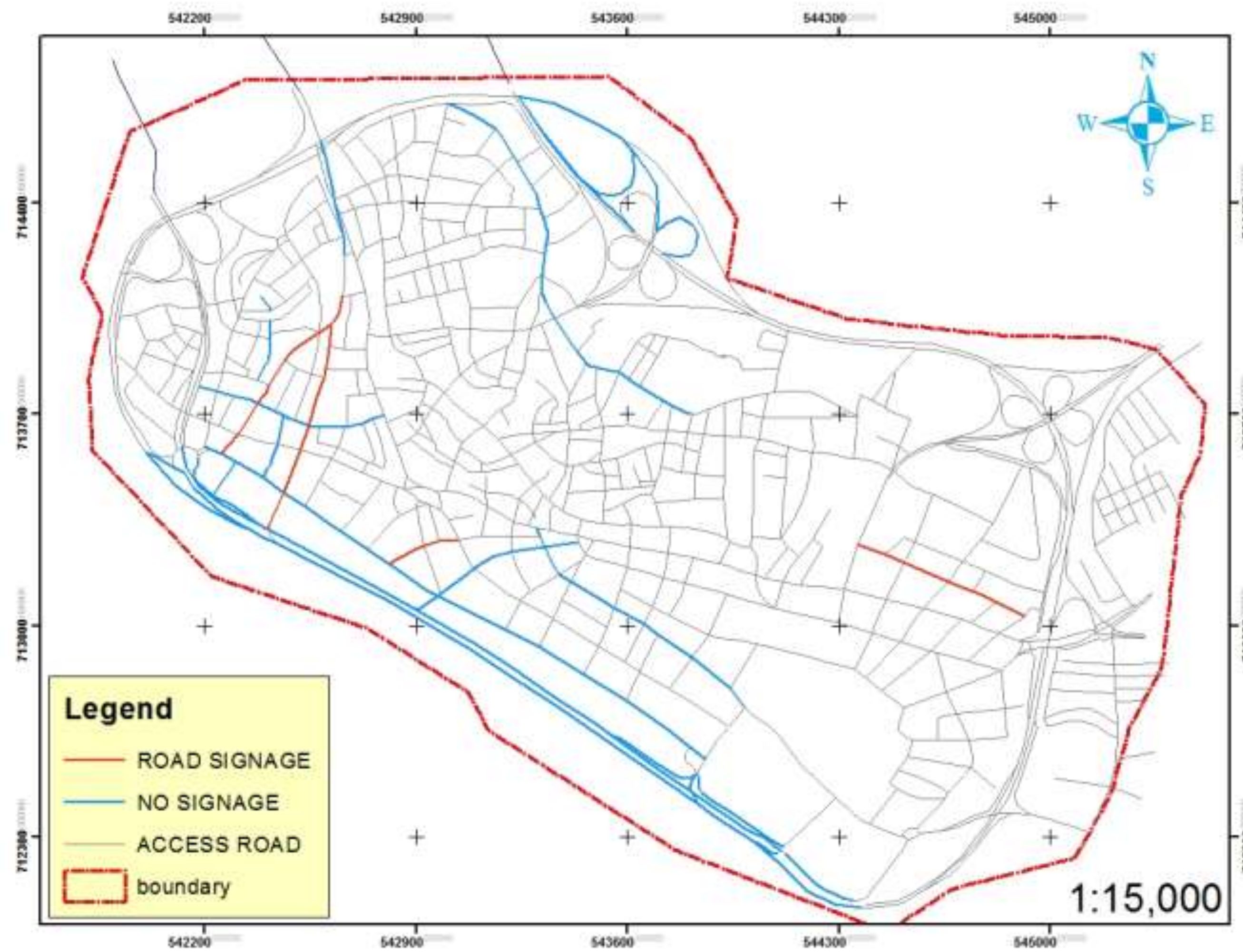
Source: Author’s household survey, October 2016©

Plate 32: Examples of jaywalking in the study area

Source: Author’s household survey, October 2016©

The study also found that seven of the seventeen selected streets do not have pedestrian crossing facilities (see Figure 96)

Figure 96: Streets with and without pedestrian crossing facilities



Source: Author's household survey, October 2016

Table 111 below shows, that, only 29% of these streets have pedestrian crossing facilities, while 71% had inadequate pedestrian crossing facilities. This causes conflict between pedestrians and drivers of vehicles.

Table 111: Streets with and without pedestrian crossing facilities

Selected roads	Yes	No
Abibu Oki Street		▪
Adeniji Adele Street		▪
Balogun Street	●	
Breadfruit Street		▪
Campbell Street		▪
Davies Street		▪
Ereko Street		
Force Road	●	
Idumagbo Avenue		▪
Kakawa Street	●	
Marina		▪
Market Street		▪
Martins Street	●	
New Balogun Street	●	
Odulami Street		▪
Oloto/Fosbery Road		▪
Outer Marina		▪
%	29	71

Source: Author's household survey, October 2016©

9.2.1.5 Signage

Pedestrian infrastructure, including traffic signals (traffic lights) and road markings (pedestrian crossings) are necessary to ensure pedestrian safety in core commercial and residential areas. Table 112 shows that only 24% of the selected streets have adequate pedestrian signage while 71% have inadequate signage. The majority of roads in the Lagos Island CBD do not have adequate road markings and traffic signals. Where these are present, they do not adhere to accepted design standards and guidelines (see Plate 33). This compromises the safety of both pedestrian and vehicular traffic.

Table 112: Streets with and without pedestrian signage facilities

Selected roads	**Yes**	**No**
Abibu Oki Street		▪
Adeniji Adele Street		▪
Balogun Street		▪
Breadfruit Street		▪

Selected roads	Yes	No
Campbell Street		▪
Davies Street		▪
Ereko Street		▪
Force Road	●	
Idumagbo Avenue		▪
Kakawa Street	●	
Marina		▪
Market Street		▪
Martins Street	●	
New Balogun Street	●	
Odulami Street		▪
Oloto/Fosbery Road		▪
Outer Marina		▪
%	24	76

Author's household survey, October 2016©

Plate 33:Improper placement of signage in the study area

Source: Author's household survey, October 2016©

Participants' evaluation of existing pedestrian facilities

This section identifies the adequacy of existing pedestrian facilities in the study area with a view to identifying gaps. A public opinion survey was conducted to determine the participants' level of awareness of pedestrian infrastructure and identify constraints as well as potential opportunities and solutions to improve intra-urban pedestrian safety in the study area.

Existing state of intra-urban transportation services and support for the pedestrian system

The participants were asked to comment on the current state of intra-urban transportation services and support for the pedestrian system. Table 113 presents the results.

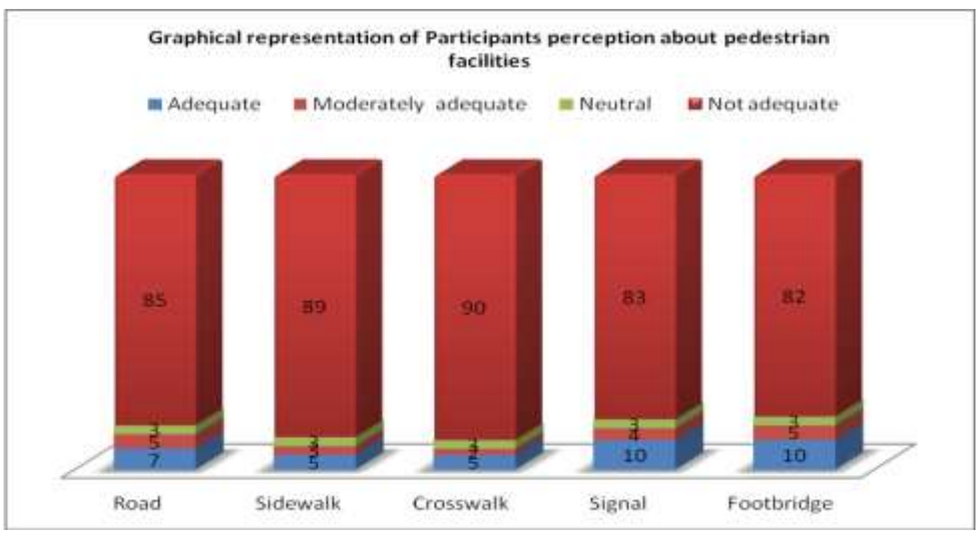
Table 113: Participants' perceptions of pedestrian facilities

Parameters	Road		Sidewalks		Crosswalks		Signage		Footbridges	
	%	No	%	No	%	No	%	No	%	No
Adequate	7	53	5	38	5	38	10	76	10	76
Moderately satisfactory	5	38	3	23	2	15	4	30	5	38
Neutral	3	23	3	23	3	23	3	23	3	23
Not adequate	85	641	89	671	90	679	83	626	82	618
Total	100	755	100	755	100	755	100	755	100	755

Source: Author's household survey, October 2016©

Using a marginal error of (±) 5, 85% of the 755 sampled participants were of the opinion that intra-urban pedestrian facilities in the study area are far from adequate to support pedestrian system. Figure 97 summarizes these findings.

Figure 97: Graphical representation of participants' perceptions of pedestrian facilities



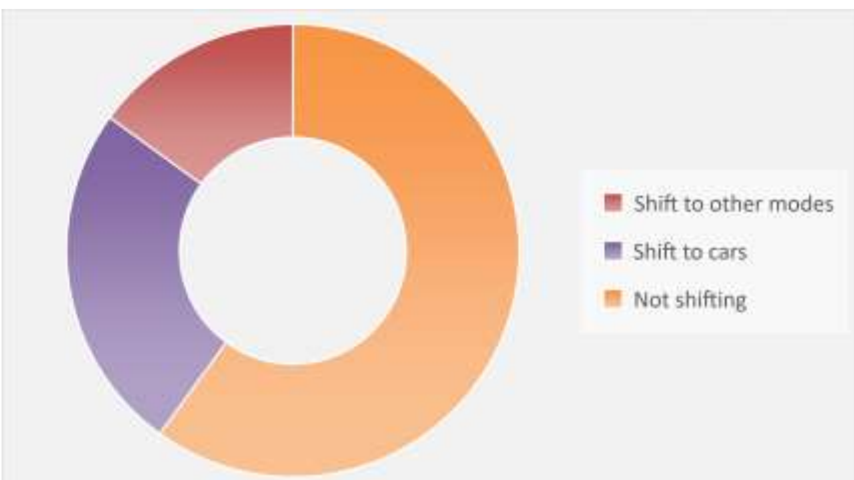
Source: Author's household survey, October 2016©

While 3% of the sample remained neutral on this issue, only 7% indicated that the existing intra-urban pedestrian facilities adequately support the pedestrian system and 5% felt that such services are moderately adequate in supporting the pedestrian system in the CBD. This confirms the findings of previous studies that found that, intra-urban pedestrian facilities in the CBDs of developing countries are inadequate to support the pedestrian system and pedestrians' safety. Government is thus called upon to address this situation.

Anticipated shift in travel modes

The participants were asked if they would switch to another transport mode should pedestrian infrastructure remained unchanged. Figure 98 shows that, around 15% of the sampled participants would shift from walking to other transportation such as public transit, while 25% would consider changing to the vehicular mode. Interestingly, 60% would not change their transportation mode. These results are statistically and significantly different and project mixed feelings among the sampled population

Figure 98: Anticipated shift in travel modes



Source: Author's household survey, October 2016©

9.2.2: Personal security and access to pedestrian spaces

Given the growing urban population, security of life and property are major concerns. Table 114 illustrates that concerns for personal safety are barriers to walking in the Lagos Island CBD.

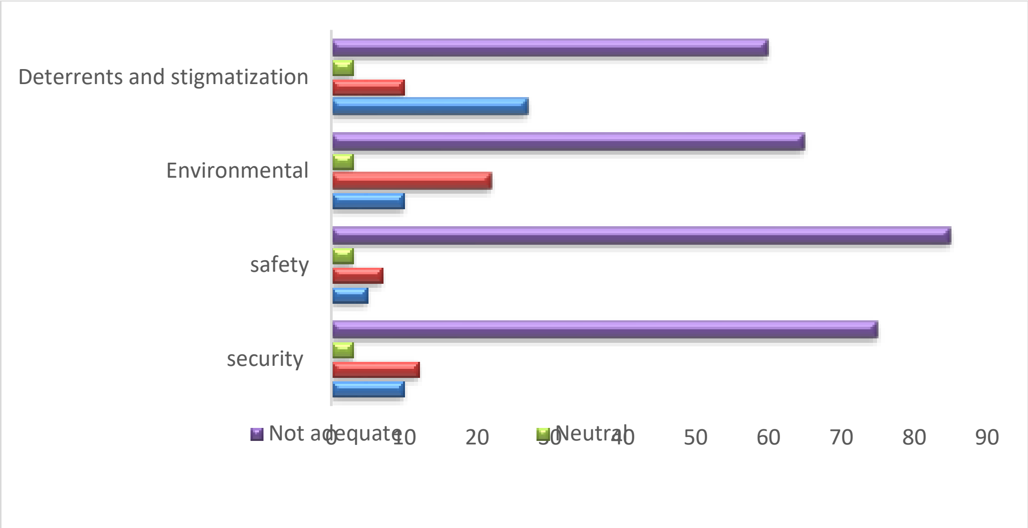
Table 114: Deterrents to walking in Lagos Island CBD

	Security		Safety		Environmental		Deterrents and stigmatization	
	%	No	%	No	%	No	%	No
Adequate	10	7	5	9	10	4	27	6
Moderately Adequate	12	9	7	13	22	8	10	2
Neutral	3	2	3	6	3	1	3	1
Not adequate	75	58	85	161	65	25	60	14
Total	100	76	100	189	100	38	100	23

Source: Author's household survey, October 2016©

Seventy-five per cent of the participants stated that security concerns impede walkability in the Lagos Island CBD, with 12% feeling that personal security is moderately adequate, 10% stating that it is adequate and 3% of the participants remaining neutral. It is thus evident that personal security concerns restrict people from walking in the Lagos Island CBD, especially after dark due to poor street lighting. One participant pointed out that women avoid having to walk alone at night, while another stated that women often feel unsafe in the locality due to the presence of miscreants on the footbridges, especially after 7 pm. These findings are consistent with those of previous studies that found that concerns relating to personal security are a major reason for the poor walkability of African cities. Additional graphical information is in Figure 99

Figure 99: Deterrents to walking in Lagos Island CBD



Source: Author's household survey, October 2016©

9.2.3: Personal safety and access to pedestrian spaces

Figure 105 also shows, that, 85% of the sampled population felt that the personal safety of pedestrians is not satisfactory in the Lagos Island CBD, while 7% felt that it was moderately adequate, and 10% adequate and 3% remained neutral. Many pointed out that pedestrians' fear being attacked in isolated or potentially risky areas. Once again, these results are consistent with those of similar studies.

9.2.4: Physical environmental issues

Figure 105 illustrates, that environmental problems are another key factor that limits walking in the Lagos Island CBD. Sixty-five of the participants surveyed felt that the state of the environment is not adequate; 35% believe that it is moderately adequate; 22% described it as adequate and 3% remained neutral. Plate 34 below shows uncovered drains in the study area.

Plate 34:Uncovered drainage systems

Source: Author's household survey, October 2016©

The study area shows signs of a decaying environment that is not suitable for walking. While the Lagos Island CBD is the largest and most unique shopping destination, it is not aesthetically pleasing and unattractive for walking (see Plate 35). This confirms the findings of previous studies in this area.

Plate 35:Refuse indiscriminately disposed of on the sidewalk

Source: Author's household survey, October 2016©

9.2.5: Potential social deterrents and stigmatization

Social perceptions and stigmatization of walking were cited by 60% of the sample population as an impediment to walking in the Lagos Island CBD as walking is associated with poverty.

9.3: What can be done to improve walkability in the Lagos Island CBD?

9.3.1: Major priorities in improving the intra-urban pedestrian system

The study participants were asked to identify the major priorities in improving the intra-urban pedestrian system. Table 115 shows the rating parameters, with a maximum score of 5 (significantly important) and a minimum of 1 (least important).

Table 115: Rating Parameters

Parameters	Characteristics
1	Least important
2	Less important
3	Average
4	Important
5	Significantly important

Source: Author's household survey, October 2016©

Within a margin of error of (±) 5%, 40% of the sample rated pedestrian infrastructure as the major issue requiring immediate attention (see Table 116). This is followed in order of priority by personal safety (39%), social deterrents (8%), personal security (7%) and physical environmental issues (6%). In other words, 60% of the sampled participants felt that personal safety, social deterrents, personal security and physical environmental issues should take priority in improving the intra-urban pedestrian system, with 40% opting for pedestrian infrastructure. The responses thus reveal mixed results.

Table 116: Ranking of different types of pedestrian improvements

Parameters	%	Weight	Ranking
Physical environmental issues	6	45	1
Personal security	7	53	2
Social deterrents	8	60	3
Personal safety	39	294	4
Pedestrian infrastructure	40	303	5
Total	100	755	

Source: Author's household survey, October 2016©

9.4: Walkability audit

In addition to context-based planning analysis, various tools and techniques are available to measuring walkability. Understanding walkability patterns involves determining how environments work for or against walking and living. Walkability audits are a primarily tool in assessing the pedestrian environment. Questions have been raised in recent studies with regard to how best to tackle the issue of walkable cities and pedestrian safety challenges using survey information. The field study indicated that as much as a quarter of the built Lagos Island CBD environment is not pedestrian-friendly, with no accessible walking facilities and fundamental safety challenges. Table 117 lists the primary features used to audit walkability in the study area. All the parameters were given equal weight in calculating the total walkability rating.

Table 117: Primary features of walkability

Features	Explanation
Connection	Are road systems providing direct access for walkers to the places they intend to go?

Legibility	Are there clear indicators for walking, especially for residents and transients?
Comfortable	Are highway systems comfortable for walkers?
Convenient	Are highway systems convenient for walkers?
Pleasant	Are highway systems walker-friendly?
Safe	Are highway systems safe for walkers?
Secure	Are highway systems secure for walkers?
Universal	Are road networks global for walkers?
Accessible	Are highway systems within convenient walking distance?
Others	Other points

Source: Author's household survey, October 2016©

Table 118 below summarizes the audit results. Only three of the 15 selected roads within the study area were found to be moderately walkable, while four were reasonably walkable and seven were walkable. Based on the results, some roads in the study area are not pedestrian friendly

Table 118: Walkability of selected roads in the study area

Point	5	5	5	5	5	5	5	5	5	5	50	%
Walkability level/Selected roads	1	2	3	4	5	6	7	8	9	10	Scores x2	%
Balogun Street	1	1	1	1	1	1	1	1	1	1	10	20
Odulami Street	1	1	1	1	1	1	1	1	1	1	10	20
Ereko Street	1	1	1	1	1	1	1	1	1	1	10	20
Force Road	1	1	1	1	1	1	1	1	1	1	10	20
Abibu Oki Street	1	1	1	2	1	1	1	1	1	1	11	22
Adeniji Adele Street	2	1	1	3	1	1	1	1	1	1	14	28
Oloto/Fosbery Road	3	2	2	2	1	1	1	1	1	1	15	30
New Balogun Street	1	2	2	2	2	2	2	2	1	1	17	34
Kakawa Street	1	2	2	2	2	2	2	2	2	1	18	36
Outer Marina	2	2	2	2	2	2	2	2	2	1	19	38
Campbell Street	2	2	2	2	1	2	2	2	2	1	19	38
Davies Street	2	2	2	4	2	2	2	2	2	1	21	42
Breadfruit Street	2	2	2	4	2	2	2	2	2	1	21	42
Martins Street	2	2	2	4	2	2	2	2	2	1	23	46
Idumagbo Avenue	3	2	2	4	2	2	2	2	2.5	1	24	48

Source: Author's household survey, October 2016©

Table 119: Categorization of walkability level of selected streets in the study area

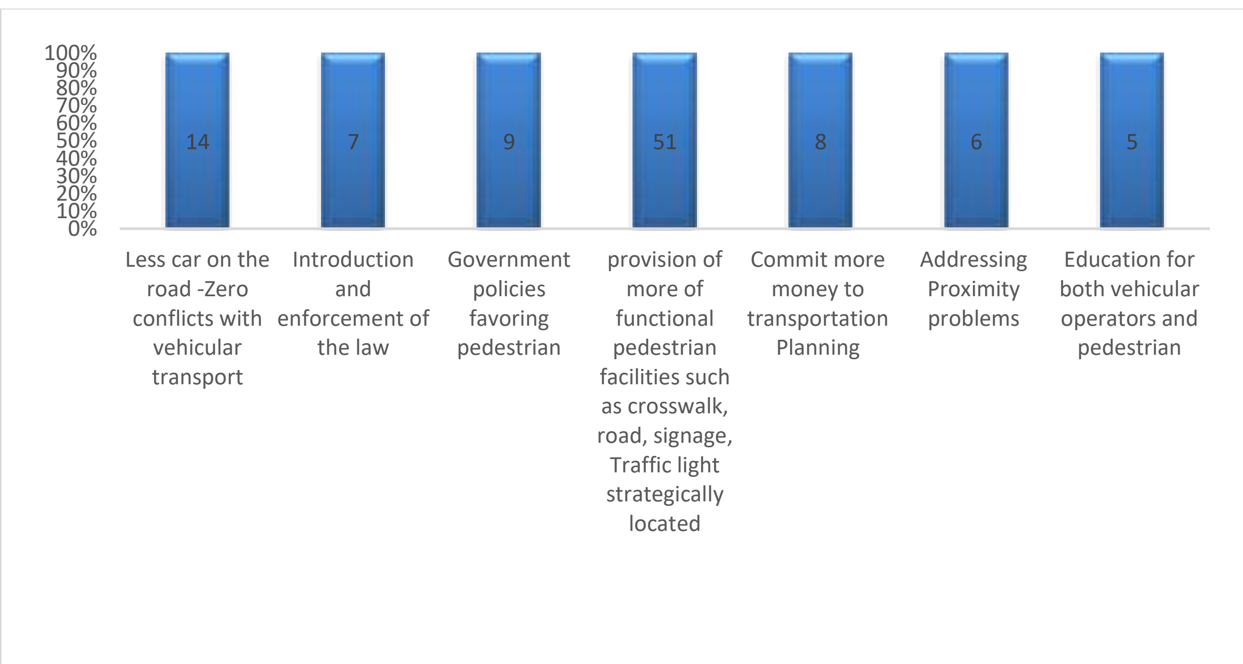
Not walkable	Poorly walkable	Moderate walkable	Walkable	Very walkable
0-30% Score	30-40%	41-50	51-60	61-100
Balogun Street, Odulami Street Ereko Street, Force Road, Oloto/Fosbery Road, Adeniji Adele Street,	New Balogun Street, Campbell Street Kakawa Street, Outer Marina Campbell Street	Breadfruit Street, Abibu Oki Street, Martins Street	None	None

Source: Author's household survey, October 2016

9.5: Participants' recommendations to create a vibrant intra-urban pedestrian system in the Lagos Island CBD

Given concerns regarding pedestrian safety the participants were requested to provide recommendations and comments on improvements to pedestrian safety in the study area. Figure 100 shows, that, 51% of the sample population cited improved pedestrian facilities such as safe crossing at intersections, the strategic location of traffic lights, and zero conflict with vehicular transport. A further 9% felt that the government should adopt legislation to encourage walking and discourage motorized traffic and 7% opted for the introduction and enforcement of laws that protect pedestrians. Fourteen per cent of the participants felt that fewer cars should be allowed on the roads; 5% advocated for pedestrian education; 9% were of the opinion that the government should commit more financial resources to transportation development, primarily pedestrianization; 6% stated that more functional pedestrian facilities should be provided close to the CBD and 8% opted for expanded spending on transportation.

Figure 100: Participants' recommendations on measures to improve the pedestrian system in the Lagos Island CBD



Source: Author's household survey, October 2016©

Adopting these recommendations would create a more sustainable CBD, improve pedestrian safety and meet current needs without compromising future ones.

9.6 The Chapter summary:

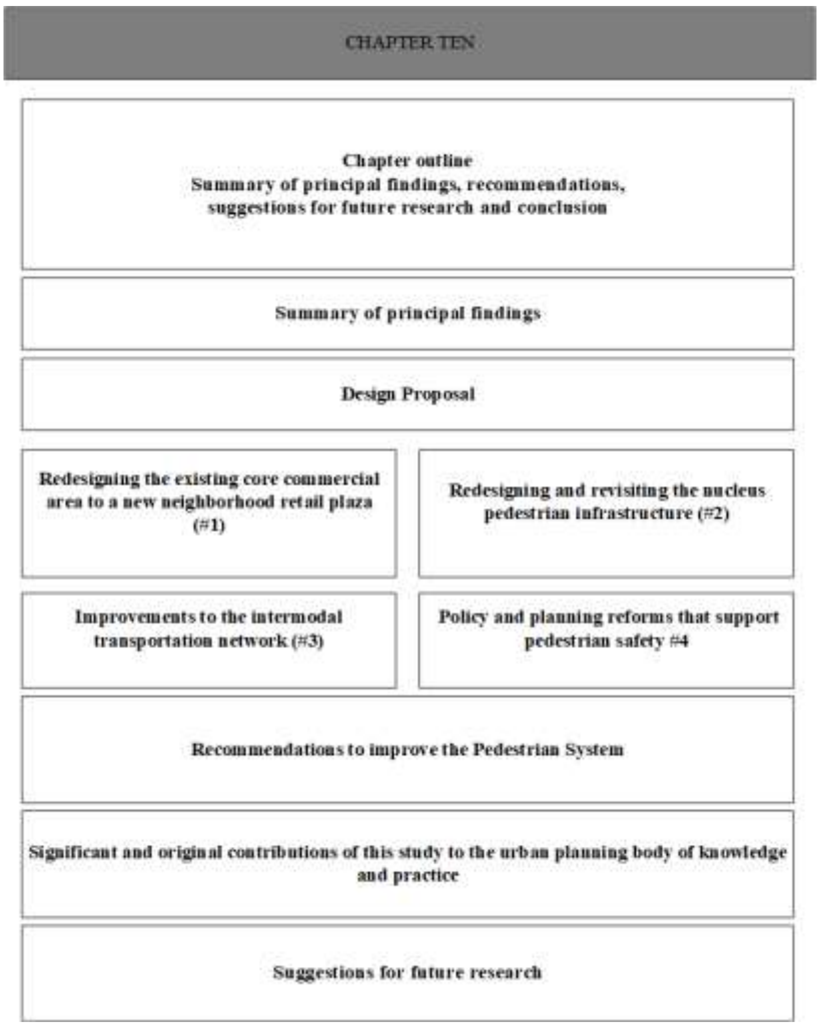
This chapter presents the challenges that confront the pedestrian system in Lagos and most importantly the study area. It is also a continuation of data presentation. Some of the comments alluded to in the last chapters also apply to this chapter, thus revealing substantially the pedestrian situation in Lagos.

10. CHAPTER TEN - SUMMARY OF PRINCIPAL FINDINGS, RECOMMENDATIONS, AND SUGGESTIONS FOR FUTURE RESEARCH

10.1: Chapter outline

This chapter provides summary of principal findings, recommendations, suggestions for future research and conclusion. Figure 101 below provides snapshot of comprehensive chapter ten outline.

Figure 101: Chapter nine outline



Source: Author's construction (2016) ©

10.2: Summary of principal findings

1) The data on the transportation mode used in total journeys to work in the study area showed that 55% of the sampled population cited walking, and 34% and 11% used private vehicles and other modes of transport, respectively.

2) Multiple, competing inter-modal and non-integrated modes of intra-urban mobility (walking, vehicular, public and other systems) were identified.
3) Private vehicles were used for more than a quarter of daily trips. Furthermore 75% of those using such transport reported that they do so due to that fact that public transport is grossly inadequate, inaccessible or unavailable.
4) The distribution of travelers during the day shows that apart from walking, private vehicles are the most common form of transport. The vast majority (80%) of the study participants that reported that they drove to the CBD on a daily basis were men.
5) The study revealed that more than 5,000 private vehicles enter the Lagos Island CBD per hour on a typical weekday. This translates to approximately 60,000 cars in 12 hours. However, with only two organized public parking spaces, parking is grossly inadequate, and this explains why there is heavy congestion in the core CBD.
6) The traffic flow is lighter over weekends; the study found that approximately 2,000 private vehicles enter the Lagos Island CBD per hour on a typical weekend day. This translates to around 24,000 cars in 12 hours. Once again however, there is not enough parking to accommodate these vehicles, resulting in heavy congestion in the core CBD over the weekend.
7) The survey revealed that 37% of the sampled Lagos Island households had three or more vehicles, with 22% and 42% having two automobiles and not owning a one, respectively.
8) The speed at which vehicles travel has significant implications for pedestrian safety. The data indicated that around 60% of the drivers observed during the free flow of traffic were travelling at 50km/h; 35% were doing 40km/h and 5% were travelling at a speed of less than 30km/h. Traffic engineering studies confirm that the higher the speed, the less the time a driver has to stop in order to avoid a collision.
9) Research shows that a car traveling at 50 km/h and 40 km/h typically requires 13 meters and 8.5 meters, respectively to stop. Adding 1 km/h results in a 3% higher risk of a collision involving injuries, with a 4 to 5% increase in accidents that lead to pedestrian fatalities.
10) Eight-five per cent of the study participants indicated that excessive vehicular transportation has safety implications, while 12% disagreed and 3% of the participants remained neutral on this issue. Thus, the large majority of the respondents felt that excessive use of vehicles makes walking unsafe.

11) Given the high volume of vehicles on the roads in the Lagos Island CBD and the Lagos Metropolitan area, pollution levels are also high, with negative health implications and threats to environmental sustainability.
12) In light of these findings, the study sought solutions to the identified challenges in the form of an improved intra-urban pedestrian system and public transport.
13) The study established that the majority of the participants were pedestrians and thus confirmed that walking is a crucial form of mobility among low and middle income-earners.
14) It was established that 50% of the daily trips made by the study participants were on foot. This finding is consistent with those of previous studies.
15) In sub-Saharan Africa, pedestrian activity accounts for close to 50% or more of daily trips in CBDs. For example, walking accounts for 81% of all trips in Dakar (Senegal), 70% in Addis Ababa (Ethiopia), 60% in Bamako (Mali), 47% in Nairobi (Kenya), and 42% in Ouagadougou (Burkina Faso).
16) It was found that the choice of transport mode is influenced by the purpose of the trip.
17) The data show that the participants walked to work and to access economic and educational activities. They also travelled on foot in order to appreciate the environment, for health and recreational purposes, and to shop and attend social events. The correlation coefficient stands at 85% for walking for these purposes.
18) The empirical test indicated an average 82% probability that walking and economic, educational and environmental activities, health, recreation, shopping, social events and exercise are connected. The simulation test shows an active, positive correlation coefficient between walking and inherent benefits.
19) The overall conclusion was that walking does not require significant infrastructure investment. It does not cause congestion but rather feeds urban life.
20) Walking does not consume fossil fuels or create greenhouse gas emissions. It is universal and inclusive. Last but not least, walking costs almost nothing and, therefore, there can be little commercial interest in promoting it.
21) A closer look at the data reveals that the features of the walking trip rather than the purpose impacts the choice of transportation mode. For example, the comparatively higher level of walking for work-related trips in the Lagos Island CBD is due to the fact that this is a predominantly commercial nerve center.

22) The frequency distribution shows that 75% of the participants sampled confirmed undertaking one to two walking trips per day. On the other hand, at the 95% confidence interval, 15% of the total sample confirmed taking two to three walking trips per day.

23) Five per cent of the total population made three to four walking trips per day and 2% and 3%, respectively undertook less than one and four to five walking trips a day.

24) The morning peak period is between 8.15 and 8.30am. It was found that, on average, 15,000 pedestrians arrive in the Lagos CBD every two hours from Monday to Friday. This translates to an average of 180,000 in a 12-hour day, 5,400,000 per month and 1,971,000,000 per year.

25) When the respondents were asked to identify the safest transportation mode, 75% cited walking. However, the lack of pedestrian facilities in roadway design and poor land-use planning hampers walking in the study area.

26) Roadway design and land use in the Lagos Island CBD favors vehicular traffic and neglects the needs of pedestrians. This analysis shows that controlling for population threshold, mixed land use and the presence of pedestrian facilities are related to higher levels of intra-urban pedestrian travel. This study highlighted the conflict between vehicles and pedestrians, particularly in the core CBD during peak hours.

27) It confirmed that pedestrians are the primary victims of road accidents and that they were the victims in 60% of all road deaths in the Lagos Island CBD.

28) On average, 40 to 50% of all fatal accidents in the Lagos Island CBD involve pedestrians.

29) The number of fatalities in the study area is 50 times higher than in other African countries such as South Africa and Kenya, and 71 times more than in European countries and America.

30) Accidents are particularly common at traffic junctions, or where pedestrian infrastructure is nonexistent or insufficient and pedestrians are forced to walk on the road.

31) Eighty per cent of the study respondents rated the existing pedestrian facilities in the CBD as weak while 15% felt that they were satisfactory and 5% remained neutral on this issue.

32) Approximately 92% of all the surveyed roads made no provision for pedestrians.

33) When the study participants were asked to identify the top five priorities in terms of pedestrian facilities, the overwhelming majority cited wider, level and clean footpaths, followed by reduced and slower traffic on roads and removing obstacles/parking from footpaths.

34) The main barriers to pedestrian safety identified by the participants were the poor state of pedestrian facilities, a lack of public awareness about the importance of pedestrian safety,

inadequate policies and guidelines, a lack of coordination among the authorities, insufficient budgets, poor urban planning and weak implementation.

35) The study also found that, while there is abundant data on motorized traffic in Lagos State, there is a shortage of reliable quantitative data to inform pedestrian planning.

36) The Lagos State government relies on mobility statistics, including data on personal travel behavior, to formulate strategic policies and improve the efficiency of transport systems. The lack of data on pedestrianization limits its ability to plan for pedestrian travel. While walking has not disappeared from the statistics, the rate of pedestrian trips recorded is negligible compared to other modes of transport such as vehicular travel.

37) The survey identified major hindrances and problems due to inadequate planning and management. Pedestrian infrastructure and facilities remain a serious issue in the CBD.

10.3: Design plan, policies, and strategies

Transportation planning plays a significant role in creating a more secure travel environment. Traditional urban development and transportation planning undervalue the impacts and veracity of pedestrian safety-conscious. Pedestrian safety is becoming a primary environmental issue throughout the world. Many city centers are becoming safer, healthier places that are more pedestrian friendly. In line with this trend, this study advocates for a well-integrated plan to promote connectivity and improve the pedestrian system in the Lagos Island CBD and thus enhance short-, medium- and long-term sustainability. These sustainability approaches focus on the proposed pedestrian planning areas and feature tools as indicated in Table 120 below. These approaches involve prioritizing and setting standard for implementation of pedestrian policy and/or incorporated in new policy as the expected results will enhance the role of central business Districts within the national urban system.

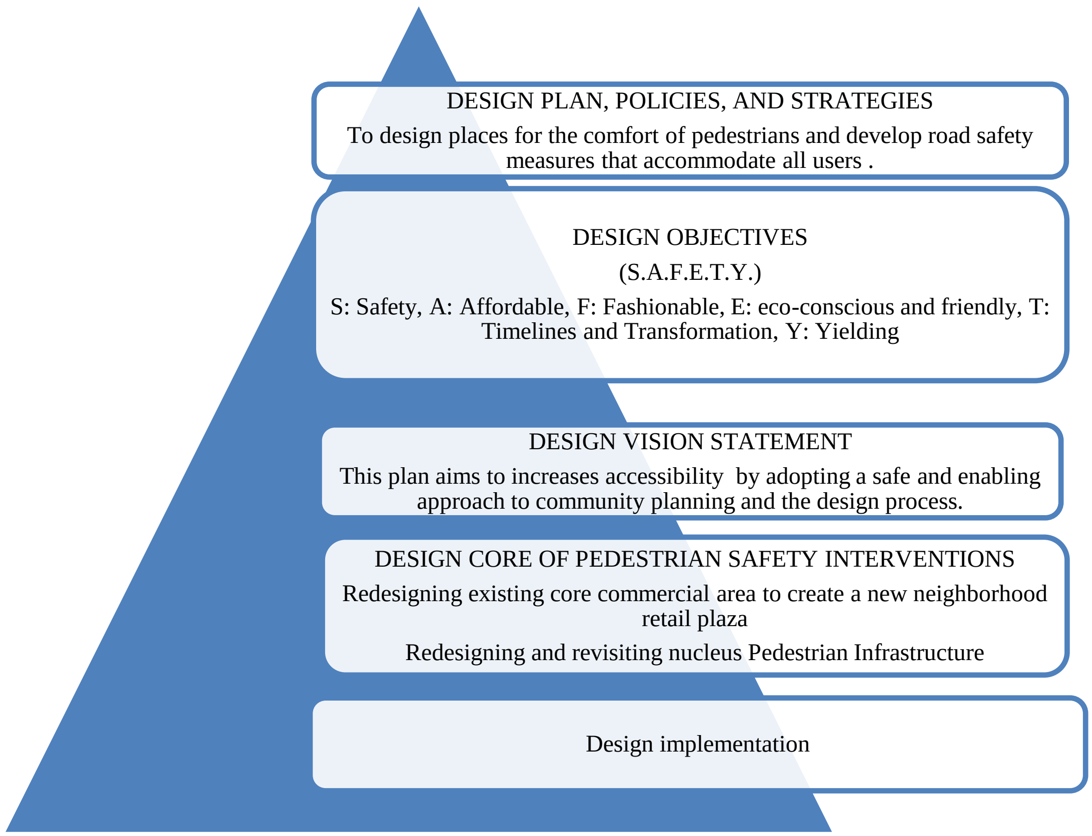
Table 120:Proposed Pedestrian improvement strategies and feature tools

The proposed pedestrian Planning areas and features tools	**Spatial Planning** **Planning and redesign of cities** **Urban densification plan** **Mixed land use plan**	**Transportation Planning** **Public and Mass transport**	**Transportation Planning** **Public and Mass transport**	**Urban Management & Urban Resilience** **Capacity development** **Public involvements**
Strategic objectives	Creating spatial structures that support pedestrian and other transports modes	Ensuring sustainability Improving pedestrian infrastructure and Transport networks	Providing a pedestrian comprehensive strategy for enhancing socio-economic growth as well as optimizing economic agglomeration	Developing a comprehensive legal and institutional framework for pedestrian system Building the resilience CBD by creating green urban spaces Lowering the ecological footprint
Policy implementation expected results	Availability of large areas of the CBD for pedestrian development will increase commercial activities patronage Creating equitable access to transportation services will propel better economic productivity and lower negative environmental impacts	Integrating transport policies and planning for better access to housing and employment opportunities; Mobility management and intermodal network for seamless urban transport systems More accessibility and efficient transport systems; and better infrastructure for pedestrians and cyclists allowing for greater safety and livability in cities Planned and designed cities that supports pedestrian activities will generate higher levels of wellbeing, employment opportunities and sustainability	Making a CBD pedestrian friendly will propel endogenous growth and resource allocation, service delivery and livelihood increasing and coordinating public investments in the CBD through pedestrian improvement, inclusiveness and environmental conditions is the key to sustainability Sound economic development, planning and pedestrian policies implementation will have promoted social inclusiveness, equity, human approach to urban economic development, and design investment Strong urban economies will create wealth and enhance competitiveness of cities to drive economic growth	When there is an Increase in urban densities accommodating, pedestrian population is an efficient way to: Maximizes urban land use propels economic agglomeration Strengthened social interactions and reduced mobility demand Increases social heterogeneity and generates economic densities Minimizes the cities ecological footprint Green street such as pedestrian system will integrates various urban sustainability principles Pedestrian friendly streetscapes and facades, and attractive neighborhood recreational centers More inclusive communities and increased social cohesion Increased access to services and infrastructure

Source: Author's construction (2016)

For example, the public roads in Lagos State were initially designed to serve private motor vehicles. Fresh designs are required that accommodate all road users, including pedestrians, transit users, private vehicles and public transport. A comprehensive intra-urban pedestrian safety plan for the Lagos Island CBD is thus proposed. Figure 102 shows the process adopted to construct an intra-urban pedestrian safety plan for the CBD.

Figure 102: Process adopted to create an intra-urban pedestrian safety plan



Source: Author's construction (2016) ©

The proposed intra-urban transportation plan is to design places for the comfort of pedestrians and develop road safety measures that accommodate all users in the Lagos Island CBD. In general, the safety interventions and countermeasures focus on raising awareness among the public and encouraging decision-makers to improve the walking environment. Road safety interventions are proposed that are consistent with the overall goals of the transportation planning system in the Lagos Island CBD. The plan sets out key short-, medium- and long-term objectives.

10.3.1: Design Objectives

The proposed intra-urban pedestrian safety plan aims to achieve the following goals using a comprehensive **S.A.F.E.T.Y.** framework. Table 121 and Figure 103 expand on the **S.A.F.E.T.Y.** framework developed by the author.

Table 121: Snapshot of the S.A.F.E.T.Y. framework

S.A.F.E.T.Y. FRAMEWORK	Objectives
S: Safety strategy	A safety plan that sets out a realistic and innovative vision to strengthen economic activities in the CBD
A: Affordable and attractive	An affordable, attractive, safe and accessible transportation system that is welcoming to all users. This objective focuses on road safety that integrates urban mobility and other city plans alongside the environment, with a long-term, sustainable vision.
F: Fashionable	Fashionably redesigning street intersections by consciously thinking of the security of all road users. This objective focuses on building safer roadways by improving streets, and providing safe pedestrian facilities and access to public spaces in an elegant manner.
E: Eco-conscious and friendly	An eco-conscious and pedestrian friendly design encourages mixed land use development that creates a modern space for shopping and residential areas while identifying other potential opportunities for local land use activities.
T: Timelines and Transformation	Timeliness and transformation are the keys to promoting safety. This objective aims to promote intra-urban connections and comfortable walking in the CBD. The proposed design reduces the need for excessive vehicle travel and fosters more consistent vehicle speeds. More importantly, it encourages people to use mass transit and cycle and limit unnecessary motor vehicle trips.
Y: Yielding	Yielding the entire CBD to promote pedestrian-friendly streets and encourage coordinated transportation alternatives is another major objective of the proposed plan.

Sources: Author's Construction, October 2016

Figure 103: The S.A.F.E.T.Y. framework to improve intra-urban safety in the Lagos Island CBD

Source: Author's construction (2016) ©

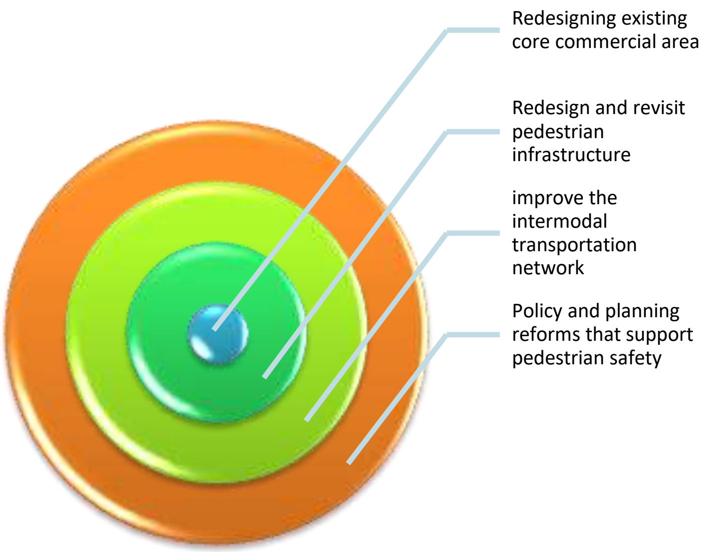
10.3.2: Design vision statement

The strategic plan aims to increase accessibility by adopting a safe-enabling approach to community planning to promote multimodal solutions and sustainable transportation design in the Lagos Island CBD. This modern design is functional and attractive and creates safe places for everyone in the area. It provides a coherent view of the changes that can be made to ensure the future of walking and sojourning in the Lagos Island CBD. The vision serves as a point of reference for evaluation of the proposed plans. It is based on knowledge of pedestrians' needs and abilities, now and in the future, as well as stakeholders' interests and priorities.

10.3.3: Design core of pedestrian safety interventions

Based on the results of the field studies, improvements in pedestrian safety are the key issue. The proposed pedestrian security measures in the Lagos Island CBD are based on a systems approach that provides a complete package. The purpose is to develop a plan and provide an optimal, and as far as possible, perfect system, where pedestrians can move and sojourn freely and vehicular operations are safe. It is proposed that the prevailing situation where roads in the Lagos Island CBD predominantly serve vehicles be replaced with eco-friendly, walkable streets. Improved pedestrian access, mobility and safety will promote a more effective mass transportation system, reduce fossil fuel consumption, and promote social justice on the roads. The design promotes accessibility to revitalize the town center. Figure 104 shows the four interrelated strategies that are part of the new design to promote pedestrian safety.

Figure 104: Interrelated strategies to improve pedestrian safety

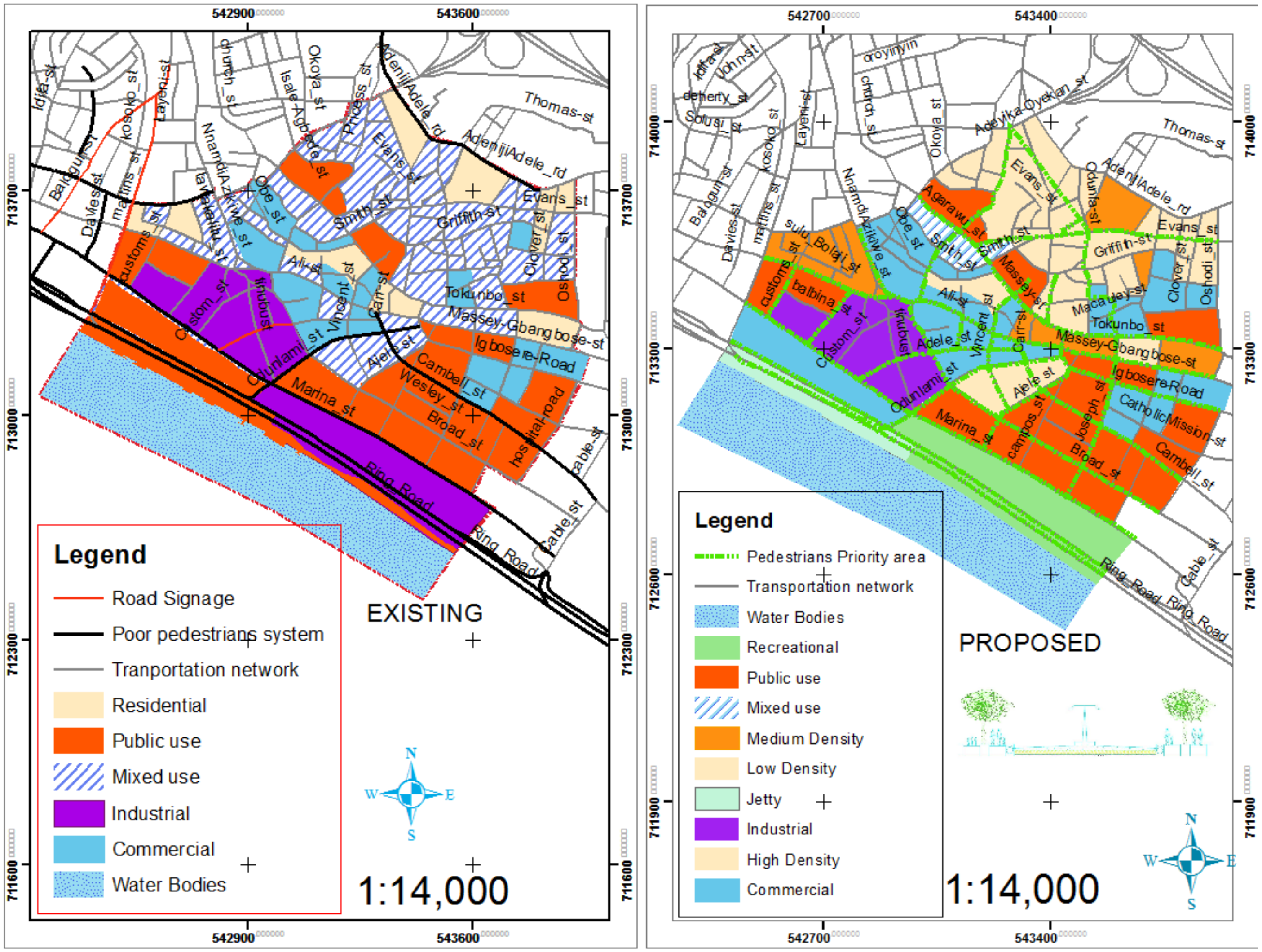


Source: Author's construction (2016) ©

Redesign the existing core commercial area to a new neighborhood retail plaza (#1)

The proposed plan creates an equitable and safe walking environment by providing a more accessible and affordable road system. The project is specifically designed to encourage walking and support sectoral or local initiatives in the Lagos Island CBD. Figure 105 sets out the prototype for the intra-urban pedestrian safety plan for the Lagos Island CBD. The left-hand side illustrates preexisting conditions while the right-hand side shows the proposed development. Redesigning the existing core commercial area to a new retail plaza involves adopting land use planning and mobility policies that favor pedestrians. This would make a significant contribution in the fight against climate change and other current environmental issues. It would reduce the total distance traveled per person and promote the use of carbon-free and public modes of transport. Comprehensive planning is imperative to design and implement the new approach. The literature notes that, in the past, reactive approaches led to ineffective solutions due to poor implementation. The proposed comprehensive planning system offers flexibility in supporting an extensive transportation network.

Figure 105: Existing pedestrian system and proposed Intra-urban pedestrian safety plan for the Lagos Island CBD



Source: Author's Construction, October 2016

Figure 105 above, Tables 122 and 123 provide a more detailed existing pedestrian system and proposed Intra-urban pedestrian safety plan for the Lagos Island CBD

Table 122 existing land use

Land use	area(hectares)	%
Waterbody	558889.965116	26.35
Residential	116669.213687	5.50
Public uses	446243.521282	21.04
Mixed used	453168.90137	21.37
Industrial	232706.142407	10.97
Commercial	153219.522485	7.22
Circulation	159993.38238	7.55
Total	2120890.648727	100

Source: Author's Construction, October 2016

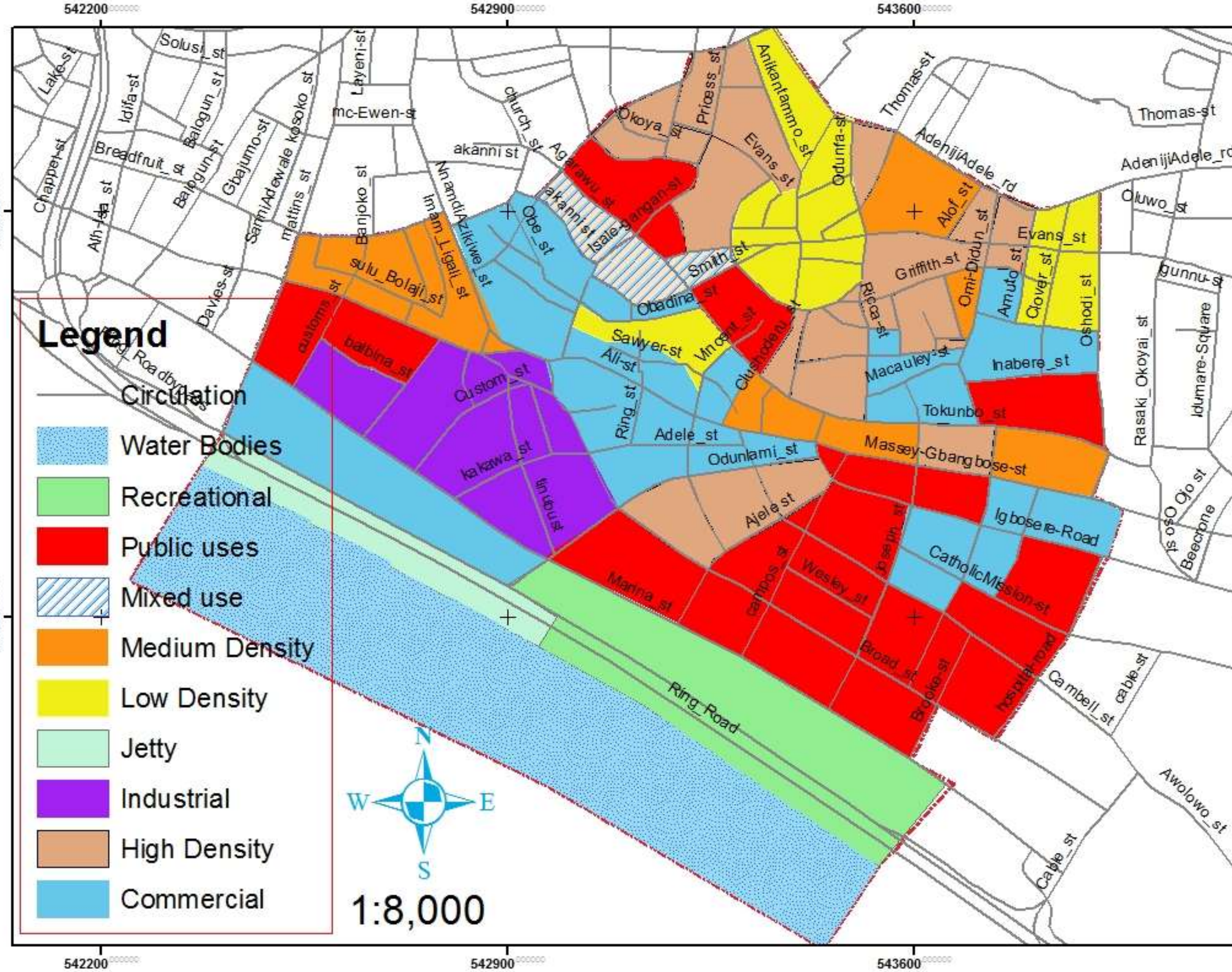
Table 123 Proposed land use analysis

Land use	Area (hectare)	%
Commercial	280984.240668	**13.25**
Industrial	107625.355013	**5.075**
Jetty	43462.242287	**2.049**
Waterbody	558889.965116	**26.35**
High density-Residential	190589.831685	**8.986**
Low density-Residential	107132.378144	**5.051**
Medium density-Residential	116423.183211	**5.489**
Mixed use	27928.003834	**1.316**
Public use	318367.769624	**15.011**
Recreational	125080.787394	**5.898**
Circulation	159993.38238	**7.54**
TOTAL	**2120890.648727**	**100**

Source: Author's Construction, October 2016

The plan in the left side of Figure 105 (fully illustrated in the Figure 106) involves redesigning various intersections in the study area to accommodate the necessary pedestrian infrastructure and creating more dedicated space for pedestrian circulation. The design integrates mobility management and urban planning that takes account of pedestrians' needs from the earliest stages with the objective of creating seamless, high-quality networks for pedestrian activity

Figure 106: Proposed pedestrian safety Improvement plan for the Lagos Island CBD



Source: Author's construction (2016) ©

Table 124: proposed land use analysis

land use	area (hectare)	%
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Industrial	107625.355013	5.075
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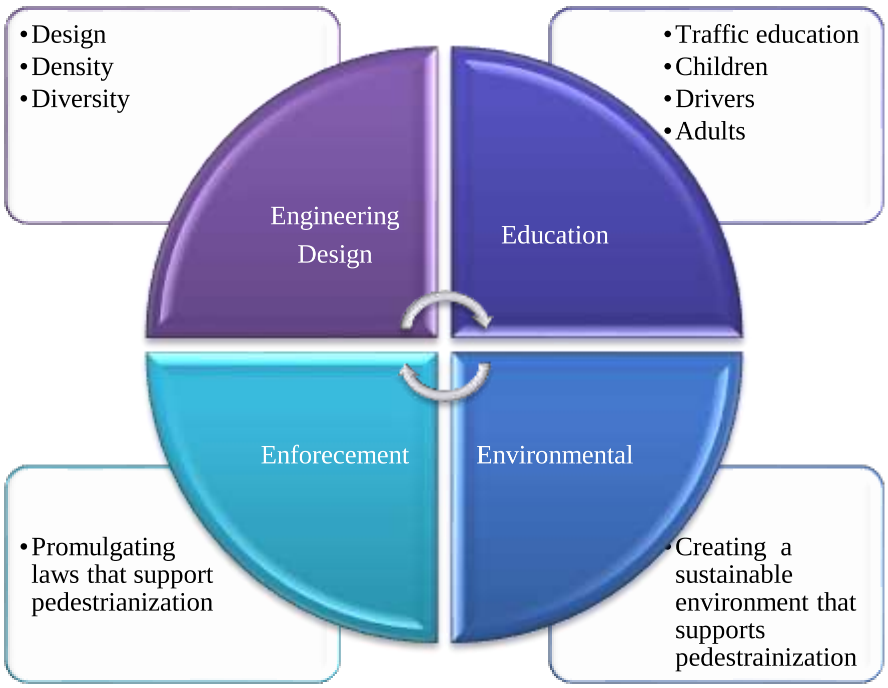
Recreational	125080.787394	5.898
Circulation	159993.38238	7.54
Total	2120890.648727	100

Source: Author's construction (2016)

This plan, which is tagged the "Revitalization Plan" calls for systemic improvement and a comprehensive pedestrian safety action plan. The action plan includes four key planning interventions in the form of the 4Es conceptual framework, namely, engineering design, enforcement, education, and environmental countermeasures. Figure 107 presents a graphical illustration of the 4Es conceptual framework. These measures address pedestrian safety at the individual and environmental levels. The circulation system promotes security in the study area and reduces the likelihood of accidents by implementing low-cost countermeasures throughout the study region and the entire Lagos State.

Figure 107: The 4Es conceptual framework



Source: Author's construction (2016) ©

10.3.3.1.1: Traffic engineering design

Traffic engineering design involves adopting a systemic approach to improve pedestrian safety in the Lagos Island CBD, using evidence-based engineering countermeasures. The proposed Pedestrian Safety Action Plan for the Lagos Island CBD is designed to reduce pedestrian fatalities by 30% by 2030. This calls for close cooperation with the Lagos State government and the Lagos Island local government authorities. The traffic engineering design covers three broad categories. It incorporates traffic engineering and urban planning improvements through a 3D approach (Density, Diversity, and Design). This approach is a recognized engineering and urban design technique to reduce overdependence on motorized transport and create a user-friendly, green environment. As such, it supports pedestrians' right of way, forbids motorbikes from riding on sidewalks and promotes a livable Lagos Island CBD (one for people, not cars). The 3Ds operate in concert. In executing the proposed design for Lagos Island, an overall layout was established. Typically, a comprehensive strategy outlines a community's characteristics, and articulated visions, goals, and actions for future pedestrian development. The comprehensive plan aims to reduce dependence on vehicles and protect the interests of vulnerable pedestrians.

Density approach

Density is a comprehensive urban planning and engineering design approach that plays a vital role in reversing perceptions that the pedestrian mode of transportation is only for second-class citizens. Viable densities would reduce travel distances and thus car trips in the Lagos Island CBD. More densely populated areas tend to have better pedestrian facilities and mass transportation services. This would render the Lagos Island CBD more sustainable. Lagos State's population is growing rapidly, and its population density is expected to double by 2050. Business development is proceeding apace. Increased density reduces per capita automobile ownership and utilization, and increases the use of alternative modalities. Therefore, improving residential and commercial areas within the Lagos Island CBD requires redesigning traditional streets to promote travel on foot and discourage the use of automobiles.

Diversity

Land use diversity involves people-centric rather than vehicle-centric design. This calls for the adoption of People First Pedestrian Policies (PFPP) in the Lagos Island CBD. Land use diversity is measured by determining the mix and intensity of uses to identify those characterized by similar land uses, such as residential or commercial, or those characterized by mixed land uses such as dense activity/urban centers. Land uses diversity creates a high level of pedestrian activity and is a vital way forward in creating a pedestrian-friendly system in the Lagos Island CBD.

Design approach

Globally, communities are putting pedestrian safety first and opting for safer designs while improving livability. Urban design is the basis for building livable cities. A livable city involves creating streets that put people on foot first, as well as accommodating those using public transport and automobiles. A safe design that promotes a walking-friendly environment is essential to prevent road users from being exposed to avoidable hazards. Safe and inviting pedestrian facilities in the Lagos Island CBD would reduce vehicular congestion, environmental pollutants, and ecological problems. The practicality of this design approach makes it theoretically applicable to similar CBDs within the state. The built environment should incorporate functional, creative and safe spaces that encourage everyone in the community to walk.

10.3.3.1.2: Educational programs

Awareness and outreach programs are highly effective in encouraging pedestrianization. However, political will and funding are required to support such initiatives. Many people that use road facilities are not familiar with the traffic code and regulations in Lagos State. It is thus vital to launch a long-term traffic education campaign in the Lagos Island CBD that teaches people how to use pedestrian infrastructure efficiently and safely. Traffic education should also be part of the primary and secondary school curriculum. When traffic codes are understood, road users can predict the behavior of others, thus preventing accidents. More orderly use of road infrastructure leads to fewer accidents and less congestion, which in turn, saves money and reduce unnecessary carnage on the roads.

Teaching and outreach programs for children

Schools should partner with non-profit organizations and government for traffic training, including understanding one's responsibilities as both a pedestrian and motorist and practicing pedestrian safety.

Teaching and awareness programs for drivers

Automobile drivers also require education on the need to respect pedestrians. Driver training by safety organizations and the police encourages positive attitudes and behaviors towards walkers. The driver training curriculum in many countries, including South Africa, Kenya, Ghana, The Netherlands, United Kingdom, Germany, Canada and the United States educates drivers to be cognizant of the presence of pedestrians. This includes yielding to pedestrians at crosswalks, and not turning right on the red when the pedestrian signal is activated.

Education and outreach programs for adults and the public

Public awareness campaigns are required for adults and the public to promote walkability as an environmentally sustainable urban mode of transport. Educating adults and the public on the benefits of walking could also improve commitment to walking. Statewide campaigns would raise awareness of pedestrian safety issues and encourage behavior change to reduce pedestrian injuries and fatalities. This calls for collaborative efforts with the Lagos Island Local Government Planning authorities to implement training that produces secure, approachable and efficient transit systems for pedestrians.

Enforcement

Furthermore, Lagos Island local government officials are encouraged to pursue non-engineering strategies, including traffic enforcement, to support the engineering safety improvements. Active traffic code enforcement and traffic education are two sides of the same coin. Rigorous traffic safety enforcement for both pedestrians and motorists is essential. Current traffic codes in Lagos State should be reviewed to strengthen the legal protection of pedestrians in case of accidents. Traffic regulations should give higher priority to more vulnerable road users to provide safer, more equal conditions among users. Adults need to obey and respect the law and thus set a good example to children. Enforcement would also generate revenue from fines that could be used to further improve pedestrian safety. The Police Department and other agencies are active collaborators in enforcing pedestrian safety laws and fining those that violate the regulations.

Environmental improvements

In related vein, the Lagos Island local government authorities are encouraged to pursue non-engineering strategies, including environmental improvements, to support the engineering safety improvements. Environmental improvements are necessary and critical in improving pedestrian safety. Collective consideration of environmental interventions and countermeasures contributes to improved pedestrian safety in the short, medium and long term. This section of the proposal focuses on environmental readiness to accept the dominance of the pedestrian system through land use development. The land-use framework provides an environmental vision for a unifying and coherent pedestrian safety action plan.

Redesigning and revisiting the pedestrian infrastructure (#2)

Structural facilities for pedestrians have been of vital importance since ancient times. Investment in walking infrastructure is a lasting solution to traffic-related problems. Proper pedestrian infrastructure, safe and convenient street crossings and lower speed are essential to curb pedestrian deaths. This proposal involves preservation and expansion of pedestrian infrastructure and revitalizing underutilized road spaces in the Lagos Island CBD. It includes identifying locations where pedestrian traffic is heavy and constructing new pedestrian infrastructure to encourage safer street crossing. The introduction of paths to accommodate urban landscape elements such as street benches and street furniture is also recommended. As in developed countries, aesthetically pleasing pedestrian islands and an exclusive pedestrian district are suggested for the Lagos Island CBD and its major roads. Plate 36 provides snapshot of proposed Road and pedestrian infrastructure improvements in the study area

Plate 36:Road and pedestrian infrastructure improvements in the study area

BEFORE **AFTER**

Source: Author's construction (2016) ©

Plate above illustrates road and pedestrian infrastructure improvements in the Lagos Island CBD. The beautification of public spaces includes street furniture, good lighting and clear signage. Redesigning and revisiting pedestrian infrastructures involves revolutionizing urban space through increased investment in such infrastructure, transforming urban space to slow vehicle traffic and creating more modern and improved human environments. It includes road network improvements and other essential transport infrastructure to promote pedestrianization.

Intermodal transportation network improvements (#3)

This proposal incorporates and integrates pedestrians, transit, and personal vehicles. It aims to achieve a multimodal system that provides more space to non-motorized traffic and public transport in the Lagos Island CBD. The proposal responds to mobility trends in a changing society. It seeks to ensure comfortable, safe, well-maintained and secure pedestrian access to public transport and destinations within the CBD. Key aspects include the development of a car-free core CBD area and provision of parking to discourage the over-use of cars. The intermodal transportation network plans consider the development and setting of targets for future levels of walking and other modal splits.

Policy and planning reforms that support pedestrian safety #4

The bane of the existing pedestrian system in Lagos State is a lack of reliable strategies and policy documents that support all categories of road users. A well-packaged pedestrianization plan is part of the general mobility system. Ideally, a pedestrianization policy supports a legal and institutional framework that provides enabling conditions for implementation. This supports land use-transport integration with a cardinal focus on urban sustainability. Lessons can be learnt from countries that have successfully drafted such pedestrian policy documents. The pedestrianization policy document clearly sets out vehicular and pedestrians' right to move across all roadways unless expressly prohibited from doing so. European states such as Germany, Spain, Sweden, Switzerland, The Netherlands and England, the United States and Peru in South America, as well as India and China have adopted well-packaged pedestrianization policy approaches. In Africa, South Africa, Tanzania, and Kenya have followed suit.

These could guide the Lagos State government and Lagos Island local government agencies. Implementing a well-packaged pedestrianization plan requires adequate planning for the change from a vehicle-dependent to a multi-modal and inclusive roadway design, public space, and land use planning approach. This would significantly improve the quality of the environment and the quality of life in the Lagos Island CBD and create an aesthetically pleasing environment. The proposed pedestrianization policy and planning reforms for the Lagos Island CBD promote safety and encourage walking as a healthy and environmentally friendly mode. They aim to create livable communities and enable all users to access the road system. There is also a need for comprehensive regulations to prevent parking and trading on sidewalks. The pedestrianization policy for the Lagos Island CBD determines who is a pedestrian, addresses their plight, and defines traffic offenses. It considers economic growth and determines the future size, character, location and shape of the pedestrian system.

10.3.4: Design implementation strategy

An implementation strategy is required for the successful adoption of the pedestrian safety plan in the Lagos Island CBD. The timeframe stretches from five to 20 years. Table 125 sets out the short, medium- and long-term schedule. Systemic planning is a complex strategy developed by professionals and implemented by the government, supported by community stakeholders.

Table 125: Projected planning schedule

	0-5	6-10	11-20
Short range measures 2017-2022			
Medium range measures 2017-2027			
Long range measures 2017-2037			

Sources: Author's Construction, October 2016

Short range measures (2017-2022)

The proposed short-range implementation of the pedestrian safety strategy includes but is not limited to reviewing, identifying and implementing the first sign and pavement marking, and initiating security training and conferences to share pedestrian safety information within and around Lagos Island local government. It also involves developing a consistent pedestrian safety outreach program, conducting safety investigations and sidewalk improvements in walkable streets in the Lagos Island CBD. Public announcements and multilingual material and a toolkit for distribution to schools, motor parks, churches, and mosques reinforce the strategy. The short-term strategy also involves enacting laws and enforcement strategies through training and assembling a professional and nonprofessional team that represents engineering, enforcement, and education stakeholders in the community.

Medium range measures

This medium range measures address a core part (#2) of the proposed design. Whatever is not achieved in the short-term period shifts to this timeframe that provides the guidelines for the promotion and implementation of pedestrian safety measures. The medium range plan develops the intra-urban pedestrian safety system over 10 to 15 years. In Lagos, pedestrian-related initiatives are currently done on project and ad hoc basis without adherence to medium-range implementation guidelines and policy directives. The main purpose of the medium range plan is to reduce traffic in the Lagos Island CBD and provide for local public transport, and pedestrians. It seeks to strike a reasonable balance between all modes of transportation. This is necessary in order to reintroduce some features such as high-density development and proximity that promote a pedestrian system. Higher density areas like the Lagos Island CBD require shorter trips, which are not dependent on a car, and should be within 500 meters of the core commercial area. Traffic calming measures reduce vehicle speeds, discourage thorough traffic, minimize conflict between street users and improve the neighborhood environment.

The medium range measures include sidewalk improvements, channelization, intersection treatment, pedestrian islands and refuge, crossing-paths, speed humps, ease of walking in every strategic area and signal installations and enhancements. Plates 37 and 38 provide a graphical illustration of the short-term improvements in the intra-urban pedestrian system in the Idumagbo area of the Lagos Island CBD. The image on the left is the “before” view of a typical arterial street designed primarily for automobile use and street trading activities on the sidewalk. The “after” view photo on the right provides a digital illustration of how the anticipated changes - a raised median, sidewalks, and landscaping - can make such spaces safer and more appealing to pedestrians.

Plate 37:A digital illustration of the anticipated changes

BEFORE AFTER

Sources: Author's Construction, October 2016

Plate 38:Removing street trading from pedestrian walkways

BEFORE AFTER

Source: Author's construction (2016)

Long range measures

The long-range measures address a core part (#1) of the proposed design. A long-term comprehensive policy on pedestrian transportation (10-29 years) is required if Lagos State seeks to reform the system and promote eco-friendly intra-urban movement. The development of such a long-term statewide system is overdue. It incorporates detailed and thorough operational plans to address pedestrian safety. This will transform the Lagos Island CBD into a vibrant and walkable city and revitalize the town center's circulation system. The plan for the distribution system includes changing the old road design pattern of the 1960s in the Lagos Metropolitan area and Lagos Island CBD to support a multimodal transportation system. It is recommended that a Lagos State Commission for the Pedestrian System be established. The chairperson of this commission should be an urban planner with experience in pedestrian transportation and safety. The commission should be charged with assessing the current system and determining the viability of the proposed design, and future pedestrian needs to determine how best to address the requirements. It would also ensure efficient administration of the planning process and oversee enforcement and monitoring. The proposed comprehensive statewide system involves redesign and reconstruction of pedestrian facilities such as high-visibility crosswalks, putting traffic lights at identified strategic places, introducing pedestrian signals, additional warning and regulatory signs, introducing pedestrian refuge areas, signal options, and parking restrictions.

10.4: Recommendations to improve the pedestrian system

The following recommendations are made to promote sustainable mobility in the Lagos Island CBD:

1) Improving intra-urban pedestrian safety requires sound management. Travel management policies that promote the pedestrian system and multimodal transportation access are recommended. General management techniques should be applied to promote development and sustainable planning for all road users. The Lagos State government and Lagos Island local government authorities should establish a Project Management Team to lead the development of the pedestrian Safety Action Plan.
2) Improving pedestrian safety requires funding support, especially for public transit. Finding the right funding mix remains the bane of transportation systems in developing countries. One of the best ways to promote general walkability as an environmentally sustainable urban model

is adequate funding for successful implementation. Pedestrian infrastructure requires adequate financial resources. Thus, further research is required on funding sources for pedestrian projects and support mechanisms in the Lagos Island CBD.

3) Participatory urban planning approaches are recommended that treat pedestrians as equal to other users. A comprehensive approach is required that focuses on a combination of engineering, environmental, enforcement, and education measures to contribute to a culture of safety and ultimately, save pedestrian lives.
4) Further research is also recommended on accidents involving pedestrians, and injuries, and fatalities in the Lagos Island CBD.
5) Inputs should be solicited from a range of stakeholders, as the government, non-governmental organizations, professionals and all road users have a role to play in promoting safe roadways and improving intra-urban pedestrian safety.

It is thus crucial to involve these groups in the development of the pedestrian safety system.

a. The Lagos State government has the responsibility of ensuring safety standards. The study identified the need for adequate facilities for walking within the Lagos Island CBD due to historical inclinations to favor the automobile. Thus, through the project management team, Lagos State should introduce laws and policies(legislation)that will generally aimed at protecting and ensuring safety of NMT and pedestrians on the roadways.
b. There is need for a complete street redesign and construction of pedestrian friendly facilities, redesigning and upgrading of the traditional markets in the CBD or elsewhere in the metropolis. The above may also be extended to streets designated for trading on the Island and the rest of the metropolis. These measures in turn will facilitate general access of NMT (and pedestrians) and in particularly that of traders and shoppers.
c. The policies should include the adoption of a state-wide Pedestrian Master Plan that prioritizes roadways that accommodate pedestrian safety; such measures are expected to help reduce fatalities in the Lagos Island CBD by 30% by 2030.
d. The Lagos State government should also provide an appropriate technical framework, provide funding and ensure law enforcement.
e. Non-governmental organizations have a significant role to play in fostering conditions that make walking safe, by supporting public demands for pedestrian safety; lobbying at local planning level, and championing the right of all road users to security.

f. The Lagos Island Local Government as a Sub-Metropolitan unit of government and grassroots institution should focus on policies that promote an environment-friendly CBD. This involves shifting to a more viable community oriented and pedestrian friendly approach.

g. This study identified appropriate engineering non-engineering strategies. The Lagos Island local government could identify additional design measures to supplement its recommendations especially when conditions – such as traffic volumes, land uses, and newly available or approved technologies – change in the future.

h. While professional opinion matters, it is important to consider vulnerable road users' opinions. Government cannot go it alone. Citizen participation is crucial and private sector partners from across industry and commerce should be brought on board to promote road safety. Indeed, it is meaningful civic engagement and private partnerships that give rise to secure and friendly cities. Local participation is critical; for example, community associations need to participate in developing urban transport plans.

10.5: The study's significant and original contributions to the urban planning body of knowledge and practice

This section discusses the study's diverse contributions to the body of knowledge. It also focuses on best urban planning practice to improve pedestrian safety. The evidence-based practice derived from this empirical study is summarized as follows: Table 126 provides the diverse contribution of this study to the body of knowledge and possible end-users.

Table 126: The study's diverse contributions to the body of knowledge

<table>
<tr><th>Original contributions of this study to</th><th>End Users</th></tr>
<tr><td>The urban planning literature
The study is thus an original contribution to the body of urban planning knowledge that will assist future researchers. It provides a theoretical foundation for future pedestrian studies and related topics</td><td rowspan="3">• Architects
• Civil public works and infrastructure services units
• Commuters
• Engineers
• Geographers
• Federal, State and Local Governments
• Government research institutions</td></tr>
<tr><td>Pedestrian planning in CBDs
This study affirms that it is imperative to redirect planning efforts not only to improve the pedestrian system in residential areas but in other land use areas such as CBDs.</td></tr>
<tr><td>Urban planning theory</td></tr>
</table>

<table>
<tr><th>Original contributions of this study to</th><th>End Users</th></tr>
<tr><td>This study thus contributes to academic knowledge of developing countries. Given the rapidly growing population in developing countries, pedestrian safety is an important issue.</td><td rowspan="7">Governmental agencies, departments, boards and councils for urban planning science and
Housing, urban development, transportation, municipality and rural affairs Consultants
International communities /Organization
law enforcement agencies and entities
Legislative bodies responsible for the enactment of laws
Non-Governmental Organization (NGO)
Other Professionals in the built environment
Policy maker
Research Institutes
Research Students
Transportation operators
Pubic
Transportation technology
Urban planners
Urban planning /Transportation units and service providers</td></tr>
<tr><td>Supporting urban transport equality
This study sought to promote equity among vehicular traffic, the pedestrian system and mass transit. Spatial heterogeneity renders most urban transportation systems unsustainable. The study illustrates the relationships between socio-economic variables and other indicators to improve the pedestrian system.</td></tr>
<tr><td>Supporting public mass transport and pedestrian mobility
An improved pedestrian system has significant effects on public transport and pedestrian accessibility. The study suggested that enabling pedestrian infrastructure and efforts to reduce the use of private transport could result in a modal shift in travel patterns</td></tr>
<tr><td>Countering fascination with the automobile
This study pointed to the importance of countering this phenomenon that should also be a topic for further research.</td></tr>
<tr><td>Extrapolating this research to other parts of the world
This study and its findings could be extrapolated to different cities and towns across the globe.</td></tr>
<tr><td>Enhancing the empirical databank
While developed countries systematically gather data on socio-economic characteristics and travel patterns, as well as well as safety data and user preferences, this is not the case in their developing counterparts.</td></tr>
<tr><td>Revolutionizing the pedestrian system
A major contribution to knowledge is that this study validates the significant connection between the poorest and most vulnerable geographical areas and poor pedestrian systems. The case of Lagos Island CBD is testimony to this point.</td></tr>
</table>

Source: Author's construction (2016) ©

The urban planning literature

One of the difficulties in improving pedestrian systems in developing countries, and Lagos State in particular, is the paucity of published literature. This added to the time taken for the researcher to complete this study. The study is thus an original contribution to the body of urban planning knowledge that will assist future researchers. It provides a theoretical foundation for future pedestrian studies and related topics. It is hoped that it will inspire further research by planners, academics and professionals.

Pedestrian Planning and Design in CBDs

Pedestrian accessibility has a profound influence on residential neighborhoods and other prominent land uses within the central city. However, contemporary developments in urban society render this difficult. This study affirms that it is imperative to redirect planning efforts not only to improve the pedestrian system in residential areas but in other land use areas such as CBDs. Another contribution to knowledge is the use of empirical data to inform strategies to improve pedestrian mobility in CBDs in highly urbanized areas. These empirical findings may be useful in understanding distributive issues in other large CBDs within metropolitan areas where transport planning occurs in the context of land use heterogeneity and the lack of policy.

Urban planning theory

While numerous studies have examined transport improvements in the major cities of the developing world, a sound theoretical framework to inform such analysis is lacking. The theoretical parameters that inform planning and design in developing countries are often imported from their developed counterparts and incorrectly applied. This study thus contributes to academic knowledge of developing countries. Given the rapidly growing population in developing countries, pedestrian safety is an important issue. This study of the Lagos metropolitan area helps to build a general understanding of fundamental strategies to support the improvement of pedestrian systems. It adds to the body of knowledge in urban planning and validates the possibility of improving pedestrian systems in developing countries.

Support for urban transport equality

This study sought to promote equity among vehicular traffic, the pedestrian system and mass transit. Spatial heterogeneity renders most urban transportation systems unsustainable. The study illustrates the relationships between socio-economic variables and other indicators in order to improve the pedestrian system. It notes that the social consequences of overdependence on vehicles and less consideration for pedestrians are sensitive to location and spatial scale and confirms that the nature and process of the transportation system lead to inequalities.

Support for public mass transport and pedestrian mobility

The study drew direct correlations between public transport and pedestrian mobility, and urban planning. An improved pedestrian system has significant effects on public transport and pedestrian accessibility. The study suggested that enabling pedestrian infrastructure and efforts to reduce the use of private transport could result in a modal shift in travel patterns. Pedestrian systems and public transportation policies could alter travel patterns in CBDs similar to Lagos with a high proportion of elderly people, children and low-income households.

Original contributions of this study to counter fascination with the automobile

Developing countries' fascination with the automobile results in traditional growth patterns based on the requirements of vehicles. This has also created a cultural phenomenon in developing countries where people tend not to walk to move from place to place. This study pointed to the importance of countering this phenomenon that should also be a topic for further research.

Extrapolating this research to other parts of the world

In light of the fact that the need to improve the pedestrian system is a universal issue, the problems identified in this study and its findings could be extrapolated to different cities and towns across the globe.

Enhancing the empirical databank

Most of the available empirical data on pedestrian systems relates to developed countries. While developed countries systematically gather data on socio-economic characteristics and travel patterns, as well as well as safety data and user preferences, this is not the case in their developing counterparts. This study thus makes an original contribution in having gathered reliable data for pedestrian planning purposes in a developing country.

Revolutionizing the pedestrian system

A major contribution to knowledge is that this study validates the significant connection between the poorest and most vulnerable geographical areas and poor pedestrian systems. The case of Lagos Island CBD is testimony to this point. The study confirms the global observation that the characteristics of pedestrianization are slowly but steadily changing and becoming sophisticated and varied. It also confirms its potential to enhance mobility, reduce congestion, improve environmental quality, and promote public health. The study illustrated that the current pedestrian system in developing countries is unsustainable and lacks integration, homogeneity and coordination. For example, the transportation system in Lagos Island CBD is multi-dimensional and attempted improvements appear to be ineffective. The development pattern is polycentric with weak connections to major economic, cultural, environmental, and social areas. The development pattern renders modal splits a fundamental issue. The study thus adds to the body of knowledge that emphasizes the need to re-contextualize the existing pedestrian system. This would result in more proactive and less reactive urban planning with an emphasis on deliverability that contributes to general urban design qualities. In this respect, this study affirms that urban planning professionals have a major role to play in identifying and delivering improved walking conditions. Practical, context sensitive transportation design will ultimately improve walking conditions and create high-quality public spaces.

- Another insight is that poor provision of quality transportation facilities discourages walking and reduces the value of land use development. This study thus highlights the need to formulate sustainable spatial development policies and to provide pedestrian infrastructure. Policies designed to improve the pedestrian system could simultaneously address other transportation issues.
- Another contribution to the body of knowledge is that poor transportation networks are the core issue influencing spatial planning in developing countries. A good example is the negative impact of the transportation network on urban development in the Lagos Metropolitan area. This calls for attention to be paid to features that are sometimes considered unnecessary such as basic street furniture that has the ripple effect of improving safety and security and providing less space for parking. The study emphasizes that prioritizing pedestrianization is the basic approach to urban sustainability. Creating a new pedestrian environment as an alternative to a traffic dominated CBD ensures durability and ecological, economic, and social sustainability.
- This study also fills a gap in that, while there has been increased interest in methods to improve pedestrian safety in developing nations in the past decade, progress has been slow.
- The study thus contributes to closing the gaps in the theory and design relating to pedestrian systems between developed and developing countries.

- Finally, the study promotes sustainable community development by promoting a safe pedestrian system.

10.6: Suggestions for future research

The scope of this study was limited due to financial and time constraints. The following areas are suggested for future research:

- Coverage of different geographic regions within the Lagos metropolitan area
- More comprehensive technical work to improve the pedestrian system across the entire Lagos metropolitan area.
- Coverage of commercial centers within Lagos like Yaba, Oshodi, and Shomolu.
- Comprehensive study of the exiting traffic and accident data
- More comprehensive technical work to examine Pedestrian safety and system;
- Examination of Sustainable mobility (land use/transportation);
- Direct efforts to improving Road and street design in the CBD across Lagos State, Nigeria.
- More study on the Creation and management of open spaces (integrated with pedestrian movement
- Extensive study of the linkage between the traditional markets and the modern commercial areas through the creation and design of pathways and open spaces.

10.7: Concluding remarks

Lagos is the largest cosmopolitan/mega city in Nigeria, its chief commercial center and a major tourist destination with more than 50% of non-oil GDP. The Lagos Island CBD is one of the most patronized shopping areas in the city and the country. This study argued that the Lagos State government and Lagos Island local government could do much more to encourage pedestrianization. It showed that the pedestrian system is the most sustainable urban mode of transport that does not consume external sources of energy and emits no pollution. The benefits of a pedestrian transportation system for individuals and society as a whole are immeasurable. They include improved health, cleaner air, less environmental degradation, personal savings, mobility and the promotion of self-realization for vulnerable groups. Such a system provides solutions to the issue of urban mobility. Improving the intra-urban pedestrian system controls the inefficient use of motor vehicles, which in turn reduces air pollution and greenhouse gas emissions.

Improving the intra-urban pedestrian system in the Lagos Island CBD will require commitment from all stakeholders. Professionals would provide technical expertise to design a road system that prevents pedestrian deaths and injuries. The government has the responsibility to attract investors, manage the system, enact and enforce laws and encourage safe use of the road transport system. It also has the duty to promote co-operation and coordination among stakeholders. Non-governmental organizations and concerned parties need to proactively participate in planning and innovation. Road users must use roadways in a responsible and safe manner. Proposals and recommendations that address physical design factors and the underlying broad policy should be properly implemented. While the renaissance of intra-urban travel will not entirely cure urban transportation ills or solve poverty and crime, such travel is integral to the life of city residents. Finally, this study calls for more context-sensitive approaches to the pedestrian system that cater for the needs of all road users. This requires the urban planning design approach, the enforcement of traffic laws and promoting awareness through safety campaigns. This would make the Lagos Island CBD, and perhaps the rest of the metropolis, a safer, more vibrant, appealing and sustainable place to live, work and visit and offer many highly-prized benefits to society, in the short, medium and long term instead of the insecurity, disorder, noise and grime that that exist today

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APPENDICES

LIST OF ACRONYMS

ACRONYM	MEANING
3D	Density, Diversity, and Design
3E	Engineering, Enforcement, and Education
CBD	Central Business District
DFID	Department of International Development
FCT	Federal Capital Territory Abuja
FHWA	Federal Highway Administration
FUMTA	Federal Urban Mass Transit Agency
HCM	Highway Capacity Manual
IWD	Inland Waterways Department
LSFSC	Lagos State Ferry Services Corporation
MMA	Murtala Muhammed (International) Airport
MS Excel	Microsoft Excel
MT	Motorized Transportation
NGO	Non-Governmental Organization
NMT	Non-Motorized Transportation
NURTW	Nigerian Union of Road Transport Workers
OD	Origin-Destination
OECD	Organization for Economic Co-operation and Development
PFPP	People First Pedestrian Policies
PLOS	Pedestrian Level of services
PME	Pedestrian Mobility Environment
RWP	Research Work Program
SPSS	Statistical Package for the Social Sciences
TOD	Transit-oriented development
TRB	Transportation Research board
UKZN	University of KwaZulu-Natal
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
VLOS	Vehicular Level of services
WHO	World Health Organization
WIS	Walkability Index Score

GLOSSARY

Glossary	Meaning
Automobile-dependent environment	Land uses environment that rely exclusively on cars to function land (overdependence on automobiles)
Buildings	Houses, structures, and constructions in various types, shapes and sizes that are designated for different uses
Car-Centric city	The *city* that take much more takes pride on *car*-oriented trips (car dependence) rather than pedestrian dependence trips
Central Business Districts	The commercial and business nerve center of a city
Central Place	Settlement center that serves as goods and services for smaller neighboring settlements
Centrifugal force	The factors that discourage settlement growth and development
Centripetal force	Factors that encourage settlement growth and development
City	A large human settlement or urban area with a population of over 20,000, and extensive land use such as transportation, commercial, industrial etc. and economic centers with a wide sphere of influence
Clustered Settlement	A settlement where buildings are clustered around a point
Compact city concept	It is a response to sustainable development just as modern utopianism is a reformist and humanitarian reaction against squalid urban development during the industrial and post-industrial revolution.
Compact development	Concentrated development of buildings, land uses, and facilities built in proximity that discourages auto-dependence due to reduced need to travel; and accommodates high population density and hence promotes maximum utilization of urban services and infrastructure
Comprehensive Plan	This plan aims to develop detailed plans for land use configuration
Concentric area model	The early urban development descriptions of form
Conurbation	Large urban clusters of continuous development merged together
Development intensity	Permissible building mass and use in specified zones
Development plan	A general plan that provides for development control indicating permissible and non-permissible development intensity and use
Dispersed Settlement	A settlement whose buildings occur randomly without a pattern or central place
Ecosystem concepts	An analytical tool to resolve social and urban phenomena such as transportation planning problems
Environmental Quality	The worth of the environment based on its good attributes; an environment is classified as good when it possesses the ambience, beauty, safety, open spaces and gardens required for recreation and most importantly, is clean and healthy for habitation

Glossary	Meaning
Environmentally friendly means of transportation	A green and eco-friendly transportation system that requires less energy and less handful impacts on the environment.
Gentrification	A redevelopment and rehabilitation process of inner city for easy access to the jobs and services of the city center
Greenbelt	A policy that prevents urban sprawl from encroaching on rural land; the policy delineates the countryside for agricultural and less urban land uses, thereby controlling growth and connecting urban dwellers to nature
Greenhouse gas emissions	Environmental effects that cause climate change such as global heating, depletion of oil reserves and pollution
Incompatible use	Land use is incompatible or non-conforming if it cannot co-exist because differences with respect to its functions and the impact on the physical environment
Inner City	The part of the urban area surrounding the CBD; it often contains older housing and industry in a state of poor repair and dereliction
Intercept surveys and in-depth survey	Typically involves data gathering using an intercept survey that uses a questionnaire to collect information on a subject
Land use pattern	Refers to the action taking place on a specific piece of property or aggregation of resources usually characterized by the arrangements, activities, and human inputs to a certain land type to produce, change or maintain it.
Livability	Striking a balance between the use of resources and limiting possible impacts on the natural environment is mandatory for livability.
Lost space	These are underused, deteriorating undesirable urban spaces that need redesign; anti-spaces that make no positive contribution to the surrounding or users. It manifests as deteriorated parks and public housing that does not serve its purpose, parking lots, edges of freeways, abandoned water fronts, train yards, etc.
Metropolitan area	A metropolitan area is a network of cities with a large population centre
Misused Land	When land is used for the wrong purpose, underused or over-used
Mixed land use	A plot, site building or structure that is put to more than one use; it may occur horizontally or vertically on different floors of a building
Mixed-use methods	This involves a mix of the methods required to provide adequate understanding and solutions to the problems under study
Motorist	Driver or traveler in a privately-owned automobile
Motorization rate	The number of passenger cars per 1,000 inhabitants and is a common indicator in international comparisons of economic development and environmental issues.
Multi-use	Denotes any project with multiple uses but falling short of the mixed-use development criteria
None Motorized Transportation	An efficient alternative means of mobility in urban and rural area

Glossary	Meaning
Pedestrian Amenities	Facilities that support walking such as safe and well-lit walkways, seating at bus stops and parks, and shelter from rain and harsh weather conditions
Pedestrian fatalities	Occurrence of pedestrian death on roads, mainly in densely populated areas while crossing roadways.
Pedestrian Level of Service (PLOS)	The primary non-invasive methods used to determine pedestrian safety on roadways
Pedestrian mobility	Ability of pedestrian to move physically from origin to destination
Pedestrian safety	The ability of pedestrian safely walking without the negative consequences of car interference
Pedestrianization	Streets exclusively dedicated for pedestrian use
Precedent studies	A method of research that focuses on a point, place and object etc. as a point of reference over a period
Proposed land use	The use to which a site, plots, or buildings are to be put in the foreseeable future
Rationality	A feature of decision-making processes that aims to identify what best to do in given situations
Redevelopment	The process whereby an existing inner city is rebuilt to a plan after complete or partial demolition of old and decayed houses, creating a new and modern development to replace the old one
Rehabilitation	A planning process whereby individual structures are improved to meet established building standards and criteria. It is also referred to as a Renovation Scheme
Research design	The strategy and approaches adopted to carry out a research project
Road Hierarchies	Classification of the various types of roads per their size and the volume of traffic they can accommodate at a point in time
Road safety	The measures used to prevent vulnerable road users from being killed or seriously injured.
Settlement Hierarchy	A classification of settlements based on their population, size, services and sphere of influence
Street Layout	The way streets are designed and laid out. Streets are laid in grids, or circular and other patterns that determine the forms of the city
Sustainable development	Development that can be maintained and serviced that achieves a balance in the ecology without exhausting natural resources
Sustainable Transport	A Green transportation system. This form of transport relies exclusively on dwindling natural resources. It involves renewable or regenerated energy rather than fossil fuels.
Town planning	The process of designing, organizing, making forecasts and development of cities guided by policies
Traffic Congestion	A Transportation condition on networks that usually occurs as vehicular and pedestrian use increases characterized by slower speeds, longer trip times. It involves in an increased vehicular queueing.

Glossary	Meaning
Transportation development pattern	The natural human growth process. Maturation includes four eras, the Neolithic, Paleolithic, Pre-classical and Classical periods
Urban Road furniture	Includes all the physical structures placed on the landscape and affixed to the land distinct from actual buildings and includes bus stop shelters, telecommunication antennae, masts and towers, cables and pipes, street signs, advertisement billboards, light statues, artefact placements, fountains and direction finders
Urban metabolism	The total function of the city systems and their outcomes, and the processes of growth, development, resource consumption and waste generation and elimination
Urban Renewal	A planning process aimed at physical improvement of an existing urban settlement to eliminate blight using any of the following methods: Redevelopment, Regeneration and Conservation
Urban Sprawl	Unplanned outward spread and growth of cities into rural low-density surrounding countryside that is mostly uncontrolled and auto dependent
Urban transport	The sinew binding together various urban land-uses
Urban User hierarchy strategy	Established an urban street user hierarchy that gave the highest priority to walking, biking, and public transit. The road user hierarchy developed to support a range of public policy goals.
Vehicular flow rate	The interactions between travelers (including pedestrians, cyclists, drivers and their vehicles) and infrastructure (including highways, signage, and traffic control devices), with the aim of understanding and developing an optimal transport network with
Vitality	The degree to which the form of the settlement supports its functions, protects life and enhances the survival of species
Walkability	This term given to a built environment or Green Cities that facilitate human-centered activities such as shopping, commuting, and socializing
Walkability index score (WIS)	The best way of judging the concise degree to which an area can extend opportunities to walk to various destinations
Walking	Traditional and most basic mode of transportation
Zoning	Allocating the use to which land in each location could be put, such as commercial, residential, industrial, and recreational areas

QUESTIONNAIRE A

Improving intra-urban pedestrian safety in Lagos metropolitan area, case study of Lagos Central Business District (CBD)

(Transients / Inner City resident)

Degree in View: Ph.D. in Town &Regional Planning

Researcher: Babatunde Kayode Tugbobo

University: University of KwaZulu-Natal

Faculty Built Environment and Development Studies;

Department of Architecture; Planning and Housing Department;

Howard Campus, Durban- South Africa.

Dear Sir/ Madam,

The attached questionnaire is meant to raise queries on Pedestrian Transportation system in the inner city of Lagos Central. The research topic is: '*improving intra-urban* pedestrian *safety in Lagos metropolitan area* Lagos, Nigeria.' Babatunde Kayode Tugbobo is conducting the study, a **Ph.D. candidate** at the University of the *University of KwaZulu-Natal*, Faculty Built Environment and Development Studies; Department of Architecture, Planning and Housing Department; Howard Campus, Durban- South Africa. The purpose of the study, apart from its strict academic reason, is to proffer strategies that will help introduce inclusionary Pedestrian in the inner city of Lagos Central. At the same time, expand and sustain Transportation System in the central town of Lagos. The study will involve data gathering through the administration of the structured questionnaires, which will be analyzed, the results of which will inform the study's recommendation. Participation is voluntary; the questionnaire seeks to elicit information about; demographic data, socio- economic characteristics, transportation mode preference and residential location and features. The questionnaire will take approximately ten to fifteen minutes to complete. There are no physical or social risks to those participating in this study. The study may have no direct benefit, but the findings and the proposal will be of general benefits the study area. Participation is voluntary; refusal to participate will involve no loss of advantages or penalty. Information obtained will be held in strict confidence and anonymity; the findings will be available only to the researcher and the University. The questionnaire does not require name identity. Thus it is optional. The researcher may ask any questions regarding this study, before or upon the completion of the questionnaire. If desire further information regarding this study, kindly contact Babatunde Kayode Tugbobo @ bktugbobo@yahoo.com. Thanks for anticipated participation.

Tugbobo, B.K. (S/N 213569947)

Respondent's status [Residents/ Transients] (Tick)

Section A: Demographic characteristics of respondent

1. sex? [ ] Male [ ] Female
2. Why are you in the study area today? [ ] Business [ ] Pleasure [ ] Others Specify.........
3. What is your marital status? [ ] Married [ ] Single [ ] Widow [ ] Widower
4. Within which of these age brackets does your age fall? 18-23 [ ] 24 – 28 [ ] 29- 33[ ] 33–38 [ ] 39-43 [ ]44-48 [ ] 49 – 53 [ ]54-58 [ ] 59 – 63[ ] 64 – 68 [ ]69-73 [ ]
5. What is your status in the family or household? [ ] Head [ ] Member
6. What is the size of your household- 1--4 [ ] 5-8 [ ]8 above[ ]
7. What is your tribal grouping? [ ] Ibo [ ] Yoruba [ ] Hausa [ ] Non Nigerian
8. Are you employed? [ ] Yes [ ] No
9. In which of these sectors are you employed? [ ] Civil/ public service [ ] Private multinational company [ ] Private indigenous company [ ] Self-employment.
10. If you are self-employed, kindly state the nature of the employment e.g. trading _______________
11. Please tick where your monthly income falls within these income brackets. [ ] Less than =N=10,000 [ ] =N=10,001 – =N=40,000 [ ] =N=40, 001 - =N=80,000 [ ] =N=80,001 - =N=120,000, [ ] 120,001-above[ ]
12. Is your spouse employed? [ ] Yes [ ] No

13. What is your spouse type of occupation [ ] Civil/ public service [ ] Private multinational company [ ] Private indigenous company [ ] Self-employment
14. Please indicate Spouse Income bracket if (known) [ ] Less than =N=10,000 [ ] =N=10,001 – =N=40,000 [ ] =N=40, 001 - =N=80,000 [ ] =N=80,001 -=N=120,000, [ ] 120,001- above[ ]
15. Where, within the metropolis is your workplace located? [ ] Lagos Central CBD [ ] Mainland [ ] Island other than the CBD [ ] Outskirt (Specify)
16. Kindly give the name of the exact location of your workplace______________
17. What is your highest level of education attainment? [ ] No formal education [ ] Primary [ ]Secondary [ ] NCE/OND [ ] BSC/HND/PGD [ ] MBA/MPA/MSC/PhD
18. What type of house do you live? [ ] Brazilian (Rooming apartment) [ ] Flat
    a. [ ] Duplex [ ] Flat let [ ] Detached [ ] Terraced [ ] Semi detached
19. How many room(s) is your family/household occupying? [ ] 1 [ ] 2 [ ] 3
    a. [ ] More than 4
20. What is the total dwelling units, in the house your family occupies [ ] 1- 2 [ ] 3 -5 [ ] 6

Section B: Transportation Related Questions

21. Which part of Lagos metropolis respondents live? [ ] Island [ ] Mainland [ ] the suburb/ outskirts [ ] Outside Lagos (please Specify)
22. If the point of this interview is your workplace, kindly state the exact location of your place of residence _____________________________ otherwise specify that of your workplace_________________________
23. Where is respondents origin- [ ] Within the study area [ ] Outside the study area
24. If outside the study area, -What is the mode of Transportation [ ] Walk from home to the Bus stop and take a bus and walk from Bus stop to my destinations, [ ] Walk from Origin to the Destination
25. Approximately what is total trip time including time spent on bus and walking to the final destination: [ ]less than 30 minutes [ ]30-60 minutes[ ]1hours-1hours-3hours[ ]3hours-6hours
26. If Within the study area What is the mode of Transportation-[ ] Walking [ ]Bus [ ] car [ ]other specify ....

27. Household vehicular ownerships no vehicle-[ ], 1-2, -[ ] 3-4, -[ ] 5+-[ ]
28. Household with Zero vehicular use Low -[ ]Medium-[ ] and Upper-[ ]
29. Vehicular ownership and gender difference in travel Male-[ ] Female-[ ]
30. vehicular expenses
31. Household maintenance expenses Private living accommodations -[ ]Food -[ ]Transportation -[ ]Medical -[ ]Vacation Others-[ ]
32. The average money spends on mile per travel

0000-5000	₦850
6000-10000	₦1,700
11000-15000	₦2,100
16000-20000	₦2,500

33. Give information on the health impacts of the excessive vehicular use Yes-[ ] No-[ ] undecided -[ ]
34. Awareness level of pollution by community members Yes-[ ] No-[ ] undecided -[ ]
35. Awareness Chaotic traffic congestion Yes-[ ] No-[ ] undecided -[ ]
36. Times individual spend per week on traffic 1-[ ] 2-[ ]3-[ ]4-[ ]5-[ ]6-[ ]7 -[ ]
37. Hours spent on traffic congestion daily 1-2-[ ]2-4-[ ]4-6-[ ]
38. Principal causes of traffic congestion

Accidents
Illegal street trading
Indiscriminate parking
General Road infrastructures
Population density and excessive influx of inbound traffic
Road system bottlenecks
Bad weather

Land use density
Loading and offloading
Poor enforcements of law

39. Adequacy of parking space in the survey region area in the study area Yes-[ ] No-[ ] undecided -[ ]
40. community perception of adequacy of roadways in the subject region Yes-[ ] No-[ ] undecided -[ ]
41. How long does it take to get from the Bus Stop from to office/ home [ ] Less than 10minutes [ ] 11 Min. – 20Min [ ] 21-40Min [ ] 41-60minutes. [ ] 60minutes above
42. How long does it take to get to work from to residential location? [ ] Less than 1hr [ ] 1 hr. – 2hrs [ ] 2hrs above.
43. What is your travelling cost in naira per day between your work place and place of residence? ______________________(specify) [ ] Less than =N=50 [ ] =N=51 – =N=100 [ ] =N=101- =N=150 [ ] =N=151 -=N=200, [ ] 200-above[ ]
44. How will you describe the quality of Pedestrian facilities in the study area? [ ] Poor [ ] Fair [ ] Good
45. How will you describe the quality of your Pedestrian facilities environment? [ ] Poor [ ] Fair [ ] Good
46. Which of these Pedestrian facilities is (are) available in your neighbourhood? Tick as appropriate

Facilities	Available	Not available
schools		
Public hospitals		
Market/Shopping Mall		
Drainage facility		
Play area/Recreation		

47. Purpose of making the Trip

Economics: Save money
Educational: Going to school to learn
Environmental: Make environmentally in a friendly way, encourage greener
Health: Heart, weight loss, reduce blood sugar, help brain enhances creativity
Recreational: Admire the scenery
Shopping: Buying for personal and family consumption
Social: Great way to meet a few neighbors and friends
Work: Source of livelihood for individual and family

48. citing different factor influencing the decision to walk

	Economic	education	Health	Recreational
Neutral				
Somewhat likely				
Rather unlikely				
Very likely				
Very unlikely				

49. distance respondent THINKS they can walk in a day (regardless of the number of trips)

Mile per day
1-5
6-10
11-15
16-20

50. response to what makes intra-urban pedestrian system robust

Pedestrian infrastructures
safety

security
enabling environment
differing to this inquiry
stigmatization

51. perception about pedestrian facilities

Adequate
Moderately satisfactory
Neutral
Not adequate

52. Expected shift in pedestrian preference

Shift in preference
Shift to other modes
Shift to cars
Not shifting

53. participant desire on intra-urban pedestrian safety

What will make pedestrian walk more often
Less car on the road -Zero conflicts with vehicular transport
Introduction and enforcement of the law
Government policies favoring pedestrian
provision of more of functional pedestrian facilities such as crosswalk, road, signage, Traffic light strategically located
Commit more money to transportation Planning
Addressing Proximity problems
Education for both vehicular operators and pedestrian

54. How long is respondents living in present place of residence? [ ] Less than 2 years ago [ ] 2- 5 years ago [ ] More than five years ago
55. Do respondents change residence in the last 6- 12 months? [ ] Yes [ ] No
56. If yes, which part of Lagos did respondants moved from? [ ] Mainland [ ] Island [ ] Outskirt
57. Give reasons for such movements answer to question 35 above is yes, what was the reason? [ ] Change of work [ ] Better accommodation [ ]connectivity issues [ ] Others __________________________ (Specify)
58. What attracted respondants to present place of residence? [ ] Affordability [ ]
59. Location [ ] State of the environment of the housing neighbourhood [ ] Nearness
60. to place of work [ ] Environmental quality [ ] Availability of social services and
    a. community facilities [ ] Housing size [ ] Housing quality [ ] Proximity to
    b. relations [ ] Attachment to family house [ ] Social life [ ] Access to
    c. employment opportunities

QUESTIONNAIRE B

Improving intra-urban pedestrian safety in Lagos metropolitan area, case study of Lagos Central Business District

(questionnaire for government Official of the Agency responsible for Transportation Management in Lagos State)

Researcher: Babatunde Kayode Tugbobo

Degree in View: PhD in Town &Regional Planning

Department of Architecture; Planning and Housing department; Howard Campus University of Kwazulu- Natal, Faculty Built Environment and Development Studies;

Durban- South Africa.

Dear Sir/ Madam,

The attached questionnaire is meant to raise queries on Pedestrian Transportation system in the inner city of Lagos Central. The study is being conducted by Babatunde Kayode Tugbobo, a Ph.D. Candidate of the University of Kwazulu- Natal, Faculty Built Environment and Development Studies; Department of Architecture, Planning and Housing department; Howard Campus, Durban- South Africa. The purpose of the study, apart from its strict academic reason, is to proffer strategies that will help introduce inclusionary pedestrian system in the inner city of Lagos Central. At the same time, expand and sustain Transportation System in the inner city of Lagos. The study will involve data gathering through administration of the structured questionnaires, which will be analyzed, the results of which will informed the study's recommendation. Participation is voluntary; this questionnaire seeks to elicit information about; transportation mode preference & land use location, demographic data and socio- economic characteristics. The questionnaire will take approximately ten to fifteen minutes to complete. There are no physical or social risks to those participating in this study. Refusal to participate will involve no loss of benefits or penalty.

Information obtained will be held in strict confidence and in anonymity; the findings will be available only to the researcher and the University.

The study may have no direct benefit to you. But the findings and the proposal will be of general benefit of the study area and Lagos in general. The questionnaire does not require your identity; thus, disclosure of identity is optional. You may ask the researcher any questions regarding this study, prior to or upon the completion of the questionnaire. If you desire further information regarding this study, kindly contact Babatunde Kayode Tugbobo @ bktugbobo@yahoo.com.

Thank you for your anticipated participation.

Tugbobo, B.K.

Location: --- Date: -------------------------------------

Draft questionnaire for pedestrian on the uses of footbridges.

1. Name of the respondent: (Optional)
2. Establishment
3. Academic qualification:
4. Designation
   (a) Years of experience:
5. Assignment / schedule of duty: What do you understand by pedestrian transport system?
6. Discuss problem of pedestrian in the selected route
7. Attitude towards pedestrian not using the footbridge?
8. What is the institutional penalty for violating the use of the footbridges?
9. How often do you enforce (item 9) above?
10. Do you usually enforce the law to later? (a) YES (b) NO
11. If "YES", explain detail
12. Any suggestion for improvement
13. Which of these pedestrian facilities is (are) available and how will you rate the facilities in your neighbourhood? (Tick as appropriate)

Facilities	**1-Strongly favour**	**2-Moderately favour**	**3-Ambiguous**	**4-Strongly oppose**	**5-Moderately oppose**
Bus Stop					

Walkways					
Traffic Light					
Pedestrian footbridges					
Side Walks					
Cross Walk					
Signalised intersection					
signalised Intersection					
Signage					

14. How long have you been living in your present place of residence? [ ] Less than 2 years ago [ ] 2- 5 years ago

    [ ] More than five years ago

15. How often do you use the Pedestrian facilities in the study area (circle one)

    [ ] 1-Very often [ ] 2- often [ ] 3-Occasionally [ ] 4-Never

16. When last did you use the pedestrian facilities in the study area?[ ] 1-everday [ ] 2- last week [ ] 3- last month [ ] 4- last year [ ] 5-never

17. Give reasons for such movements if your answer to question 35 above is yes, if your answer to question 35 above is yes, what was the reason? [ ] 1-Change of work [ ]2- Better accommodation [ ]3-connectivity issues [ ] 4-Others(Specify)

18. What attracted you to your present place of residence? [ ] Affordability [ ] Transportation network[ ]Aesthetic Quality of the Read[ ]Road Design

Major challenges of Pedestrian Transportations system	1-Strongly favour	2-Moderately favour	3-Ambiguous	4-Strongly oppose	5-Moderately oppose
Collisions or users attempting to avoid potential collisions					
Unsafe user behavior					
Low-level user skill or poor user judgment					
Pedestrian footbridges					
Dangerous conditions on the road such as rain or physical obstacles					

Poor road design, construction or maintenance					
Speed of Motorcycle operators					
User conflicts often go unreported, which leads to managers being unaware of situations creating conflicts until a serious incident occur					
Conflict between Trader and pedestrian					
Narrow road system that barely accommodate motorist					
Fear of Crime and Appearance					

19. Reason for not using pedestrian facilities in the study area Location [ ]1-The poor state of the transportation environment [ ] 2- distance of the available facilities to Transportation [ ] 3- Environmental quality [ ] 4- distance from all functional social services and community facilities [ ] Housing size [ ] Quality of the service [ ] Proximity to other transportation facilities [ ] too far from Place of work

20. In your own opinion, what are the major challenges of pedestrian transportations system in the study area.

21. Suggestion for improvements...

Thank You

QUESTIONNAIRE C

Improving intra-urban pedestrian safety in Lagos metropolitan area, case study of Lagos Central Business District

Inventories of an existing pedestrian facility in the study area

Degree in View: PhD in Town &Regional Planning

Researcher: Babatunde Kayode Tugbobo

Department of Architecture; Planning and Housing department; Howard Campus, University of Kwazulu- Natal, Faculty Built Environment and Development Studies. Durban- South Africa.

Field Assistant Name

Date & Time data collected/ performed

Climate condition during the survey

Street Name

(1) Measurement of the Road Way
(2) Category of the Road Way
(3) Number of Lanes
(4) Inventories / Measurements of Type of Transportation and pedestrian facilities available in the study area

a. Available Travel Directional Signs
b. Bus stops for loading
c. Footbridges
d. Posted Speed limits signs
e. Side walks
f. Transportation & parking Facilities available and Locations
g. Transportation Control Device available including Signalization

Walkways

10. Predominant Land Use and
    a. General Land Use pattern (With land Use Map Updated)
    b. General pavement conditions
    c. Typical Road sections
11. Other Features