SPATIO-TEMPORAL ANALYSIS OF PEDESTRIAN TRAFFIC IN IKEJA AREA, LAGOS

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CERTIFICATION

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DEDICATION

This thesis is dedicated to:

(i) Almighty God (Allah)

(ii) My Mother (Matinée Odjounne Fonglo-RAJI) and late Father (Salami Olajuwon RAJI) whose investments in their children's educational careers are outstanding.

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When Allah helps and Victory comes (Q110:1) But His
Command, when He intended a thing, is only that He said
Unto it: Be! And it is. Therefore, glory be to Him in whose hand
Is the dominion over all things: Unto Him you will be brought
Back: (Q36:82-83).

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ABSTRACT

In spite of the fact that vehicles and pedestrians constitute important urban traffic, conceptual explanations and investments have focused more on vehicular than pedestrian traffic and activities. This study was carried out to examine pedestrian volumes and patterns of flow, factors influencing decision to walk, and pedestrian level of safety in Ikeja, Lagos.

Data on the socio- economic characteristics, landuse and street maps of Ikeja were collected from relevant ministries. Seventeen landuse zones were identified in order to examine the spatial variations in landuse type, pedestrian traffic and related activities. Buildings on identified streets were systematically selected. Random sampling was used to select heads of households in selected buildings and pedestrians. Between May and August 2009, data were collected through a questionnaire survey administered to a total of 1,205 respondents. Vehicle speed, road width and number of pedestrians that walkway width carried were recorded along all the 56 streets. Mean and standard deviation were used to present results on pedestrian traffic and walking distances; t-test and analysis of variance were used to measure respondents' walking distance to facilities. Multiple regression was used to evaluate frequency of pedestrian trips and level of safety on roadways; logistics regression was used to estimate the decision to walk, and analytical hierarchical process was used to rank respondents choice of walkways.

An average of 56,663 pedestrians walked along all the streets between 7:00am and 7:00pm; and flow pattern varies significantly ($F_{16}^{187} = 56.76, p \leq 0.05$) across zones. The highest average hourly flow of pedestrians ($\bar{X}$=6,313±6,765.04) on road networks across zones was observed between 5:00-6:00pm and the lowest ($\bar{X}$=1,788±2,277.72) was observed between 7:00-8:00am. Residential landuse (28.1%) and commercial landuse (27.7%) were the most prominent landuse types while financial landuse (10.9%) and industrial landuse (8.0%) were discreet. From 7:00am to 7:00pm, Otigba zone with highest commercial activities (48%) recorded the highest average pedestrian traffic ($\bar{X}$=18,791±5,445.59) and Mobolaji Johnson zone with the lowest commercial activities (5%) recorded the least ($\bar{X}$=509±182.46). The mean walking distances by household heads to bus stations and landuse activities was 0.244±0.02km while that of pedestrians was 2±0.10km which was significant (t=71.01, p=≤0.05). Trips to work (30.4%); religious centres (20.5%) were the most important trip

composition while social trips (3.3%) and visit to friends (1.3%) trips were the least. Work trips (β=0.35, t=3.82) and trips to fast food points (β=0.29, t=2.63) were the significant factors explaining frequency of pedestrian trips. Respondents' decision to walk ($e^{(\beta)}$=1.81) under cool weather was almost twice than when it was hot. Female respondents walk ($e^{(\beta)}$=1.02) 1.02 times more than their male counterparts. Safety on walkways ranked highest (λ=0.44) while congestion on walkways (λ=0.04) ranked lowest in the choice of walkways. Pedestrians' level of safety increased with distance of walkways from moving vehicles (β_1=0.60, t_1=5.14), but decreased with higher vehicular volume (β_2=0.20, t_2=1.73) and speed (β_3=0.07, t_3=0.76).

There was a limited distance over which household heads could walk this encourages driving close to facilities thereby, creating congestion and parking problems. Increased investment through more pedestrian friendly roadways in central business districts of urban centres would enhance pedestrian mobility and safety.

Keywords: Pedestrian Traffic, Safety of Walkways, Urban Centres.
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CHAPTER ONE

BACKGROUND TO THE STUDY

1.1 INTRODUCTION

Human movements in cities over the world are made possible by transport, which provide vital clues to the understanding of human spatial behaviour. Particularly significant in urban analysis are the day-to-day movements of people, because they represent both functions and processes (Ayeni, 1979; Axhausen and Garling, 1992; Hoyle and Knowles, 1998). They are functions because of spatial relations of different parts of the city they maintain, and they are processes when changes in their volume, intensity and direction come to determine the pattern of growth and organization of the spatial structure of the city. For the fact that cities consist of spatially separated and highly specialized land uses; such as commercial, industrial, institutional and so on, people must move to obtain goods and services.

In many countries, residential areas and places of other activities such as work, school, recreation, market, religious camps, and so on are no longer close. People can now choose to live long distance from places of work, school, religious camps and travel everyday using different modes of transport. Transport therefore is highly significant in the existence of urban areas; and also creates demand for it (Hutchinson, 1974; Marlock, 1978; Ojo, 1990; Oyesiku, 2002; Solanke, 2005).

Road transport comprises of both motorized and non-motorized mode. While motorized mode includes cars, trucks, buses, motorcycles, and so on, non-motorized include pedestrians and bicycling. Pedestrian as defined by Australian Pedestrian Council (2004) is “any person wishing to travel by foot, wheel chair, or electric scooters, throughout the community. James and Walton (2000) further observed that pedestrian movement to transport experts is a mode of travel taken to access certain destinations on foot.

For several years, urban design and city planning communities all over the world have struggled with the challenge of the walking environment in a car-dominated landscape. Many designers of infrastructure planning work from an engineering paradigm that might not have fully recognized human experience as part of the design equation (James and Walton, 2000). Consequently, researches have focused on motorized mode to the exclusion of non-motorized (pedestrian and cycling). A key search of the engineering INSPEC (a major database for scientific and technical literature) shows a 53 times or more articles published since 1969 with 'vehicles' in the titles than 'pedestrians' a count for about 10,211 and 192 respectively (Desyllas, Duxbury, Ward. and Smith, 2003).

With rising dependency on the automobile and the disparity in research between motorized and non-motorized modes, motorized modes became ingrained in nations' transport policy (Hillman and Whalley, 1979; Brog and Erl, 2001; Gem Zoë, 2001; Desyllas, Duxbury, Ward. and Smith, 2003; Tight, Kelly, Hodgson, and Page 2004; Kim, 2005). But many nations particularly developing countries do not recognize the significance of pedestrian movement and the need for their infrastructural provision. Hence, there is no comprehensive transport policy that caters for this mode.

Studies have shown that low and middle-income earners and people with certain cultural background are found to engage in walking (Gunnay, Harvey, Woodside, and Vaganay, 2004; Rahman, 2007). In Nigeria, with diverse cultural background, there is tendency that significant number of Nigeria population will walk, or embark on a walking distance greater or less than 3.2 km propounded by Fruin (1971) in the United States of America to areas of socio-economic activities.

Furthermore, researches have also shown that the quality of footpaths or walkways and other pedestrian facilities on roads influence the decision to walk (Hass-Klau., Dowland, and Nold, 1994; Gehl, 1999; Association of Pedestrian Council, 2001). There are evidences in cities such as Gothenburg, Lund and Malmo (Sweden), York and Central London (UK), Portland (USA), and Copenhagen in Denmark.

In Nigeria, for instance, many city roads lack walkways and other pedestrian facilities. Where these facilities are available (in form of covered drainages), they become

spaces for street trading, on- street parking and avenue to generate revenue for Local Government Authorities who in some other cases allocate the spaces to traders, who later erect kiosks on them. Pedestrian facilities also serve as refuse sites, and home to destitute and robbers. During vehicular traffic peak periods, available walkways for pedestrians turn to motorways for motorcycles and tricycles, thereby exposing pedestrians to danger.

The reasons why people choose to walk and the physical factors that influence their decisions vary over space. These factors according to the Association of Pedestrian Council (2001), Rahaman (2007), Tight, Kelly, Hodgson, and Page (2004) and Boon, Tong and Olszewski (2005) include age, sex, level of income, location, weather, distance, season, time, safety, security, dirtiness of walkways, continuity of walkways, cohesiveness of walkways, statistics of which can hardly be found in Nigeria due to non-availability of data.

The need to understand the way people move in urban centres leads to the desire to predict their movements in order to assist planners in: (i) optimum location of facilities; (ii) allocation of staff to manage emergency services; (iii) organizing street festivals or religion camps;(iv) designing road network; and (v) pedestrianizing some urban central business districts.

In developing countries particularly Nigeria, the transportation system needs continuous evaluation. Achieving this requires designing efficient models or the use of predictive models in explaining pedestrian trips. Furthermore, researching into pedestrian movement in our urban areas will assist various local, states, and the federal governments in:

(i) Incorporating pedestrian mode of movement into national transport policy;
(ii) Incorporating pedestrian mode into on-going land development process in the urban centres;
(iii) Integrating pedestrian infrastructures and facilities with existing mode of transport;
(iv) Focusing on areas of density, land use, and network connectivity in urban centres so as to improve the potential for pedestrian travels;

(v) Identifying areas in urban areas where pedestrian activities predominate; already take place at high level;

(vi) Linking priority investment in pedestrian facilities to the areas where high usage will provide greater justification for the investment especially in relation to other transportation areas; and

(vii) Identifying urban centres that may likely receive a higher return for their effort to plan, develop and fund pedestrian facilities.

At this juncture, the need for pedestrian study in urban centres cannot be overemphasised.

1.2 THE RESEARCH PROBLEM

Movement of people and information has continuously been fundamental components of cities. Cities, people and their activity patterns therefore revealed themselves in transport flow and physical infrastructure that supports them (Wilson, 1972; Ayeni, 1992; Rodridge, 1998). With growing urban population and increasing vehicular volume, many cities are facing mobility and accessibility problems due to heavy traffic congestion, vehicular pollution and other environmental related issues. In order to address this situation, various governments have become more supply oriented and thus pre-occupied with building more roads, flyovers and they have completely neglected other means of transportation (Oni, 1992; Raji and Otun 2008).

Transport does not only mean 'to take or carry people and goods' from one place to another by means of vehicle, aircraft or ship but also by foot (Stradling, Meadows and Beatty, 2000). Stradling, Meadows and Beatty (2000) further observed that people's reduction in the use of private vehicles involve users changing their current patterns of life, and the main alternative to the use of private vehicles for short and unburdened trips is by walking.

Walking as a component of non-motorized transport is an ancient urban transport mode in both developed and developing countries. In recent times, around 25% of all trips and about 80% of trips under a mile in length are made on foot in the UK (DETR, 1999; National Statistics, 2001; DFT, 2003; Desyllas, Duxbury, Ward. and

Smith, 2003; ITS, 2004; Buchanan, 2005). In the United States of America about 100 million Americans do not drive, and about 10% of all trips are made on foot (FHA, 1971; Highway Statistics, 2001).In India and Dhaka city of Bangladesh, 60% of all urban trips depend on walking (Rao and Sharma, 1990; Rahaman, 2007), Maunder (2002), Howe and Dave (2002) observed that the most prevalent mode of transport in many African countries in recent time is walking. In Nigeria, for instance, it accounts for more than 80% of short-distance trips that take place in urban centres (Arosanyin and Ipingbemi, 2004).

Walking is the most primordial means of transport, but in this automobile age, it is the most neglected. Many researchers (Daniels and Warnes, 1980; Adeniji, 1981; 1985; 1986; 1991; Oyesiku, 1990; Ojo, 1990; Badejo, 1993; Ogunsanya, 1993; 2002; Adeniji-Soji, 1995; Okoko, 2002; Solanke, 2005), while tabulating modal split of any city; often miss out or focus less on the share of pedestrians. Furthermore, various governments' attention has been focused on public transport systems that would move people but pedestrians who form the prominent ingress and egress to the mass transportation system point have been ignored and either without or with little investment (Raji, 2010).

Even when pedestrians have perhaps been the most neglected of the transport system, cities have not braced up to the needs of pedestrians in the central areas. An important area or aspect of the overall issue in urban traffic problems is the set of problems that arise in relation to pedestrian trips.Trip analysis practices centrally focus on the problem of congestion, and on the construction of highways in its mitigation. Furthermore, parts of trip surveys have also shown that walking or pedestrian trips account for only 15% of the main mode split creating perceptions that trip by foot is relatively unimportant.

As Brög (2001) noted; "Walking is ignored in transport policy and planning because it is often not considered in traditional transport models. But even if it is included in behavioural transport surveys, the methods applied are very often inadequate and insufficient to show its relevance for everyday mobility. And from this neglect ……walking is underestimated for transport needs and in town planning."

Most urban planners particularly in developing economy, recognize the need for integrated urban transportation. However, they fail to recognize (i) the differential impact of various transport modes on the general qualities of urban environment;(ii) the unequal impacts of transport investment on the access of various socio-economic group of employment opportunities and to educational and other types of community facilities; (iii) the impact of changes in accessibility on the spatial distribution of urban activities; (iv)the uncertainty under which transport investments are made and the fact that they are made sequentially over a number of years and (v)the relationship of the financial resources required by recommended plans to the resources required by other public sectors.

Furthermore, the urban planners who must regulate and manage the transportation system in urban areas have little or no knowledge of modelling tools that can help in understanding pedestrian flows and trips. Few empirical studies have shown that many questions regarding pedestrian trips have been addressed poorly, among of which are:

(i) What factors are most important in individual decision to walk?
(ii) Which measures are successful in encouraging walking?
(iii) What are the maximum distance pedestrians are willing to walk?
(iv) What factors influence pedestrian number of walk trips?
(v) What are the factors that determine pedestrian level of safety and comfort on roadside environment?

As at late 1996, Department of Transport (1998) in the UK observed that solution to the questions raised above remain poorly understood and the picture has changed little today, particularly in most developing countries. For example, in Nigeria, cities and towns are growing and expanding without concomitant response to road transport infrastructure provision, the pedestrian aspect of these infrastructures have been ignored and as well used for other purposes.

In Lagos for instance, there is heavy vehicular traffic and motorists experience difficulties to move and park their vehicles. Consequently, cars are parked in a disorderly manner along sidewalks, street corners and thresholds creating serious

bottlenecks and traffic congestion within the city. These difficulties are more pronounced in the city's central business district. The phenomenon also presents itself in suburban business centers as well. In relation to these problems is the demand for pedestrian trips, non-availability of pedestrian facilities, and non-availability of pedestrian trips information as well as model that can assist in the decision processes.

The level of poverty and economic decline in the country has further made pedestrians vulnerable to attack and robberies. This has made the use of pedestrian facilities more dangerous and probably not encouraging. There is also lack of empirical knowledge regarding information about pedestrian activities under varying circumstances that require model-based approach.

It is against these backdrops that this study seeks to address questions raised, and to provide further understanding by analysing pedestrian trips, with the view at evolving effective and efficient patterns of pedestrian trips in Ikeja area of Lagos, and thus, contribute to the literature on pedestrian trips in developing countries.

1.2 AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to examine the fundamental developments that explain spatio-temporal analysis of pedestrian traffic in Ikeja area of Lagos State, Nigeria; with a view to identifying, understanding and explaining the processes and patterns associated with pedestrian trips in urban areas. The specific objectives are to:

1. Examine pedestrian walking distance and walking limit to various functions, services and bus stations or terminals in the study area.

2. Examine pedestrian trip frequencies in relation to their trip types, economic activities and level of accessibility.

3. Examine the decisions that enable people to walk.

4. Examine pedestrian movement in relation to pedestrian level of safety.

1.4 BASIS FOR THE CHOICE OF THE STUDY AREA

Pedestrian activities occur all over Nigeria, but they are more noticeable in urban areas. In Nigeria, urban centres can be found in the 36 states and the Federal Capital Territory, Abuja. This study therefore can be carried out in any Nigerian city, but Lagos is chosen for the study.

Lagos stands out as one of the 36 states in Nigeria with the highest concentration of industries and commercial activities with explosive population. The attribute of Lagos state as the commercial nerve of the country, also places her as the most chaotic in terms of pedestrian and vehicular traffic (Raji and Otun, 2008; Raji,2010). Lagos is also rated as the second fastest growing city in Africa and 7th in the world (Wikipedia, 2009).

However, Ikeja, one of the local government areas in Lagos state is most preferred for this study over other urban areas in the state because of:

(i) its role as the capital city of Lagos state and the seat of the local council till date,

(ii) it is inhabited by people of all sub-ethnic groups in Nigeria and West African states;

(iii) it is one of the vibrant Central Business Districts in Lagos State and Nigeria.,

(iv) it is known for its transit activities,

(v) it houses both local and international airports,

(vi) it is known for commercial, residential, financial, institutional, trading, shopping mix , religious activities, and so on,

(vii) it is known to be one of the major market areas for information technology that attracts people within and outside the country,

(viii) it is ranked highest with 35.7% in terms of socio-economic characteristics and development among the Local Government Areas in Lagos State, and

(ix) the possibilities of Ikeja being the destinations of many people coming from abroad, north, east, west and south of the urban area.

A look at the high intensity of businesses and commercial activities in Ikeja local government area of Lagos, and its roles as the capital of the state and local government headquarter, the amount of pedestrian and vehicular traffic generated daily in and out of Ikeja, has made pedestrian and vehicular congestion a recurrent problem in the area. Parking problems is clearly prominent while pedestrian circulation during the day is critical.

However, the study area is part of Ikeja, and it is the core economic area of Ikeja. The boundary is defined by major road corridors in the part of Lagos State. The western boundary is bounded by Lagos –Abeokuta and Agege Motorways, bounded in the east by Lagos – Ibadan Expressway, in the south by Mobolaji Bank Anthony way, and in the north by WEMCO Road.

1.5 LIMITATIONS OF THE STUDY

A number of problems are obvious in a research that concerns itself with examination of households, On-street persons (pedestrians found on the streets), and sequence of pedestrian activities. In developed economies, information on travel activities is available at the door steps of agencies such as Land Use Administration, National Household Travel Survey, and Association of Pedestrians Council. Information about travel behaviour can be collected from these institutions by picking travel diaries of individuals, which may be complemented with self-administered questionnaire and observational study.

Obtaining travel diaries of households and on-street persons in the study area was not possible through government agencies, hence, the need to use self-administered questionnaires. Although, the respondents in the study area were educated, almost all the respondents sampled did not keep travel diaries. Furthermore, getting information from household respondents required daily visits by the enumerators, and the visitation lasted several weeks before this could be achieved. This involved altering the time frame for data collection and incurring additional costs.

Acquiring information from on-street persons is not an easy task either; ever busy and impatient on-street persons ignored the enumerators, particularly the male

enumerators. The restructuring and on-going developmental projects in Lagos State also contributed to the problems encountered. Majority of the respondents (particularly, household respondents) are not friendly because, they believe the enumerators could be working for the state government and information obtained from them might be used against them. They were of the opinion that the information was meant for building tax, and some of the household respondents did not return their questionnaires.

The streets map obtained from Lagos State Physical Planning Department was not detailed and some of the streets names shown on the map did not match field observations. Consequently, the streets map had to be updated. Taking measurements of road segments in the study area was also very tedious and risky. Apart from the exposure to road traffic accident, the tapes used for measuring the road segments were damaged by passing vehicles during the field survey.

In spite of the problems encountered before, during and after the field survey, substantive information required for analysis for the thesis were retrieved from household respondents and on-street persons' interviewed.

1.6 ORGANISATION OF THE THESIS

Apart from chapter one which provides background to the study, there are six other chapters. Chapter two discusses the theoretical framework and literature review. Chapter three focuses on the methodology. Chapter four examines physical, socio-economic characteristics and movement patterns of pedestrians; chapter five discusses pedestrian walking distances and trips generated; chapter six examines people's decision to walk and pedestrian level of safety in Ikeja and the concluding part of the thesis was discussed in chapter seven.

1.7 SUMMARY

The chapter introduces the study by examining travel activities and the significance of the research in an urban area. The chapter also discusses the research problem by arriving at questions relevant to the study that are not well understood in the literature

and particularly in Nigeria. Achieving the aim of the study requires and exploration of concepts, theories, models and methods that explain the drive of the thesis. These are discussed in the next chapter.

CHAPTER TWO

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

2.1 INTRODUCTION

Human movements, particularly pedestrian trips have evoked several ideas and thoughts all over the world. Accordingly, there have been concepts, theories and models on the processes that underlie these ideas and thoughts. Among these concepts, models and theories that are significant to human movements (particularly pedestrians) are: Models of the Urban Spatial Structure, Models explaining Urban Circulation and the Ullman Triad. There are also Urban Transport Models, Behavioural modelling of Urban Traffic, Modelling Techniques of Pedestrian Traffic, Road Networks in Graph Theory and Walking Distance Concept. The chapter also reviewed empirical works in pedestrian movement, and as well examined the gaps that exist in the literature.

2.2 CONCEPTUAL FRAMEWORK

2.2.1 Urban Spatial Structure

Human movements in urban areas are consequences of spatial imbalance created by urban land use types. Urban spatial structure therefore, emerged along two different lines of survey. The first, which is relevant to this study, is characterized by classical theories, which give details about economic and human ecological patterns of land use organization through three major theories: The Concentric Zone Theory (Burgess, 1925); the Sector Theory (Hoyt, 1939) and the Multiple Nuclei (Harris and Ullman, 1945).

Burgess (1925) theory of "concentric zones" examines the expansion of city by explaining the processes of urban metabolism and mobility that revolved around a single centre; the Central Business District (CBD) (Figure 2.1a). Hoyt (1939) provided alternative explanations by describing urban expansion as 'axial growth', pushing out from the centre along transport lines. He argued that different income

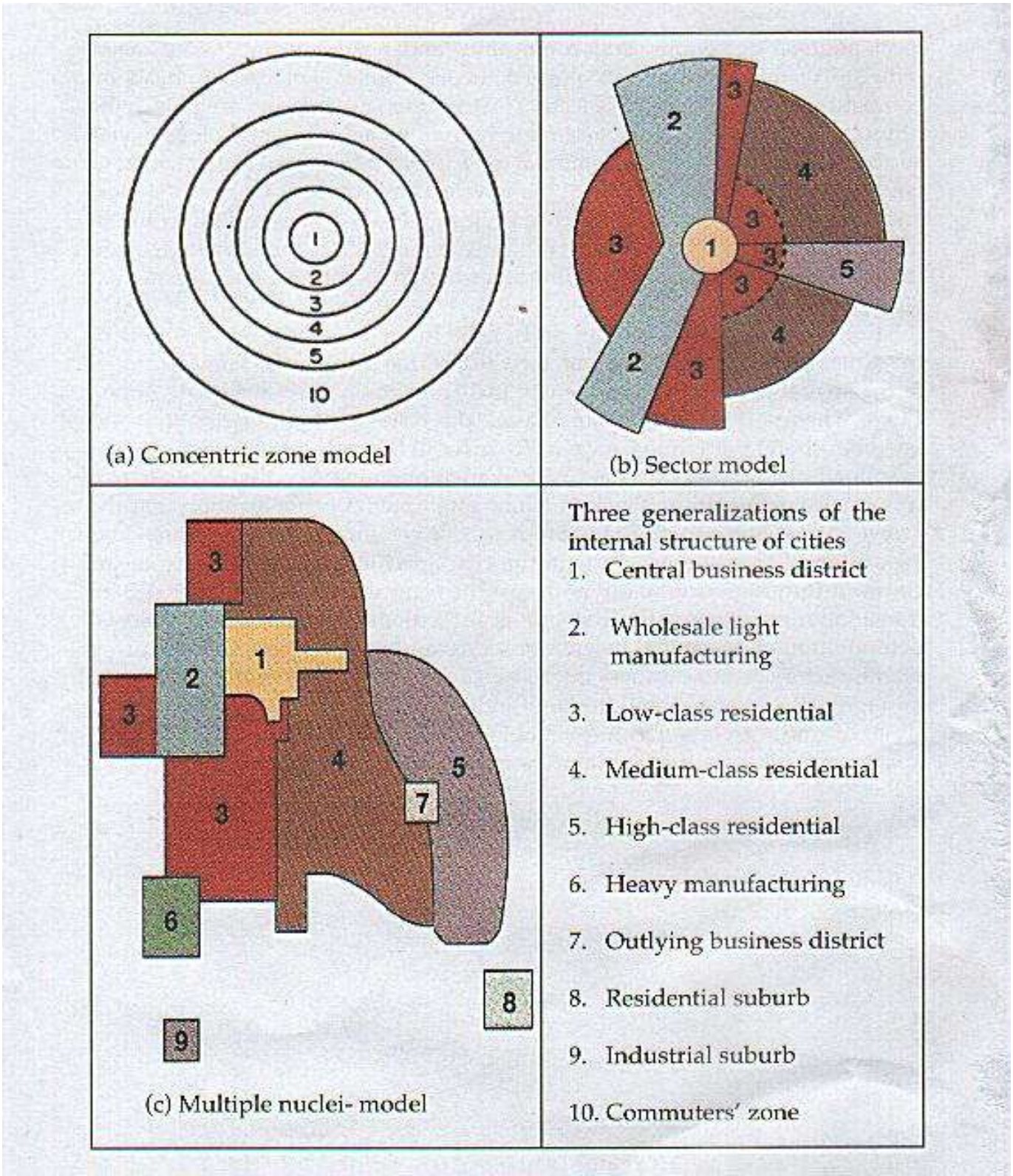

Figure 2.1: Models of Internal Structure of Cities

Source: Palen (1981) 'The Urban World' adapted from Oyesiku (2010).

groups tend to live in distinct areas and major lines of transportation constitute lines of least resistance for growth as well being important arteries along which similar types of land uses are situated (figure 2.1b). Nevertheless, mono-centric assumption was a major criticism of Burgess (1925) and Hoyt (1939) and this necessitated the proposition of multiple nuclei theory by Harris and Ullman (1945) (figure 2.1c).

Harris and Ullman (1945) observed that the land use of a city is built around several discrete nuclei rather than a single nucleus as postulated by Burgess (1925) and Hoyt (1939). They observed that nuclei are pre-existing agglomerations which become urban nuclei as areas between them are filled through urban growth, or new centres emerging from the need for certain types of services as the size of urban areas increases. Because of different origins, the functions performed by these nuclei differ from city to city. Theories of urban spatial structure provide basis for urban mobility in the city. They also provide explanations to location behaviour of households and groups (Ayeni, 1979; Aluko, 2004).

The relevance of these theories to pedestrian movements is based on their trip generating capability. City centres are focal point of socio-economic activities and because of their potential trip attractions, different land use types generate varying pedestrian trips within and outside residential, commercial, industrial, institutional and recreational zones.

2.2.2 Urban Circulation and the Ullman Triad

Human movements in urban areas are processes that extended over time and space. These processes which examine routes, modes and speed are called travel, and may be classified into *radial, circumferential, residential, travel to and from major activities and travel within the central business district* (Hutchinson, 1974; Abler, Adams and Gould, 1977; Adeniji, 1984).

The inputs to an urban transport system are the demands for the movements of person and goods between activity centers. These inputs are of two dimensions, (i) the spatial patterns of travel demand that exists throughout an urban region and (ii) the times throughout the day at which the dominant spatial patterns of demand occur (Hutchinson, 1974). A major output of the urban transport system is the travel times

that it produces for movement between various parts of an urban region. The magnitude of this output depends on the size of the travel demand and the capabilities of various links of the network. Urban transport system also produces indirect (or secondary) outputs such as the impacts that the transport system has on the spatial distribution of urban activities.

However, human movements in urban areas are made up of a number of different trip types that have specific spatial and temporal characteristics. In urban transport analysis, the trip types studied in a particular area depend on the types of transport – planning issues at hand (Solanke, 2005).

All movements in urban areas are basically point-to-points movements originating from a set of origins and ending at a set of destinations. It is also possible to resolve these mass movements into individual movements from point to point. Thus, point – to – point movement, leads to trip chaining and also serves as foundation for all kinds of movements. So, the spatial structures of the origins and destination points are important determinants of the structure of passenger movement systems and also contributed to spatial interaction theory postulated by Ullman (1956).

Spatial interaction theory as postulated by Ullman (1956) was based on three principles namely; complementarity, intervening opportunity and transferability (the Ullman triad). Complementarity means areal differentiation and the existence of supply and demand in different areas while intervening opportunities set up constraint as to the possibility of interaction. The argument being put forward is the fact that even when there is a supply in an area and a demand in another, interaction would only take place if there are no alternative sources of the same material (Ayeni1974; 1979; Ojo, 1990).Transferability is the ease with which demands are met. In fact, it is a distance issue measured in terms of transfer and costs. Hence, Complementarity may generate interaction but the factor of intervening opportunity brings about areal substitution and transferability factor results in substitution of products (Ullman, 1956)

Spatial interaction theory has offered some explanations to the issue of interaction in urban centers. The day-to-day movements of people to places of work, markets,

shopping centres, religious camps, recreation and to school, offer explanations to movement in urban areas.

In spite of the significance of Ullman's theory in explaining spatial interaction, it is rather insufficient in explaining complex interactions in contemporary world due to the dynamics in technology and human activities. Therefore, in the determination of the outcomes of urban transport system, it has been observed that models cannot be the only aid to understanding a complex process but can also serve as a measure of its effectiveness (Thomas and Hugget, 1980; Ayeni, 1979; 1992; Salter 1983). In the last three decades, series of models have been developed in explaining movements in urban areas. . These models which help in forecasting urban trips are discussed in the section that follows.

2.2.3 Urban Transport Models

Models symbolize reality and allow further study, analysis, evaluation and manipulation of systems of interest. Mathematical models therefore, serve as functional mechanism for, planning, evaluating and understanding various strategies of urban growth (Ayeni, 1979; 1992). However, the issue of how trips take place involves travel choices of individuals. As most commonly practiced in the world over, trip issues may be represented by "four step process" as shown in figure 2.2 and figure 2.3.

These four steps are supposed to represent the thought process of individual, because, individual makes four travel decisions as follows: (i) the decision that a trip is necessary to fulfil some need or purpose (generation), (ii) the decision where that need or purpose is best fulfilled (distribution), (iii) the decision of which means is best to get there (mode choice) and (iv) the decision of which route to take (trip assignment) (Wilson,1974; City of Rifle Transportation Master Plan, 2007). These basic analogies of the traditional 4-stage transport models are discussed below.

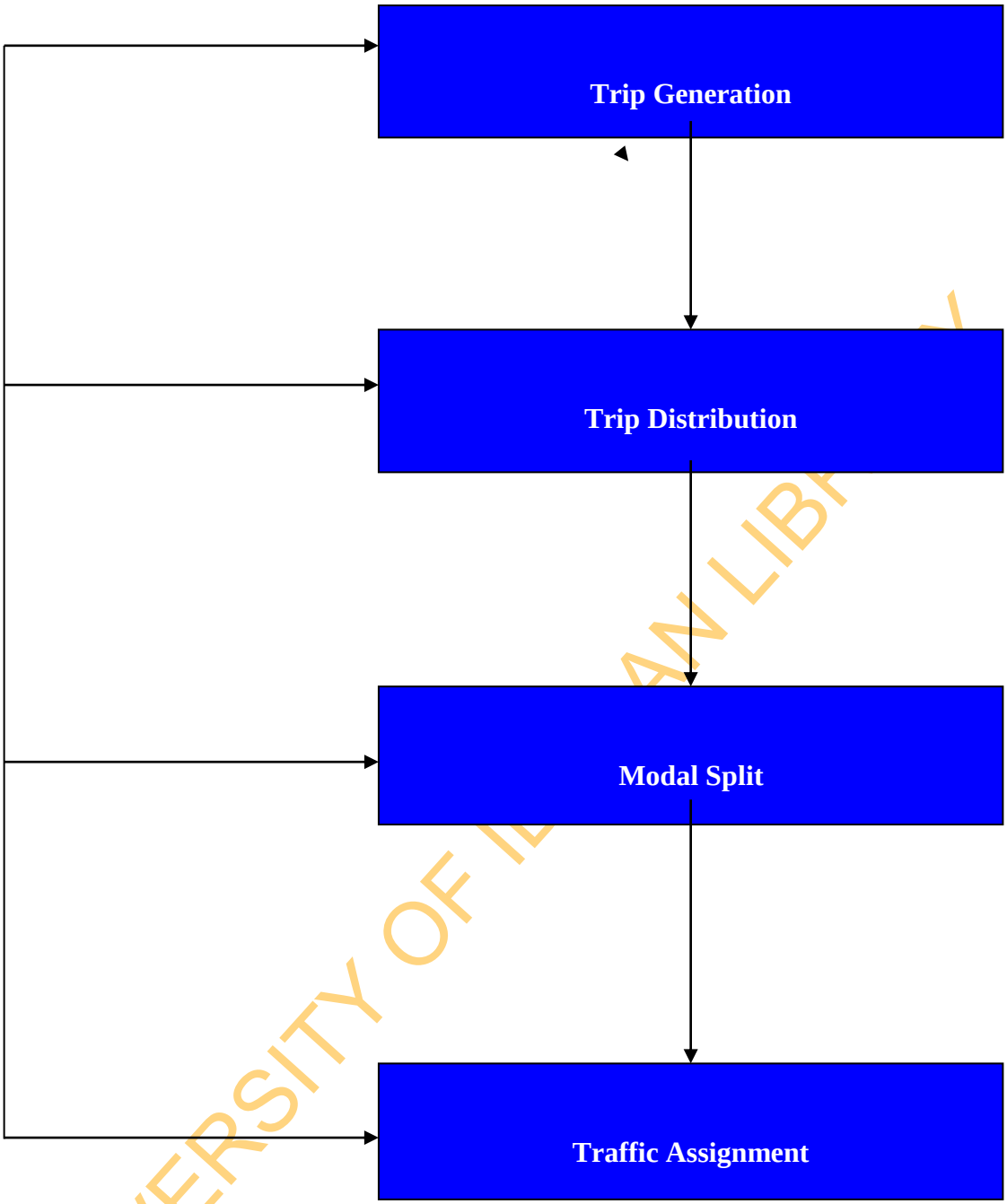

Figure 2.2: The Four-Stage of Urban Transportation Modelling.

Source: Paulley (2001)

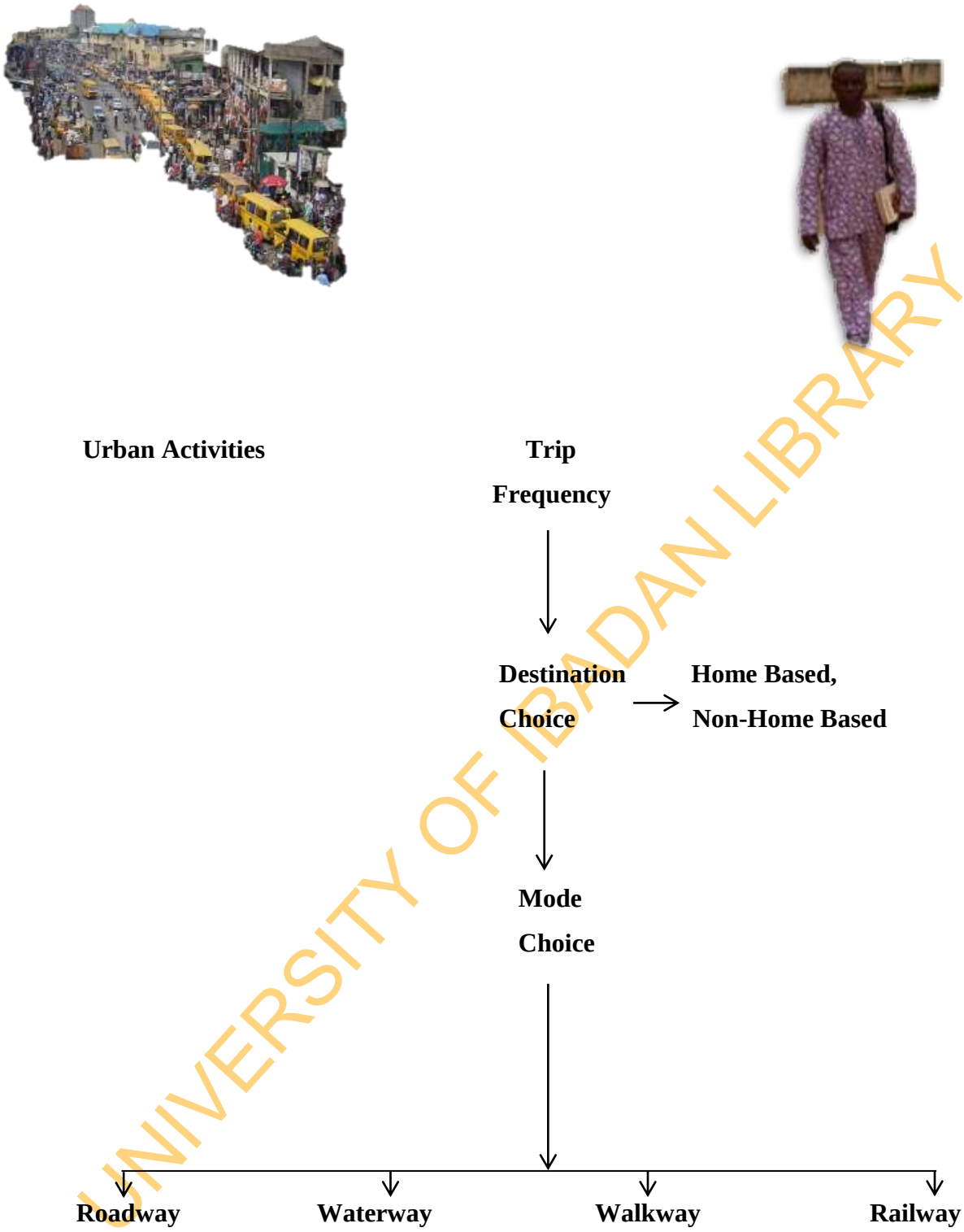

Figure 2.3: Individual Travel Demand Forecasting Process.

Source: Author's Conceptualization, 2009.

2.2.3.1 Trip Generation

Trip generation is the first step in demand travel forecasting and it involves *trip production and trip attraction* (Wilson, 1974; Salter, 1983). The aim is to estimate the numbers of trips generated by each zone in a study area. In trip generation, information from land use, various household characteristics such as car ownership, size of household, or income, and economic forecasts are used to estimate how many person trips will be made to and from each zone. Trip purposes that can be used include: home based work trips, home based shopping trips, home based other trips, school trips, non-home based trips, truck trips and taxi trips (Chicago Area Transport Survey, 1956; Salter, 1983; Wright and Ashford, 1989; TPH, 1992; IHT, 2001).

Regression and Category (Cross-Classification) Analysis are the major models used in trip generation (Hutchinson; 1974; Wilson, 1974; Ayeni, 1979; Papacostas, 1987; Okoko; 2006); although the most widely used is regression model. Trip generation equations have as their dependent variables the number of trips generated per person or per household for different trip purposes, pedestrian volumes, pedestrian level of service, and so on.

The independent variables such as land-use and socio-economic factors are considered as factors influencing trip making (Chicago Area Transportation Study, 1956; Fruin, 1971; Pushkarev and Zupan, 1971; Wilson, 1974; Behnam and Patel, 1977; Ojo, 1990; Kitamura, 1991; 1991; IHT, 2001; Desyllas, Duxbury, Ward. and Smith, 2003; Timmermans, 1992). Other independent variables observed by the studies of (Landis, Vatticuti, Ottenberg Mcloed and Guttenplan, 2001; Rahman, 2007; Boon, Tong and Olszewski, 2005; Nakkash and Grecco ,1972; Vic Kerman, 1974; Golding and Olsen, 1976; Leake and Huzzayin, 1979; Southworth, 1979) are availability of sidewalk, lateral separation, motor vehicle's traffic, motor vehicle's volume, motor vehicle's speed, driveway frequency and accessibility

Major problems with regression technique in estimating trip generation rate include (i) errors involved in least-square regression equations to predict future trip generation rates, and (ii) aggregate representation of household travel behaviour by assuming that the choice criteria in micro-economic decision-making for all individual are the same.

In spite of inadequacy of regression analysis as observed by (Meier, 1962; Weber, 1964; 1980; Salter, 1983; Thorngren, 1970; Hanson,1979; 1980; Hanson and Hanson, 1979; 1981; Anas, 1983; Horowitz,1980; Lierop and Nijkamp,1982; Ayeni,1986a; Kitamura, 1991) the technique remains a useful tool in forecasting trip generation in the literature. Nonetheless, allocation of the trips generated in terms of origin and destination (OD) is termed trip distribution, and it was discussed in section 2.2.3.2.

2.2.3.2 Trip Distribution

Trip distribution forecasts the distribution of trips between pairs of traffic zones and is usually conceptualised in terms of an interaction matrix known as "Origin-Destination Matrix." The origin-destination matrix shows the amount of trips from any zone (i) to any zone (j), including (i=j).

The purpose of trip distribution modelling is to find equations that reproduced the intra- urban and inter-zonal pattern of trips. Trip distribution models estimate trip volumes (X_{ij}) that interchange between all pairs of zone (i) and zone (j). In any urban area, if (O_i) trips are generated from zone i and (D_j) trips are attracted to zone j, this model calculates the volume of trip (X_{ij}) from zone (i) to (j), bearing in mind the effect of travel impedance (λ_{ij}) which could be the distance between (i) and (j) or the cost, or the travel time.

Although, spatial interaction theory has offered some explanations to the issue of interaction in urban centres and also provide reasons for the day-to-day movements of people to places of work, markets, shopping centres, religion camps, recreation and to school but it is limited in its applicability to complex movement patterns. Nevertheless, the use of gravity or spatial interaction techniques has a long and distinguished history in modelling the relationship between attractions and movement (Batty, 1976; Ayeni, 1979; Foot, 1981).

Reilly, a sociologist, was probably the first to introduce the Newtonian concept of universal gravitation to social science. Drawing an analogy from the gravity model, Reilly (1953) postulated that: two cities attract retail trade, primarily shopping goods, from an intermediate city or town.... approximately in direct proportion to the

population of the two cities, and inversely proportion to the square of the distances from these two cities to the intermediate town". Casey (1955) applied Reilly's idea to transportation planning when he discovered that "the purchases of the residents of a neighbourhood attracted to the retail centres is directly proportional to the size of the centres and inversely proportional to the squares of the driving time (distances) from the neighbourhood to the retail centre". Voorhees (1956) used gravity model to trip distribution in Baltimore by translating trips generated in land use areas into a matrix and he was able to identify the number of trips from origins to each destination in Baltimore in the US.

Gravity models enable prediction of intensity of interaction between where people start their journeys (the origins) and where they are going (their destinations), and form the basis of many transport-planning models. However, the model has not been successfully applied to modelling pedestrian movements at the scale of buildings and streets. Furthermore, the uses of Euclidian distance or shortest path through networks in gravity models are less applicable at small spatial scales. Gravity models are also criticised for modelling general patterns of movement and can never be used to model the movement of individuals (Hacklay, O'Sullivan, Thurstain-Goodwin, and Schelhorn, 2000).It also lacks theoretical basis besides its analogy with Newtonian concept of gravity (Ayeni, 1974; Openshaw, 1976; Lee, 1973). Another model that gives explanation to pattern of movement due to inconsistencies in Gravity model is the entropy maximisation model.

The entropy maximization gravitational operatives are derived from the concept of entropy in thermodynamics or statistical mechanics and partially from information theory in communication engineering (Clark and Avery, 1978; Ayeni, 1979). The concept of entropy is probably one of the most misapplied analogies drawn from the physical sciences (Ayeni, 1974; 1979). This misapplication arises from the simple descriptive use of a concept that is purely mathematical and which has very strong theoretical assumptions as well as inadequate appreciation of the difficulties emanating from the fact that the concept has been introduced into geography from two different sources. The simple descriptive use of the concept results in its somewhat ambiguous definition in the literature whilst the dual origin generates a certain degree of contradiction in its usage. Nevertheless, the model provides explanations to

movement in urban areas. The next model in urban transport model is modal split. This step involves the decision of individual in the choice of transportation mode to their destinations.

2.2.3.3 Modal Split Model

Trips may be made by different modes of travel and the determination of the choice of travel mode by individual is known as modal split (Salter, 1983). Typically, modal choice has two levels, the choice between private and public transport at one level, and between different public transport modes at the other level. Modal split model therefore is a model of human choice that explains how people select between competing alternatives of transport modes (Kanafani, 1983; Hutchinson, 1974). Mode-choice also helps in estimating amount of patronage on different transport modes and indicates the spatial pattern of this demand (Black, 1981). The models also attempt to predict the mode of travel that will be chosen for a particular journey or trip.

Daniels and Warnes (1980) identified five sets of variables that influence the choice of mode for a trip. First is the location of the individual to his or her destinations. If an individual lives only a few blocks from his or her destination, he or she might walk or ride a bicycle. Second and related to location factor are sets of trip factors. These factors include trip length, the travel costs, and the travel-time ratio which compares the travel time associated with different modes of transportation. Third is the number of private transportation factor which influence the decision whether to use private transportation. Fourth, is the public transportation factor, which includes accessibility of individual to public transportation facilities such as bus shelters, buses and trains. Fifth, is a set of economic variables, which particularly, involves economic status and auto-ownership of people, for instance, areas characterised by high economic status tend to be less dependent on walking and use of public transportation than areas characterised by low economic status.

Modal split could be analysed using any of the following models: (i) the stratified diversion curve model; and (ii) probabilistic models such as discriminant analysis, probit analysis and logit analysis. The diversion curve model is difficult to calibrate if more than two competing travel modes are involved. As a result of this, the

probabilistic models such as the discriminant analysis, probit and the multinomial or dichotomous logit models are widely used (Okoko, 2006).

In modal split model, decisions are made by comparing operation characteristics of alternative urban transport modes, but there are some subjective factors such as reliability (Golob, Canty, Gustafson and Vih, 1972), convenience (Spear, 1976), comfort and safety (Hartgen and Tamer, 1971), which contribute to any assessment of the attractiveness or otherwise of each of transport mode. Furthermore, socioeconomic characteristics of the travellers, his or her attitude (Golob, Canty, Gustafson and Vih, 1972) and the type of trip all play part in undermining any simplified explanation of choice.

Black (1981) was of the opinion that the complexity of factors in individual choice of means of transportation makes it difficult in the explanations of modal split. Furthermore, he observed that the complexity in individual choice factors enhances varieties of modal-split models. Their modelling sequence includes (i) combined with trip generation; (ii) between trip generation and trip distribution (trip end models); (iii) combined with trip distribution (gravity type models); and (iv) between trip distribution and trip assignment (trip interchange models).These modal-split models were based on motorized trips which include the pattern of mass public transport and personal transport but excluded pedestrian trips.

2.2.3.4 Traffic Assignment Model

The final task in terms of forecasting traffic flow is to assign trip to a particular road or route within the city. Once trips have been split into highway and transit trips, the specific path that they use to travel from their origin to their destination must be found. These trips are then assigned to that path in the step called traffic assignment. Traffic assignment therefore involves models of route choice and when predicting flows between traffic zones, it involves everybody choosing the routes with the shortest travel time. The process involves the calculation of the shortest routes from each origin to all destinations.

Some of the techniques of allocating trips to routes are: (a) All-or-Nothing Assignment (b) Assignment using diversion curves; (c) Capacity restrained

Assignment; (d) Multi-path proportional or probability assignment and (e) Linear programming assignment of trips

All-or-Nothing Assignment involves a route carrying all the traffic. However, a variety of problems occurred when using this approach. Lane et al (1971) observed that, (i) as with modal choice, people not only consider travel time when selecting route, but also travel costs;(ii) that individual perceptions of travel time varies;(iii) that traffic conditions and travel time vary at different times of the day and (iv) most importantly when two or more routes are close together, one route has to be only marginally quicker than the other for it to be assigned all the trips.

In an effort to address the last problem, Cadwallader (1985) observed that many transportation models use proportional or probability assignment rather than All-or-Nothing Assignment. Basically, proportional assignment involves assigning proportions of traffic among a number of alternative routes, as a function of time differences between these routes. Furthermore, he noted that though, this approach is more realistic in terms of producing multipath solutions, it is believed to be rather simplistic, as travel time is still only the determinant of route choice. However, in recent times, various traffic assignment models have been developed and they are based on (i) dynamic or time-dependent network attributes, and (ii) travellers' decision making and travelers' route travel time perception of the network (Liu et al 2002).

An alternative approach in urban traffic or trip which emerged during the 1970s are still relevant in research (Hensher and Stopher, 1979), and this involves analysis of individual travel behaviour. Analysis of individual travel behaviour is also embedded in behavioural models. Thus, section 2.2.4 discusses behavioural modelling of traffic.

2.2.4 Behavioural Modelling of Traffic

Behavioural modelling is an alternative approach which emerged during the 1970s and still being refined (Hensher and Stopher, 1979). It is the analysis of individual travel behaviour. A behavioural model according to Domencich and McFadden (1975) represents the decisions that consumers make when confronted with alternative

choices. Travel related choices include whether to make a trip or not, time of the day to travel, destination, transport mode and route.

A behavioural model is based on a representation of individual choice when faced with alternatives or common experience. Black (1981) suggests that in choice situation, a person weighs up advantages and disadvantages of course action against the advantages and disadvantages of the alternatives. The comparison is made on an assessment of the attributes of each alternative such as quality of pedestrian walkways or facilities.

A logical decision is to select the alternative which gives the greatest enjoyment. Hensher (1977c) observed that analysis in behavioural models look more realistic because behavioural pattern of individuals are investigated instead of statistically derived through zonal correlation. One of behavioural models which is relevant to this study is Analytical Hierarchical Process (AHP).

Analytic Hierarchy Process (AHP) is a decision algorithm developed by Thomas L. Saaty in the 1970s (Nataraj, 2005). Saaty (1990) describes AHP as "a method of breaking down a complex and unstructured situation into its components parts; arranging these parts or judgments on the relative importance of each variable; and synthesizing the judgments to determine which variable have the highest priority and should be acted upon to influence the outcome of the situation". Partovi (1994) observed that AHP has three broad steps: (i) the description of a complex decision problem as a hierarchy, (ii) the prioritization procedure, and (iii) the calculation of results.

Analytical Hierarchy Process (AHP) is a model with well-defined mathematical structure of matrices that are used to generate eigenvectors that are used in assisting people in making complex decisions (Merkin, 1979; Saaty, 1980; 1994). AHP methodology compares criteria, or alternatives with respect to a criterion, in a natural, pair wise mode. To do so, the AHP uses a fundamental scale of absolute numbers that have been proven in practice and validated by physical and decision problem experiments. The fundamental scale has been shown to be a scale that captures individual preferences with respect to quantitative and qualitative attributes better

than other scales (Saaty 1980, 1994). It changes individual choice of preferences that does not fit into linear framework into ratio scale weights. These weights help the decision maker in making a choice.

Analytical Hierarchy Process helps planners to capture both subjective and objective evaluation measures. It also provides a useful mechanism for checking the consistency of the evaluation, measures and alternatives suggested by planners and thus, reducing bias in their decision making. Analytical Hierarchical Process can therefore be considered to be both descriptive and prescriptive model of decision making. It is perhaps, the most widely used decision making approach in the world today (Nataraj, 2005). Its validity is based on thousands of applications which are well documented in the literature.

Like Logistics Regression and Multiple Regression models used in the study, Analytical Hierarchical Process is also important in this study in that as a model, it can be used to examine in order of hierarchy the most significant factors or variables affecting the decision of households and on-street persons' to walk along walkways as pedestrian. It can equally help in pedestrian route selections from many alternative routes. Analytical Hierarchical Process also helps in the examination, construction and maintenance of pedestrian facilities.

Several transportation planning researches and textbooks normally use regression analysis and categorical analysis to explain vehicle trips. Pedestrians that form part of the travel are often neglected in the models. The variables tend to focus on vehicle trips and these includes factors such as: household size, distance from CBD, residential density, income, occupation of the household head, and social area indexes (Oi and Whuldiner, 1962; Hutchinson, 1974; Meyer and Miller, 2001). These factors have been commonly used as the independent variables to explain vehicle trip making. However, it is not proven that the same factors are associated with pedestrian trip making. Section 2.2.5 discusses walking distance concept and modelling techniques of pedestrian's movement.

2.2.5 Modelling Pedestrian Traffic

Pedestrian movement or traffic, in the context of this study has to do with any person that travels by foot and the focus is on walking as a mode of transportation. Thus, this study examines pedestrian modelling techniques as it relates to pedestrian movement.

Pedestrian modelling is frequently used for making decision regarding the planning, design, and management of pedestrian areas. Modelling pedestrian flows or movements is quite useful in any strategy aimed at improving efficiency and comfort in mobility for large number of daily visitors, and it as well proves crucial for the profitability of such activities as retailing. For example, the designer of a new shopping mall would be interested in what location people are likely to be attracted to, or the operation of large-scale events (e.g. religious activities), might want to know where congestion will occur so they can develop management plans (Sinclair, 2004; Ronald, 2004; Ronald and Sterling, 2005; Boisvert, 2005; Ronald, Sterling and Kirley, 2006)

Approaches to modelling pedestrian movements can be *Macroscopic*, *Mesoscopic* and *Microscopic* (Hoogendoorn and Bovy, 2000; 2001; Hoogendoorn, Bovy and, Damen, 2002; Blue and Adler, 2000). However, the historical event in pedestrian studies and the position of automatic microscopic pedestrian data collection of pedestrian studies as presented by Tecknomo, Takeyama and Inamura (2002) is shown in figure 2.4.

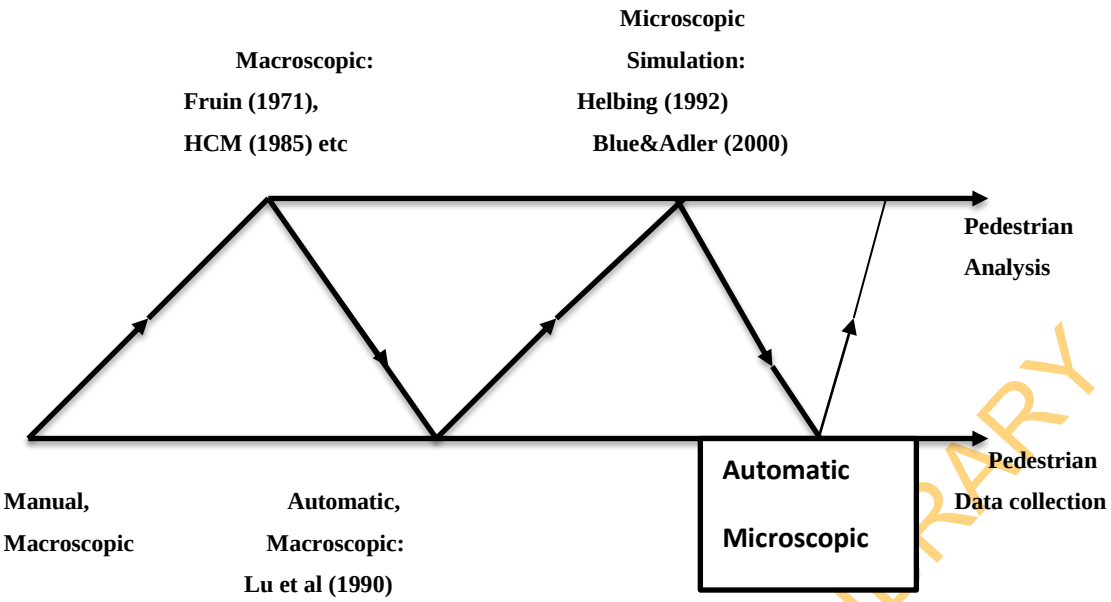

Figure 2.4: Automatic Microscopic Data Collection in Pedestrian Studies.
Source: Tecknomo, Takeyama and Inamura (2001)

2.2.5.1 Macroscopic Approach

Macroscopic models neither distinguish individual pedestrian nor describe the behaviour of pedestrians individually. Macroscopic models aggregate the characteristics of pedestrian movements (Hoogendoorn and Bovy, 2000; Harney, 2002). However, Fruin's work in the 1970s provides an understanding on macroscopic approach.

Fruin (1971) developed a level-of-service measurement that showed how congested areas are based on the density of people in that area. Level of Service (LOS) of a pedestrian is a pedestrian threshold, which attempts to measure the level of safety or comfort of pedestrians along roadways. It quantifies congestion by measuring the flow of pedestrian per unit width of walkway.

Six levels of Service are identified along roadways (Fruin, 1971) from A (free flow with typically less than 23 people per minute per metre of walkway), B (flow with typically between 23-33 people per minute per metre of walkway), C (flow with typically between 33-49 people per minute per metre of walkway), D (flow with typically between 49-66 people per minute per metre of walkway), E (flow with typically between 66-82 people per minute per metre of walkway) to F (extreme

congestion, more than 82 people per minutes per metre of pavement) where progress would be made by means of shuffling. Different areas, such as open space, lifts and stairs, have different density values for each level from A to F, where A is free flow and F is severely congested. However, this does not take into account the origin and destination of pedestrians, but the number of pedestrian passing at a particular point.

Mathematical models, such as regression and Markov, Spatial Interactions / Entropy maximizing models have also been used to model pedestrian movement (Harney, 2002). Regression models estimate the number of pedestrian that will visit certain area, based on elements such as retail floor space and parking spaces (Sandahl and Percival, 1972). For example, Pushkarev and Zupan (1971) used regression models to describe observed pedestrians in area of Manhattan in the US. In their study, Pedestrian volume per hour per block was used as the dependent variable. The explanatory variables used include commercial space, office space, cultural and entertainment space, manufacturing space, residential space, parking space, vacant space, and storage and maintenance space. Behnam and Patel (1977) study is similar to Pushkarev and Zupan (1971) study. Using regression analysis, Behnam and Patel (1977) estimated pedestrian demand in high density areas by using existing land use data and pedestrian counts in Milwaukee CBD in the US. They counted the number of pedestrians and observed the characteristics of their trips, including trip times and distances. Based on future land use variables, Behnam and Patel (1977) predicted future pedestrian volumes in Milwaukee CBD.

Timmermans,Vander Hagen, and Borgers (1992) used a regression model to describe observed number of pedestrians in various parts of the centre of Oregon in the United State of America and Sweden. Matlick (1996) used regression analysis to describe pedestrian demand by using household population, transportation mode share, and activity centre data. Matlick (1996) analyses determine the priority areas or corridors for improvement of pedestrian facilities. Ercolano, Olson, and Spring (1997) however, used peak vehicles per hour, transit vehicle/ ridership, and non-motorized modal share to estimate the pedestrian travel demand at the peak hour in suburban areas of Baltimore, Plattsburgh in New York to determine the location of pedestrian crossings, sidewalks, and signal re-timings.

Moudon, Hess, Snyder, and Stanilov (1997) using regression analysis showed effects of site design on residential density, income, automobile ownership, and intensity and type of commercial development. Six urban areas out of twelve neighborhood sites studied showed on the average, a volume of 37.7 pedestrians per hour per 1,000 residents, while the six suburban areas sampled showed an average volume of 12.5 pedestrians per hour per 1,000 residents. Ewing and Cervero (2001) providing synthesis of the relationship between travel and built-up environment, observed the effect of walking trips are on four variables: that is, prototypical neighborhoods, activity center, land use, and transport network. Ewing and Cervero (2001) results showed that walking trips are associated with transit-oriented neighborhood, the distance between commercial districts and residential areas, higher density areas, land use mixing areas, and multi-story buildings.

Quantifying pedestrians' perception of safety and comfort in the roadside environment, Landis, Vatticuti, Ottenberg, Mcloed, and Guttenplan, (2001) used stepwise multivariate regression analysis of 1,250 observations from event that placed 75 people walking on a road course in the Pensacola Metropolitan area in Florida. The Pedestrian Level Of Service (LOS) model incorporates statistically significant roadway and traffic variables that described pedestrian' perception of safety or comfort in the roadway environment between intersections. In the study of Dhaka city of Bangladesh, Rahman (2007) observed that LOS is a function of safety, security, convenience and comfort, continuity, system coherence and attractiveness.

Predicting average total pedestrian flow, (Desyllas, Duxbury, Ward and, Smith, 2003) used multiple regression analysis to test samples from manual observation studies of average total pedestrian flow per hour on 237 sites in Central London in the UK. The model provides predicted flow values for 7,526 street segments in 25 square kilometres of Central London. Boon et al (2005) used regression model to establish the relationship between walking distance perception and the corresponding measured route characteristics like walking time, presence of barriers and signalized crossing. They further used time contour and walking time ratio to determine pedestrians' accessibility to city centre. The results of the regression analysis showed that walking facilities and their characteristics did have substantial impact on pedestrians' perceptions of personal walking comfort and route quality.

The regression model had been criticized by Timmermans, Vander Hagen, and Borgers (1992) on the basis that the model has not been able to provide much insight into the factors influencing route choice behaviour of pedestrians, the sequencing of visits, complementary relationships, the strength of functional relationships between streets and the influence of locational pattern of shops on pedestrian movement. Nevertheless, the model is still relevant in predicting pedestrian movements.

The markov chain model is based on the assumption that only the last state occupied by the process is relevant to its future behaviour. The model has been used to analyse the kind and intensity of functional relations in multi-purpose trips (Harney, 2002). Markov Chain models is useful as it can be used to explain where pedestrian have visited most recently as this will have an effect on where to go next, and are most useful for trip chaining analysis (Horton and Schuldiner,1967; Wheeler,1972; Timmermans, Vander Hagen, and Borgers ,1992; Harney, 2002; Ronald, Sterling, and Kirley, 2007). However, this approach is severely limited due to its simplicity. The model does not include preference structure or a choice rule, thereby making the model theoretical underpinning relatively weak and not easily applied to changes in variables or conditions. Over the years, various proposition to overcome these limitations have been made, however, they seem to complicate the model, resulting into slight improvements in its applicability to a worldwide pedestrian movement (Harney, 2002).

Spatial interactions/entropy maximizing models are the most popular modelling form earlier used. They can be applied to model many types of interactions; hence, they form the basis of classical transportation models. Spatial interaction / entropy maximizing model form the basis for many computer applications used to model pedestrian and vehicular movements, and their goodness -of – fit has increased dramatically over the years. An example is PEDROUTE developed by Buckman and Leather (1994) a simulation model developed for Hal crow Fox and London underground Limited. PEDROUTE– is a pedestrian modelling software that produced detailed simulation of the movement of pedestrians around a station and provides statistics of their journey times, the delay, congestion and the level of service (LOS) for each segment of the road. Pedestrians are assigned along routes through the station using an integral dynamic assignment taking into account bottleneck and congestion

effects. Stations are broken down into different blocks representing stairs, escalators and platforms, ticket halls, with each of these blocks having different speed or flow curves associated with the movement of pedestrian through them.

Although providing powerful graphics and computational ability, the underlying assumptions and principles used in PEDROUTE and other similar computer program are the same as other spatial interactions/entropy maximizing models fail to incorporate the individual basic mechanism underlying pedestrian movements. These programs cannot represent the interaction of each pedestrian with other pedestrians and the external environment, only the overall or system-wide behaviour.

2.2.5.2 Microscopic Approach

Microscopic models consider the time-space behaviour of each pedestrian separately. Moreover, the behaviour of pedestrians is described in relation to other pedestrian in their direct environment. Examples of such models are the microscopic model by (Helbing, 1997) and the cellular automata model of (Blue and Adler 1999).

Helbing and Molnar (1995) observed that pedestrian modelling involves pedestrian movements in either positive or negative social fields, where pedestrian behaves as if acted upon by external forces. Using attraction and repulsion to model behaviour, Helbing, Molnar, Farkas, and Bolay (2001) developed complex equations to describe a range of pedestrian behaviours commonly referred to as "social force" model. They observed that streams formed in the crowd resemble fluid flows. Hoogendoorn and Bovy (2004) used the same starting point of basic mechanics formula and developed a three-layered model encompassing activity choice, way finding and walking.

A similar approach is the use of cellular automata (CA) where pedestrian occupies cells on a grid and move according to some simple rules. Cellular automata is an artificial intelligence approach to simulation modelling defined as: mathematical idealizations of physical systems in which time and space are discrete, and physical quantities takes on finite set of discrete values. A cellular automaton consists of a regular uniform lattice, (of 'array') usually infinite in extent, with discrete variables at each site ('cell'). These models generally use grid-based paths, where one person can occupy a cell at once. Most of the models based on this approach, used the

Schreckenberg-Nagel approach to modelling vehicle traffic using CA as a starting point (Nagel and Schreckenberg, 1992).

Cellular automata were extended to study pedestrian simulation by Blue and Adler (1998) who were first to generate fundamental pedestrian flows using CA micro-simulation of a pedestrian walkway with unidirectional flow. Each pedestrian in the study was allocated individual walking speeds and other characteristics, and their movements were governed by local rules. These local rules govern when cells are occupied, when pedestrian overtake, when they can change lanes and directs basic forward movement. This simple model replicated both the system-wide effects and individual behaviour of the pedestrian effectively as measured by various performance indicators.

With bi-directional pedestrian walkway Blue and Adler (1999; 2000) used micro simulation model for of uni-directional pedestrian flow by updating lane assignment, lane movement, and travel speeds. These experiments were conducted with unidirectional flow with varied lattice widths and lengths. But bi-directional flows were assigned to directional lanes with no direction cross over. The first experiment was to examine the sensitivity to the size of the lattice, and it was found that the changing in the dimensions of the lattice did not provide significant change in system performance. The second experiment examined the distinction that arises when directionality is added to the pedestrian stream, with no cross over between lanes. The results showed that field observations of bi-directional flows do not have different characteristics from single-direction flows (Blue and Adler, 1999).

The third experiment examined walkway where opposing traffic mingles and directional lanes are not set up. The results show the modelling power of CA that complex and reasonable group behaviour can emerge from a simple set of behaviourally based rules. The CA pedestrian model shows speed-flow density and fundamental flow characteristics that are acceptable based on their works. Although CA modelling is ‘grainy’, discredited in approach, complex movements are accommodated with a manageable set of parameters, resulting in viable directional pedestrian models. In spite of imperfect reproduction of pedestrian movements, Harney (2002) was of the opinion that emergent behaviours realized using this

modelling technique shows that CA modelling of pedestrians is a potentially powerful tool for traffic engineers, planner and facility designer.

In urban area, all trips or movements either home-based or non-home-based are generated through vehicular traffic, or pedestrian traffic. These movements are channeled through a path which can either be a walkway, a street, a road, a motorway and a highway, all of which are referred to as "networks". Networks also includes analysis of location of intersections, nodes and terminal, the density and length of routes; the accessibility of individual points on a network to other points; and the distance travelled to reach every point on a network. Section 2.2.6 discusses road networks and walking distance concept and their relevance to the study.

2.2.6 Road Networks in Graph Theory and Walking Distance Concept

The significance of road networks and walking distance in the explanation of trips, routes, and distance in geography is well documented in the literature. The two concepts are discussed in the following section.

2.2.6.1 Road Networks

The theoretical explanation of road networks in geography is rooted in graph theory. Graph theory is widely used in many disciplines and many applications of the theory exist in the form of network analysis. In geography, roads, transportation networks, boundaries etc are line patterns often referred to as networks. A network is defined as 'a mesh' of intersecting lines or a set of geographical locations interconnected in a system by a number of routes, junctions and termini (Elliot-Hurst 1974; Bradford and Kent, 1977; Biggs, Lloyd and Wilson, 1986; Ayeni, 1994).

A network tells us about how far locations are from one another, whether the lines are joined or not, whether the joining lines are straight or not, what commodities go through the network and whether flow is continuous or intermittent. A graph on the other hand, is defined as an array of points that are connected or not connected to one another by lines. There is little or no concern with the straightness or curvature of the length of the lines (Ayeni, 1994; 2000).

Chorley and Hagget (1967), Elliot-Hurst (1974), Bradford and Kent (1977) and also Ayeni (1994; 2000) described graph theoretic analysis of networks as the bridge between human and physical aspects of the subject. In graph theory, links as lines are usually called edges, sides, area segments, or branches. Points on the other hand, are called nodes, vertices, junctions, intersections, terminals etc.

In graph theory, there are measures for assessing road network. These measures are based on gross and shortest path characteristics. The gross characteristics include; Cyclomatic number, Beta index, Alpha index and Gamma index. Measures based on shortest path characteristics are the diameter, accessibility index and dispersion index (Bradford and Kent, 1977; Ayeni, 1994; 2000).Any nodes that is well connected to other nodes in a network is said to be accessible.

Accessibility is measured using either Konig number or the Shimbel index. However, Shimbel index is the most widely used in measuring level of accessibility. Shimbel index is derived from shortest path matrix and it indicates the number of arc needed to connect any node with all other nodes in the network by the shortest path (Elliot-Hurst, 1974; Bradford and Kent, 1977; Ayeni, 1994; 2000; Okoko, 2006).

Networks in graph theoretic forms carry both benefits and penalties. The gains are the high level of abstraction involved. It also enhances flexibility in making analogies between networks in human and physical geography. Network analysis is amenable to rigorous analysis through the use of factor analysis. Most artificial intelligence analysis of patterns in geography using topology makes use of these techniques (Ayeni, 1994; 2000).

Roads as network allow us to study common geometrical properties such that: (i) origins of pedestrian trips is represented by nodes (ii) routes or streets that pedestrians move is represented by links and (iii) various destinations of pedestrians is represented by nodes. Networks are structures designed to tie together nodes via routes, whether they are flows of people, goods, information, money, and so on.

Pedestrian use different modes and transport facilities to achieve their trips from point of origin to their various points of destinations. These could be achieved through

roads, railways, footpaths, streets, etc. At the street level, the level of accessibility of the street network in relation to land use and economic activities may have contributed significantly to the volume of pedestrians produced along such network. Nevertheless, there is also a ***'maximum distance'*** pedestrians would wish to walk to bus terminals or stations and to landuse activities along the road network. Therefore, section 2.2.6.2 describes the concept of walking distance.

2.2.6.2 Walking Distance Concept

The concept of 'walking distance' has been employed since mid-sixties as a criterion required in the planning of facilities in new urban sub-divisions. Walking distance is the distance from home or the origin of a trip to the bus stops or other public transport pick up points. Put in a broader perspective, it is a hypothetical distance which people usually those without a car, should be expected to walk to public transport stops as well as to locations of neighbourhood facilities (Adeniji, 1988). For instance, in the UK, 15 minutes is assumed to be the minimum walking distance for persons who do not readily have the use of a private car, and 5 minutes is taken as maximum distance that a car owner can be expected to walk to local facilities or public transport pickup points without using a car.

Exploring some urban plans that have adopted walking distance concept in the design of urban physical sub-division, Creswell (1976) observed that in the Abuja aster plan, a region that neither have specific population nor defined land area (during establishment), 400 metres or five minutes walking distance was proposed as maximum distance to neighbourhood facility. In Dodoma in Tanzania, a ten minute or one kilometre walking distance was proposed to neighbourhood facility. As shown in Gothenburg city, Sweden in the 1960s, a planned maximum walking distance to public transport was 500 metres (Gothenburg, 1960). But Swedish Public Transport Association (1969) recommended a walking distance of 300 – 900 metres to public transports stops to Swedish government (Wilson, et al, 1966). Their recommendations were accepted and became the standard criteria for calculating distance in Gothenburg and subsequent urban development schemes in Sweden.

According to Swedish Public Transport Association - SPTA (1969) walking distance can be determined if the cross section of each footway is drawn from local centre to

its extremity, while the level of the centre is considered to be datum line (see figure 2.5). In calculating the walking distance, the datum line is usually drawn, and for each one metre rise or fall above this datum line, the length of the footway (the walking distance), is reduced by ten metres as presented in figure 2.5. This reduction of walking distance is made so as to provide some allowance for the effects of the neighbourhood topography on the passengers. The walking distance recommended by the Swedish Public Transport Association is as follows:

W_1 = Actual walking distance in metres

W_2 = Level walking distance in metres

The actual walking distance (W_1) is determined by using equation 2.1

$$W_1 = W_2 - 10[(X_1 + X_2 + ... + X_n) + (Y_1 + Y_2 + ... Y_n)] \quad \textbf{2.1}$$

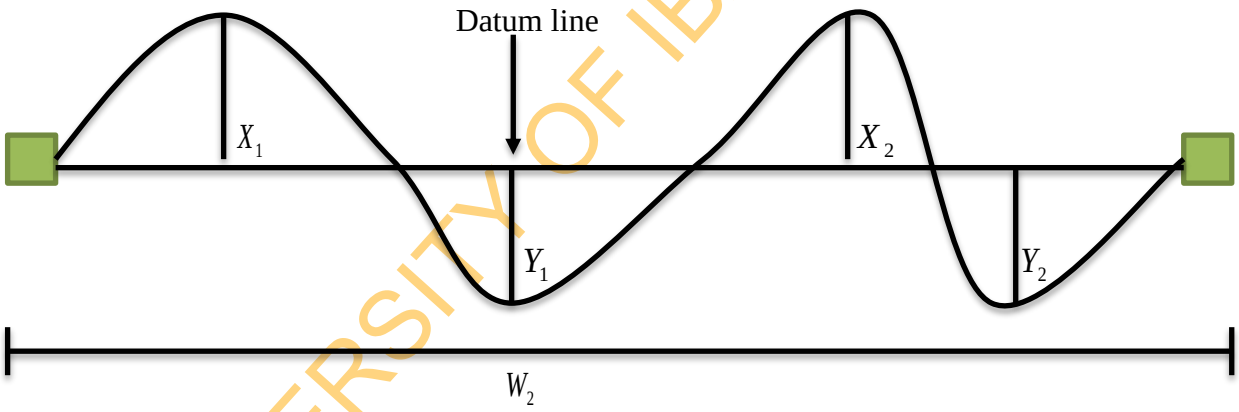

Figure 2.5: Walking distance Scheme of Swedish Public Transport Association. (1969) adapted from Adeniji (1988).

Where

X = Rise above datum line in metres

Y = Fall below datum line in metres

10 = Deduction factor for every one metre rise or fall above or below the datum line.

Like other theories, graph theoretical approach and walking distance concept have been criticized on several issues. One of the criticisms of graph theory is the loss of some attributes of networks such as orientation and shape as well as information in respect of volumes of flows. Harary and Palmer (1973) observed that counting graphs meeting specified conditions often known as "graphical enumeration" is a problem. Apart from colouring, there are also routes and covering problems; another common problem associated with graph theory is the sub graph isomorphism problem. This problem involves finding a fixed graph as a sub graph in a given graph. Despite these shortcomings, the theory provides an insight into network analysis in geography and as well help in the measurements of accessibility index of the road networks in the study area using Shimbel index.

Regarding the walking distance concept, the result of actual walking distance in equation 2.1 may vary across cities when considering their different socio-economic and physical conditions that also vary. However, in recent times there are computer designed programmes that simulate the movement patterns as well as distance covered by pedestrians in a particular location. However, empirical evidences of pedestrian movement and modelling are discussed in section 2.3 as literature review.

2.3 EMPIRICAL FINDINGS OF PEDESTRIAN MOVEMENT

There have been several pedestrian studies based on empirical examination of the effect of land use activities and socio economic characteristics on pedestrian movement and walking trip frequency.

In a pedestrian survey on the factors that influence pedestrians decision to walk other than socioeconomic characteristics, Forward (1999) summarized the factors as accessibility, comfort, heavy traffic, safety and security, and aesthetics. Fitzpatrick et al (2006) on the other hand, observed that the decision to walk usually takes into account the distance of the trip, the perceived safety of the route, and the comfort and convenience of walking in relation to alternative mode.

Furthermore, Fruin (1971) put the limit of people's walking distance at 3.2km in the United State of America. Nonetheless, studies have shown that distances between services have grown and studies have shown that about 80% of trips of trips under one mile or (1.6km) are undertaken on foot in developed countries (Demetsky and Perfater, 1975; Mitchell and Stokes, 1982; Central Bureau Voor Statistics; Forward, 1998a; Forward, 1998b; DETR, 1999; Living Streets, 2001;National Statistics, 2001; DFT, 2003; Desyllas, Duxbury, Ward. and Smith, 2003; ITS, 2004; Buchanan, 2005;; Fitzpatrick et al, 2006).

Fears about personal safety are one of the factors that have been identified explicitly in empirical work as influencing both pedestrian route and mode choice (Tight, Kelly, Hodgson and Page, 2004). Studies have shown that some people do not walk because of fear of attack (Crime, Concern 1997, Hamilton, 2000). Tight, Kelly, Hodgson and Page (2004) further observed that this fear is different in men and women, children and adults, elderly and young, ethnic groups and for those with learning and or physical impairment. There is also evidence that levels of fear are greater in urban areas compared with rural areas. Anxieties about personal security are particularly acute at night time and many people; women in particular organize journeys to avoid having to walk at night (Forward, 1998, Mackett, 2001, Living Streets, 2001; Hamilton, 2000).

In most studies, night time or the absence of adequate street lighting or dark spots were areas where potential assailants could hide, and were mentioned as factors deterring people from walking. Burkitt (2000) observed in his study that shift workers such as nurses in particular go to extraordinary lengths to make sure that they do not walk or catch public transport at night. Complex social trends have also affected children's activities and particularly walking over the past twenty years. In recent years, parents and guardians have come to fear that children could be attacked and abducted by strangers whilst on the streets thus leading to a restriction on children's freedom to play out or walk. There have been growing fears about the danger of road traffic that has meant that many more children are being escorted when they go out and not allowed to make journeys on their own. Hillman, Adams and Whitelegg (1990) found that parents restricted their children's freedom more because of their fears about road traffic than their fears about strangers assaulting their children. One

result of road traffic situations is that more and more parents are deciding that their children should be driven rather than walk to school (Bradshaw and Jones, 2000).
Road traffic type and volume are also given as factors in choosing not to walk. Appleyard and Lintell (1972) in a comparison between three streets observed that the street with the greatest amount of traffic resulted in the least amount of contact between people living on opposite sides of the road on the same street. Road traffic encompasses a number of different elements such as volume, speed and other behaviours.

In a study of mode choice for short trips (Forward, 1998) travel time was identified as a factor in the decision to walk and if the individuals believed themselves to be "in a hurry' they were less likely to make a walking trip. Hass-Klau , Dowland, and Nold (1994) ; Living Streets (2001) observed that urban form, that is, the structure and shape of the urban environment do influence peoples' decision to walk. Furthermore they opined that if the urban environment is designed and managed properly, it will encourage walking.

Quality of the footpath and other facilities designed for pedestrian use do influence the decision to walk (Pedestrian Association, 2000; Hass-Klau, Dowling and Nold, 1994; NCC, 1997; and Gehl 1999). The particular factors identified in the studies are space, continuity, cleanliness, rubbish, dog dirt and the condition of the pavement. Furthermore, there are evidences that provision of distinct footpaths for pedestrians in cities such as Gothenburg, Lund, Malmö (Sweden), York (UK), Copenhagen (Denmark), Portland (USA) encourages more walking journeys.

Weather often comes up in the lists of factors that people find significant in the decision to walk. Forward (1998) showed that for short trips, dry weather had a positive impact on the decision to walk. It is not only the discomfort of walking in inclement weather that can deter people from walking but also the fact that one has to dress in the appropriate clothes for the weather (Hodgson, 2000).Section 2.4 of the thesis examines the gaps observed in the literature.

2.4 GAPS IN THE LITERATURE

The literature reviewed above has shown that some urban structures readily lend themselves to integration of public transport into urban development than others, and in the micro urban level of planning, one form of physical unit or the other is relevant to planning concepts especially for the location of facilities and public transport pick-up points. In such physical urban sub units, proximity in the location of local facilities and public transport stops are given serious consideration in order to provide convenient and increase efficiency of public transport systems. In the planning of housing estates or major urban expansion schemes, research has shown that attention is paid more on population size and the sphere of influence of the supporting local facilities, with the neglect or little focus on acceptable walking distances to location of such facilities and public transport pick-up points. Hence, the distance people are ready to walk to public transport stops and facilities is overlooked and least understood.

Some researchers believe that the main generator of movement is the configuration of the street network itself, and their patterns of movement are largely determined by this configuration, rather than by the distribution of attractors within the network. They however, ignore the evidence of changing land use patterns on movement rates. So, it is significant to note that the actual street configuration has not changed, but the location of geographical phenomenon such as shops has, untimely responded to changing activity patterns of the town's inhabitants.

Macroscopic pedestrian models earlier described are useful at the macro-scale in the explanation of pedestrian movement. Unfortunately, this highly aggregative nature of these models constitutes their greatest weakness. These models view human movements on earth's surface as being homogeneous. Hence, the four travel decision processes of, the need or purpose of to fulfill a trip (trip generation), where the need or purpose is best fulfilled (trip distribution), the decision of which means to get there (modal choice), and the decision of which route to take (traffic assignment) are considered to be the same. This is rather unrealistic when considering the heterogeneous nature of urban transportation, the structure of urban areas and individual decision making processes that differ.

Although, microscopic pedestrian models explain pedestrian movement at micro-scales, but the microscopic models assumptions placed pedestrian into lanes and grids as vehicles. Microscopic models also placed people on walking trips and their movements are guided by set rules such as direction of movement, where to stop, distance to cover and so on. Human movements however are more complex than been restricted to lanes and grids, and their directional movement makes it difficult to understand the behavioural pattern of their movement.

Another approach to urban modeling that found favour in urban geography is behavioural approach which puts greater emphasis on the decision making processes that generates various kinds of spatial patterns and introduced into urban geography the study of movement patterns, especially those associated with intra-urban migration and journey to shop (Herbert and Johnston, 1978; Hensher and Stopher, 1979).A major stand within the behavioural approach relate to the notion of individual cognitions of urban environment. Urban dwellers believed to possess cognitive or mental maps of their surrounding environment, and these maps are far from being identical to the physical structure of the city. It is the distortion contained in such maps, however, that are primarily of interest as they shed more light on the behavioral context within which decisions concerning spatial choices are reached. In as much as pedestrian models allow chaining of the origins and destinations of people and as well give room to predicting the likely destination of an individual at a given time, however, they do not include preference structure or a choice rule, thereby making their theoretical underpinning relatively weak and not easily applied to changes in human rational thinking or condition. Based on the background of the study, the research problem and review of literature, section 2.5 examined the hypotheses of the thesis.

2.5 HYPOTHESES OF THE STUDY

The hypotheses of this study emanated from background to the study, the research problem, conceptual framework and literature review. These hypotheses are:

I. The maximum distances people are ready to walk to bus stations, landuse activities and various functions and services do not vary across zones in the study area.

II. The number of pedestrian trips made by households' and on-street persons' in urban centres is a function of their trip types, number of economic activities engaged in and the level of accessibility.

III. The decision to walk and the pattern of movement vary with socio-economic characteristics, nature of pedestrian facilities and factors such as distance, time, season and weather.

IV. Most people walk in areas where their level of safety is higher, than in areas where their level of safety is lower and their trips safety is a function of lateral separation, traffic volume, vehicles' speed and drive way access.

For the testing and understanding of the hypotheses, there arose the need to operationalize certain concepts. For example, level of accessibility, the decision to walk and pedestrian level of safety. Level of accessibility was measured using Shimbel index, the decision to walk was measured using dichotomous response 'ready to walk' and 'not ready to walk' and pedestrian level of safety was measured using pedestrian level of service. Details of the operationalization and measurement of these concepts were discussed in appropriate sections of the thesis.

2.6 SUMMARY

This chapter examines concepts, models and theories that explain pedestrian movements as a basis for the examination of characteristics and factors of pedestrian movements. Although, the development of models may have identified some critical factors, most of the proved concepts used in these models appear to be minimally necessary but incompletely understood. In their applicability, most of these models were developed in advanced economies where there are adequate and effective pedestrian facilities. Furthermore, most of these models have not been applied to

pedestrian movements in developing economies particularly Nigeria. Applying these models to the study in Nigeria where pedestrian facilities are inadequate, and with diverse cultural background may generate similar or different results from those observed in advanced economies.

The chapter showed that main sources of information of pedestrian trips in the literature rely on the information based on Census of National Household Travel Survey (NHTS), airport, substation, underground metro lines, rail station, shopping mall and stadia.The data of which can hardly be found in country like Nigeria. Hence, Pedestrian modelling researches based on households and people walking along city streets in the literature particularly in Nigeria are grossly inadequate.

Furthermore, the distance people are ready to walk; the factors that encourage people to walk; and factors that explain pedestrian level of safety along walkways have been advanced in the literature. However, little is known about these factors in Nigeria, particularly Lagos the economy nerve centre of the country. Also, very little researches look specifically at how far pedestrians walk to any destination. The survey often examines the number of pedestrian trips made, but do not include walk trip distances. Thus, making the maximum distance people can walk to urban facilities least understood. Based on the analysis above, there is the need for empirical research in the area of pedestrian movements and modeling in Nigeria using both households and city street data so as to contribute to knowledge in the area of pedestrian movements and modeling in Nigeria. The methodology of the study was examined in the chapter that follows.

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

This chapter of the thesis discusses the methodology used in accomplishing the aim and objectives of the study through the testing of hypotheses of the last chapter. Details of the methodology include research design, types of data source and method of data collection, sample size, questionnaire administration and sampling procedure, measurement of variables and techniques of analysis.

3.1 RESEARCH DESIGN

Survey research design was employed in obtaining data and variables required in the explanation of pedestrian movement in this study. Movements in urban areas are concerned with spatial interaction. The spatial interaction involves examination of both vehicular and human movements in cities. The focus of this study however is on pedestrian movement patterns. The study is based on aggregate movement pattern of urban residents as pedestrian in relation to their socio economic characteristics and disaggregate pattern of their movement as pedestrian based on their level of service, level of economic activities, safety, comfort, security, distance, weather and so on in the urban area.

The study focused on household heads and on-street persons' (*people observed while walking on the streets*) in Ikeja area of Lagos. The choice of household heads and on-street persons is because most individual is a pedestrian at a particular time of the day. Particularly, a member of a household can be a pedestrian either at the beginning, at the middle or at the end of household member's journey.

On-street survey was used to obtain information from pedestrians walking on the streets. Observational study was used to record and measure pedestrian flow and pedestrian level of service along streets segment in the study area respectively.

Quantitative and qualitative measures were used to examine urban land use pattern; purpose of trip and pedestrian trip types in the study area. The delineation of the study into seventeen zones (see Figure 3.1 and Figure 3.2) was based on: (i) the need to observe spatial variations in the landuse types, pedestrian traffic and related activities of the subunits that made up the study area, (ii) the need to focus on areas in Ikeja where pedestrian activities predominate and (iii) the studies by Hutchinson (1971), Salter (1983), Okoko (2002) who were of the opinion that survey area in which trip making is to be studied in detail may be bounded by an external cordon, such that all developed area which influences travel patterns are included with areas which are likely to be developed. Permitting disaggregation of data obtained for the study area therefore, required the division of the study area into zones and each zone is named after a popular street inside the zone (see Table 3.1).

Information was sought on pedestrian day-to-day movement and land use pattern of Ikeja metropolitan area of Lagos. Other information sought include: availability of pedestrian infrastructure, factors affecting pedestrian walkability, pedestrian walking distances as well as maximum distance pedestrians are ready to walk to various activities or functions. Availability and non-availability of pedestrian walkways inform the need to model pedestrian level of safety in the study area. Variables used in explaining the research hypotheses were operationalized under measurement of variables. Schematic presentation of the research process is presented in Figure 3.3.

Figure 3.3 showed the delineation of study area into zones after a pilot study. The zones consist of industrial, institutional, residential, commercial and other landuse area. Information was sought from households and on-street persons through questionnaire and direct observations. The inter-nets and journal publications and maps are also of important sources of information. Road width and vehicle speed were measured with tapes and radar gun respectively. Statistical software enables analysis of data obtained using logistic and multiple regression. Other techniques used include analytical hierarchical process, Shimbel Index and ArcView GIS.

Table 3.1: Summary of the Sample Size and Questionnaires Administered

Zones Code	*Name of Zones*	*Number of Streets in each Zone*	*Estimated Population in each Zone*	*Stratum of the Anticipated Household Sample Size*	*Household Sample Size*	*On-street Persons Sample Size*	*Total Sample Size for each Zone*	*Number of Questionnaire Retrieved*			
								Household Sample Size		**On-street Persons Sample Size**	
			(n)	***(N_k)***	***(n_k)***			**Male**	**Female**	**Male**	**Female**
1	Otigba Area	19	9,975	1,002	79	16	95	56	23	05	11
2	Awosika Area	12	6,300	525	50	10	60	35	15	02	08
3	Obanta Area	19	9,975	1,002	79	16	95	63	16	07	09
4	Kudeti Area	22	11,550	997	91	19	110	45	40	11	08
5	Akeem Balogun Area	13	6,825	1,001	54	11	65	39	13	07	04
6	Ajanaku Area	14	7,350	912	58	12	70	31	27	04	08
7	Governor Area	10	5,250	988	41	09	50	30	11	03	06
8	Kadiri Area	10	5,250	988	41	09	50	23	18	04	05
9	Olanrewaju Area	11	5,775	1,008	46	09	55	29	17	05	04
10	Mobolaji Johnson Area	07	3,675	998	29	06	35	21	08	01	05
11	Kasumu Aleshinloye Area	09	4725	991	37	08	45	22	14	04	04
12	Morrison Area	18	9,450	1,004	75	15	90	46	25	06	09
13	Allen Area	15	7,875	996	62	13	75	28	32	05	08
14	Unity Area	17	8,925	1,006	71	14	85	31	39	03	11
15	Alabi Area	13	6,825	1,001	54	11	65	37	15	04	07
16	Community Area	15	7,875	996	62	13	75	29	32	08	05
17	Acme Area	17	8,925	1,006	71	14	85	41	27	05	09
	Total	241	N =126,525	16,421	1000	205	1205	978		205	

Source: Field Survey, 2009

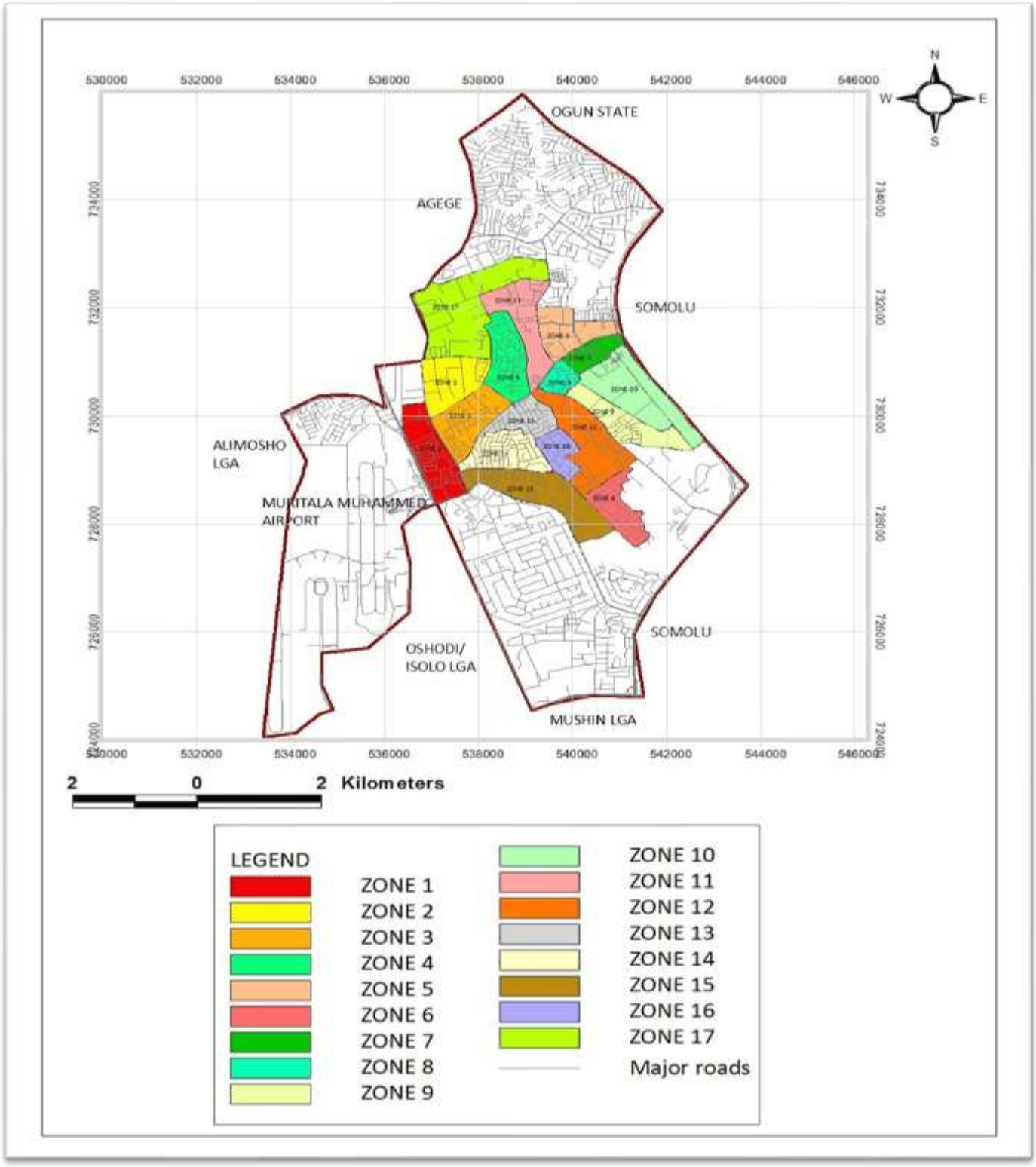

Figure 3.1: The Study Area within Ikeja Local Government Area.

Source: Field Survey, 2009.

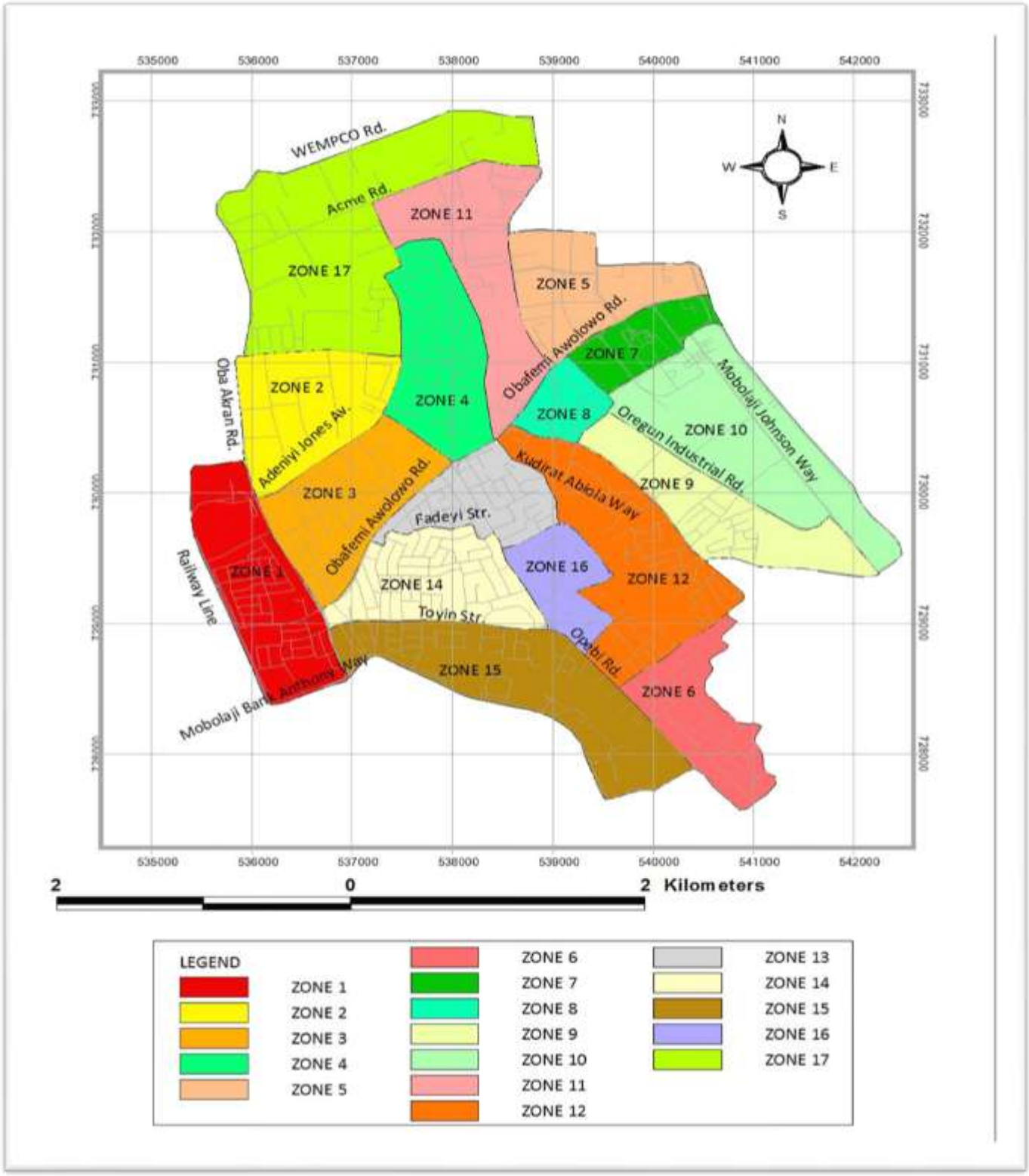

Figure 3.2: The Delineation of the Study Area into Zones.

Source: Field Survey, 2009.

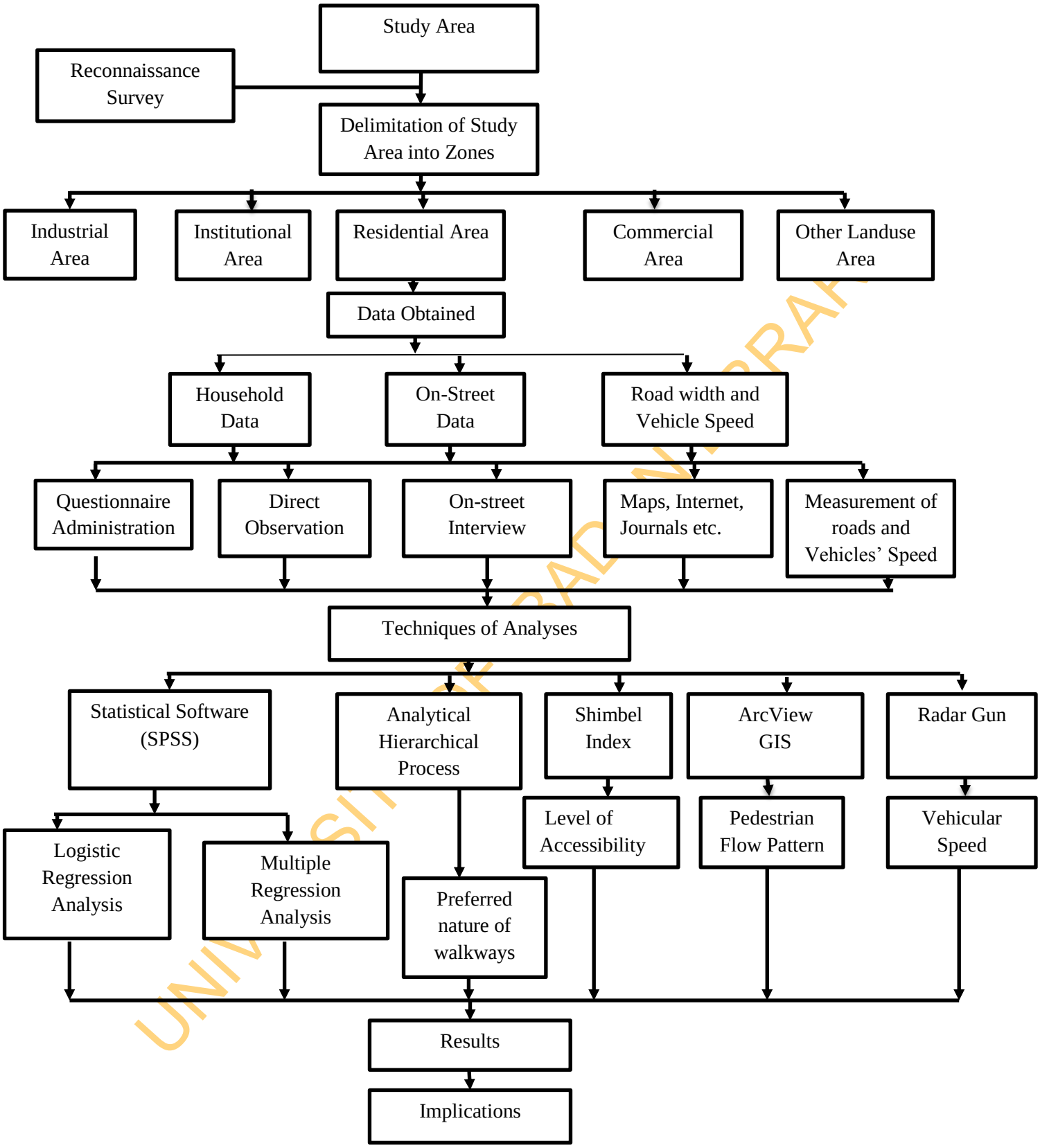

Figure 3.3: Schematic presentation of the Research Process of the Study.

Source: Field Survey, 2009.

3.2 TYPES OF DATA AND METHOD OF DATA COLLECTIONS

Data used for the study were collected from both secondary and primary sources. Descriptions of data types and methods of data collection of the thesis are described in section that follows.

3.2.1 Secondary Sources

Secondary sources used are the Local Government Year Book, Annual Abstract of Statistics, Local Government Digest, Technical Reports, Academic Journals and other periodic publications of Lagos State that contains historical development of Ikeja.

Administrative and landuse maps of Ikeja were obtained from the Lagos State Urban Development Planning Department. Population figures of Ikeja Local Government Area were obtained from National Population Commission (NPC) office in Lagos. The population figures obtained from National Population Commission were used to explain the significance of population distribution in the development of the study area.

Data on Ikeja road network and length of road network was obtained from Ikeja Local Government Secretariat. Information from this source was used to determine the number of road network in each zone in the study area. This information was useful in the questionnaire administration for both household and on-street respondents. Furthermore, information on the road network eased administration of questionnaire and as well helped in identification and selection of streets that engage in pedestrian activities on daily basis.

A review of research work on regional development in developing societies reflects concentration of social and economic variables in various forms. In the study area, the following variables were considered to complement available data of socio economic development of the seventeen zones under study. They are:

(i) High, medium and Low density residential areas and Government Reservation and Acquisition Areas;

(ii) Commercial Area;
(iii) Institutional Area;
(iv) Shopping Malls;
(v) Recreational Area;
(vi) Industrial Area;
(vii) Airport;
(viii) Open Space; and
(ix) Health Facilities.

Explicitly, these variables include retail shops, manufacturing industries, motels, hotels, restaurants and bars, construction and allied industries, financial and financial related institutions, hospitals /maternities/clinics, printing and publishing companies, Secondary schools, Primary schools, nursery schools, office and other governmental and non-governmental agencies and religion activities.

These variables were chosen for the study because they are functions and services that are measurable. They have also been recognized as measures of urban socio economic growth and are found relevant in the volume of pedestrian trips generation in the study.

3.2.2 Primary Sources

Primary sources of data used to complement secondary sources in the study include questionnaire administration, on-street interview, observational study, and field measurement.

3.2.2.1 *Questionnaire Survey*

Questionnaires in appendix I were used to obtain information from urban residents. The questionnaires were designed to capture the behaviour of household heads and on-street persons. Household, on-street person's survey and survey based on the land use types are known to be significant in decision making of individual movement patterns. These surveys also constitute the major points of origin or destination of urban trips as discussed in chapter two.

The questionnaire (appendix I) provided information on urban residents' movement pattern, the proportion of household heads that are pedestrians, and their purposes of trip as pedestrians. Information on the questionnaire was divided into four sections. The first section provides information on household composition, and their socio economic characteristics. Questions on household composition include the nature of the family system, and the relationship of individual household to the household head. Information on socio economic characteristic include, age, sex, marital status, household size, level of education, income, occupation, auto ownership, household driver, and length of stay in the area under survey.

The second section of the questionnaire focused on household heads and on-street person's origin, destination and trip purposes. Information obtained include intra-city trips to home, work, shopping, school, social function, hospital, leisure and sport, recreation and religious activities for four weeks. The third section of the questionnaire dealt with household and on-street persons' trip types. Questions in this section include origin of trip, trip destination, trip length; time spent on the journey, preferred mode of transport, days of the week the trip was made and distance of trip to residence. The fourth section focused household and on-street persons' trips as pedestrian. Questions in this section include preferred walking distance to the bus stations and land use activities, number of times household and on-street persons visit activities such as hospital, recreation centre, manufacturing industries, shopping malls, hotels and restaurants, retail shops as pedestrian. Other information includes availability of pedestrian facilities such as walkways, zebra crossing and pedestrian traffic light along individual route choice.

In collecting this information retrospective activities listing questionnaire was used. The choice of a retrospective activities listing questionnaire is based on difficulties observed by Ojo (1990), Oyesiku, (1990), Solanke, (2005) and Samuel (2005) in the use of self-administered travel diary in Nigeria. So, urban residents were required to give account of their daily movement activities for a week. The choice of a week is based on: (i) the willingness of respondents to fill in the form not more than a week and (ii) the need to allow respondents relating their recent activities because; information of their movement is believed to be fresh in their memory. However, the survey lasted for 16 weeks (May 2009 and August, 2009) and this afforded the

opportunity to collect essential information from household heads and on-street persons (pedestrians interviewed while walking on the street).

3.2.2.2 *On-street Interview and Observational Survey*

In addition to household response, on-street interview based on the design on-street person's questionnaire was used. Personal observation was used to complement On-street interview along selected streets in the study area. Direct observation was equally used to record pedestrian flow, on-street parking, nature of walkways, and walkway width in the segregated road segments in the study area.

Most of the questions asked are similar with household heads questionnaire as described in appendix II. Other information obtained includes socio-economic characteristics of the respondents, modal choice between (i) origin and boarding point, (ii) boarding point and alighting point, (iii) alighting point and destination and factors influencing pedestrians' walkability.

3.2.2.3 *Field Measurement*

Pedestrian and vehicular traffic situation in the study area were recorded through a digital camera. Measurements of walkways and road width were made in fifty-six (56) road segments in the study.

The number of pedestrian walking along road networks in the zones understudy were also recorded in a data sheet with the help of 35 field assistants. Furthermore, average speeds of vehicles along 56 road segments in the study area were also recorded during off-peak period of vehicular flow using radar gun. The choice of off-peak period was based on the fact that at peak period, the average speed of vehicles on the road network is approximately zero and this is due to congestion and long queue of vehicles along the road networks under study.

3.2.3 Sample Size

Ikeja Local Government Area had a population of 313,196 inhabitants' comprising of 169,233 male and 143,963 female (National Bureau of Statistics, 2006). Considering the need for a representative sample for the study area (a part of Ikeja LGA) which is difficult to obtain through electoral districts, telephone directories and existing

political wards in the local government area, the study made use of the number of buildings in each of the seventeen zones created.

On the average, a zone has about 666 buildings, an average of 35 buildings per street. With an average of 15 people per building and total of 241 streets, the estimated population for the study area was about 126,525 ($241 \times 35 \times 15 = 126{,}525$).

Bruton (1975) however, recommended sample sizes between 1% for population under 50,000 and 10% for population over 100,000. Neumann (1994) on the other hand observed that the question of sample size can be addressed in two ways. One way is to make an assumption about the population of interest and use statistical equations to determine the degree of confidence (or number of errors) that is acceptable and in variance with the population. A second way and more frequently used method is a rule of thumb - a conventional or commonly accepted amount which is based on past experience and requirement of statistical methods. Supporting his argument, Neumann (1994) concluded that sample of 2,500 that is used for population of 200 million can also be used for 10 million population due to practical limitation of costs and time of the researcher.

In this study, based on the costs, time and difficulties observed in administration of 170 pilot questionnaires and Neumann (1994) rule of thumb, one thousand (1000) household heads was selected as total sample size for household heads, and the sample size was drawn from anticipated sample size of sixteen thousand four hundred and twenty one (16,421) households of estimated population of 126, 525 in the study area. The distribution of 1000 sample size used in the study in table 3.1 was based on statistical allocation of sample size to strata.

There are various methods of allocating sample size to strata of which include (i) Proportional Allocation, (ii) Equal Allocation, (iii) Optimum Allocation and (iv) Neyman Allocation (Okafor, 2002). Improvement in the methods of allocating sample size to strata increases from proportional allocation to that of Neyman allocation. Based on the data available for the study, proportional allocation was used.

In proportional allocation, Thomsen (1976), Sukhatme, B. V. S., and Asok (1984) and Okafor (2002) observed that the stratum sample is selected such that the size of the sample is proportional to the total number of units in each stratum, such that (n_k) varies directly as (N_k) or (n_k) varies directly as (W_k). If the total sample that is to be allocated is (n) , then the stratum sample is given as:

$$n_k = \frac{n}{N} \times N_k = nW_k \qquad 3.1$$

Where n_h = Stratum sample size = the sample size of each zones

n = Total number of sample to be allocated ($n = varies\ across\ zones$)

N_h = Units or stratum of the anticipated population

N = Observed total population = Estimated population of the study area.

However, two hundred and five (205) on-street persons were randomly interviewed and the sample size was based on the number of on-street respondents that yielded to the interview. As earlier discussed in section 1.5 (limitations of the study) in chapter one, it was difficult to seek the attention of on-street person's during the survey period. Hence, the total number of on-street persons willing to be interviewed in the seventeen zones understudy summed up to two hundred and five (205) and number of on-street persons' interviewed in each of the zones understudy are presented in table 3.1.

However, in the course of retrieving questionnaire administered to household heads in the seventeen zones understudy, 948 respondents were retrieved for analysis as shown in table 3.1. The questionnaires comprises of 606 male household respondents and 372 female household respondents. Regarding on-street persons, 84 respondents are male and 121 respondents are female. In summary, of the 1,205 questionnaires administered in the course of this study, 1,183 questionnaires were retrieved for analysis. The number (1,183) questionnaires retrieved for analysis, represents 98.2% response rate of the total (1,205) questionnaires administered and the value (98.2%) is supportable in analysing the findings of the study.

3.2.4 Questionnaire Administration and Sampling Procedure

For the purpose of questionnaire administration, a pilot study of 140 household heads and 30 on-street persons' questionnaires was administered in the 17 zones. This exercise gave an insight into inherent problems in the questionnaire design and necessary corrections were made. There are 241 road segments (some not named) in the study area (see table 3.1) with a zone having a minimum of 7 streets and another having a maximum of 22 streets. Since identification of individual household head for administering the questionnaire in urban area like Ikeja is a non-trivial task, the following process was adopted. The process includes:

(i) Stratification of streets into 17 zones in other not to oversample a particular zone.

(ii) A simple random sampling was employed in the selection of streets that questionnaires were administered in each zone.

(iii) On each street, a systematic random sampling technique was employed in the selection of housing units of the targeted respondents.

(iv) Selection of eligible household heads within selected household was made. In a multi-housing unit, a simple random sampling technique was employed in the selection of a household head.

(v) A random sampling technique was used in the administration of questionnaires to on-street persons along selected streets of the seventeen zones under study.

3.3 MEASUREMENT OF VARIABLES AND TECHNIQUES OF ANALYSIS

Measurement of variables and techniques used in the study were discussed in section 3.3.1 and section 3.3.2.

3.3.1 Measurement of Variables

Operationalizing variables in research is fundamental in the design of methods needed to achieve the stated objectives and hypotheses of the study. Variables used in the study include trip characteristics or purposes (work, religious, recreation, business, social, shopping, schooling, visiting, exercising); economic activities respondents

engage in (industries, hotels and restaurants, shopping malls, financial and related institution, fast food points); and level of accessibility.

The variables also include; respondents' socio-economic characteristics (age, sex, marital status, level of income and education, employment status, number of vehicles owned work location); preferred nature of walkways (safety, security, ,cleanliness, spacious); distance; time, season and weather. Other variables include lateral separation; motor vehicle's volume and speed; and vehicles' driveway access In order to measure these variables, some calibrations were made. The descriptions of how the variables were calibrated are discussed in relevant sections of the thesis. Techniques of analysis used in the thesis are discussed in the section that follows.

3.3.2 Techniques of Analysis

Statistical techniques were used in analysing information obtained from questionnaires administered, field observations and field measurements made include descriptive and inferential statistical techniques. Descriptive statistical techniques such as frequency tables, bar graphs, percentages, averages, range and standard deviation were used to discuss some of the data collected on the field.

The first hypothesis in this study seeks to examine the variation in respondents' maximum walking distance to walk to bus stations, various functions and services. Examining this hypothesis, means, range, standard deviation, student t-test and analysis of variance were used.

The second and fourth hypotheses used multiple regression analysis to explain the dependent variables with respect to some explanatory variables. While the second hypothesis predicted the number of pedestrian trips made by household heads' and on-street persons' with respect to their trip types, number of times economic activities were visited and level of accessibility; the last hypothesis modelled pedestrians (level of safety) using pedestrian threshold (Level of Service) along walkways or road corridors. Pedestrian level of safety was predicted with respect to lateral separation, traffic volume, vehicle speed and drive way access and volume.

In the second hypothesis, level of accessibility was measured using Shimbel index $\left(\boldsymbol{Min}\sum_{j=1}^{n}\boldsymbol{d_{ij}}\right)$ described in chapter two. Shimbel index was used in the computation of nodes, links of streets in each of the seventeen zones understudy.

The third hypothesis examined household heads and on-street persons' decision to walk in an urban system and their pattern of movement with respect to explanatory variables such as socio-economic characteristics of household heads and on-street persons, preferred nature of pedestrian facility and factors such as distance, time, season and weather. The statistical techniques used are Logit regression model and Analytical Hierarchical Process (AHP) model.

In analysing the third hypothesis however, logit or logistic regression analysis was used. The choice of logistic model over Ordinary Least Square (OLS) regression, linear probability, discriminant function analysis and probit models was that, linear probability model assumes linear increase in the explanatory variables as well make the incremental effects of these variables constant, which is not applicable in dichotomous response variables. Discriminant function analysis on the other hand has many assumptions, of which the data for the explanatory variables must represent a sample from multivariate normal distribution. Although the relationship between probit and logit models is almost similar in concept and interpretation, the logit model is preferable if data used for the study are not normally distributed and involve complex samples. For this research, the data used are not likely to be normally distributed and also involve a two-stage sampling techniques.

Statistical software used includes Statistical Packages for Social Sciences (SPSS 17.0). Statistical Packages for Social Sciences (SPSS 17.0) was used to run both descriptive and inferential statistical analyses of the study. They were also used in the explanation pedestrian movement in the study area. Nevertheless, the study used both qualitative and quantitative approaches in achieving the aim and objectives of the research.

3.4 SUMMARY

The chapter discusses hypotheses of the study and methods of analysis used in addressing the study objectives and the set hypotheses. The chapter explored the primary and the secondary sources of information of the research. Furthermore, the chapter explains the sample size, questionnaire administration and sampling procedure of the study. In the same manner, the techniques used in analysing the research hypotheses were discussed by justifying the use of such techniques for the study's hypotheses.

CHAPTER FOUR

PHYSICAL, SOCIO-ECONOMIC CHARACTERISTICS AND MOVEMENT PATTERNS OF PEDESTRIANS

4.1 INTRODUCTION

This chapter examines the physical and socio-economic characteristics of the study area in order to explaining the activities that generate pedestrians' movements. The chapter discusses Lagos and Ikeja, where the subunits that make up the study area were mapped. The chapter is divided into three subsections under the following headings: (i) Ikeja and the Study Area, which describes the geographical setting of Ikeja, (ii) land use pattern in Ikeja, which explains the landuse activities in Ikeja and the study area in relation to urban spatial structure models discussed in chapter two and (iii) patterns of pedestrian movements in Ikeja.

4.2 IKEJA AND THE STUDY AREA

Ikeja is a Local Government Area in Lagos State. Lagos was created in 27th may 1967 in the south western part of Nigeria. Lagos is the economic, financial and commercial nerve centre of Nigeria and it attained mega city status in 1995 (see figure 4.1). The capital of the Lagos state is located at Ikeja which is one of the twenty local government areas of the state (see figure 4.2).

Ikeja occupies a unique position among the 20 local government areas in Lagos state. It is located on $Latitude\ 7^0\ 3', Longitude\ 3^0\ 3'$ and occupies an area of about 46.2 kilometres square in the State (Lagos State Physical Planning and Urban Development, 2008). It is bounded by Agege LGA in the in the west, Ifako-Ijaye LGA in the north-west, Alimosho LGA in the south-west, Kosofe LGA in the east and east, Oshodi-Isolo and Mushin LGA in the south and Ogun State in the north (see figure 4.3).

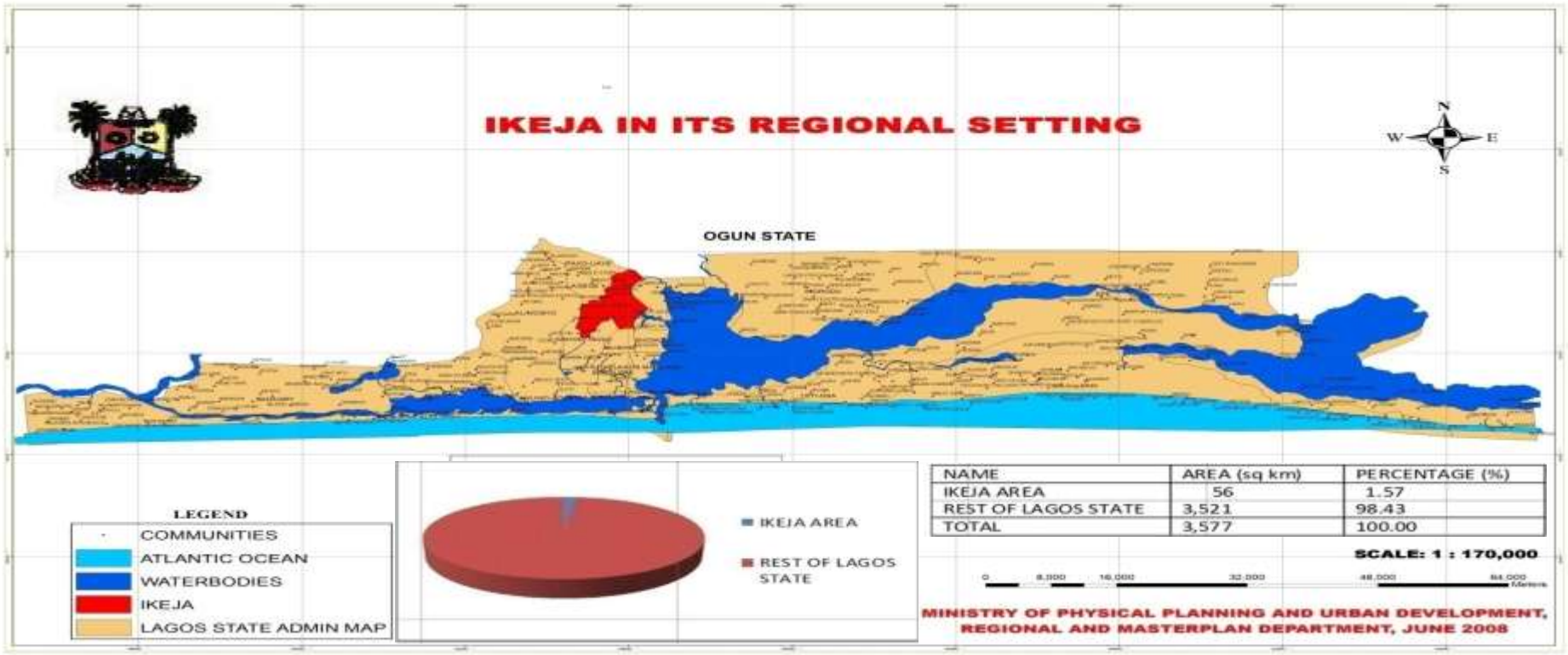

Figure 4.1: Political map of Lagos state showing Ikeja Local Government Area.

Source: Lagos State Physical Planning and Urban Development (2008).

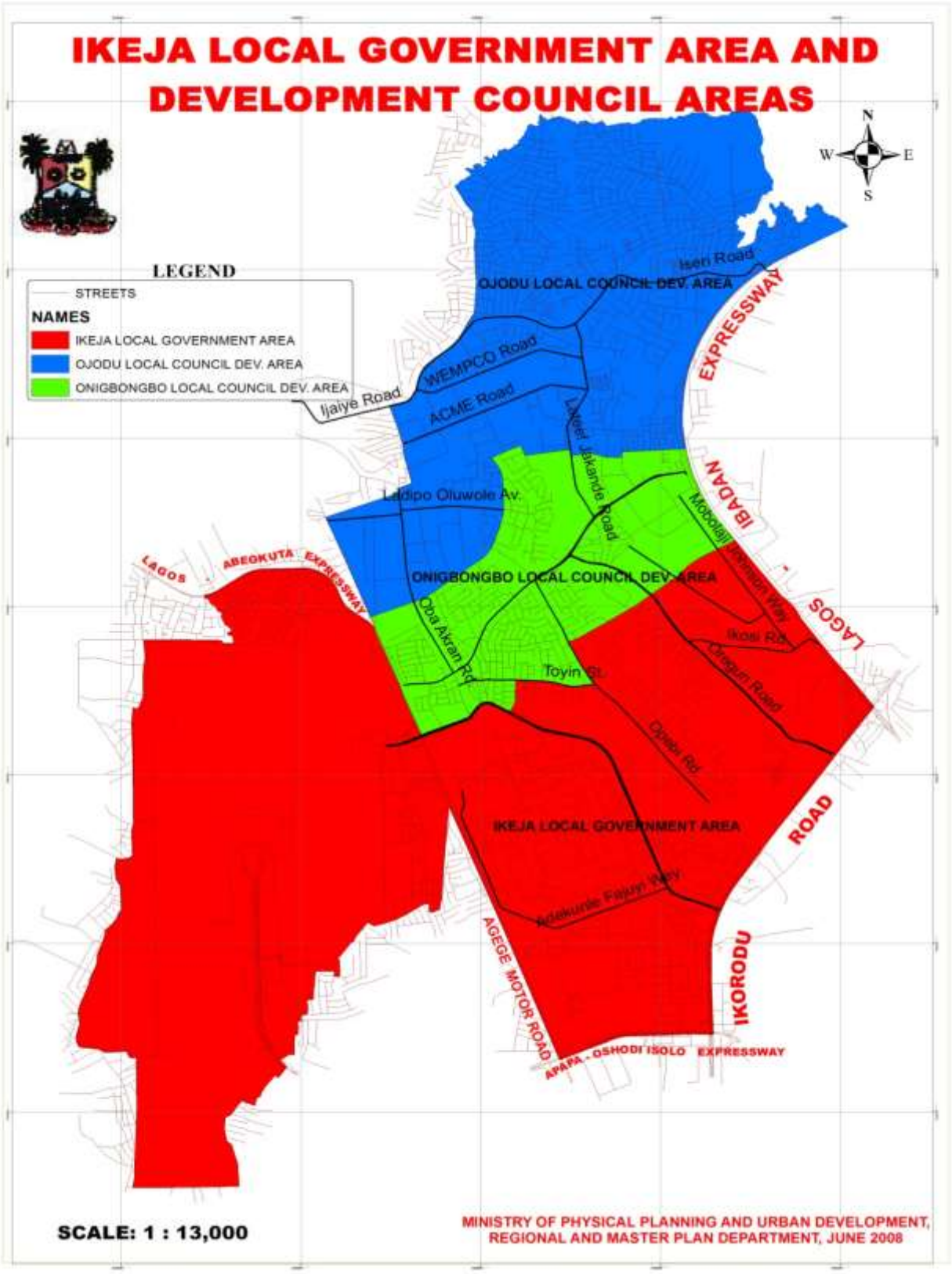

Figure 4.2: Ikeja Local Government Area and Development Council Areas.

Source: Lagos State Physical Planning and Urban Development (2008).

Figure 4.3: Ikeja Local Government Area within the Bounded Areas.

Source: Lagos State Physical Planning and Urban Development (2008).

Ikeja is one of the local government areas that double as the state capital. It is also one of the most developed, harbouring most of the medium scale industrial establishments in the state. Ikeja LGA has busy streets such as Allen Avenue, Opebi Road, Simbiat Abiola Road, Oba Kodesoh street, Awolowo way, Adeniyi Jones Avenue, Aromire Avenue**,** Toyin street, Oriyomi street, Olowu street, Afariogun street, Oba Akran Avenue, Francis Oremeji street, Ola-Ayeni street, Pepple street, Unity street, Otigba street and so on.

Ikeja Local government area has high rate of accessibility in terms of transportation network to almost all communities in the local government area. Apart from being a local government area with the busiest local airport and largest International Airport, Ikeja also serves as rail terminal to Tran-city rail services of Nigeria Railway Corporation from Ifo in Ogun State to Lagos State. It is also a home of one of the largest ICT centre in West Africa popularly called *'Computer Village'*. Ikeja is equally a home of many daily newspapers, Radio (Radio Lagos, Choice FM, Eko FM) and (Television stations Lagos State Television, Muhri International Television).

However, the study area is small part of Ikeja LGA as shown in figure 4.4. Figure 4.4 shows the study area with the classified names of the zones. Having one of the largest market areas in Sub-Saharan Africa, Ikeja contains different types of land uses that generate both human and vehicular traffic on daily basis. The land use types that generate both human and vehicular movements, particularly pedestrian movement in the study area are discussed in section 4.3.

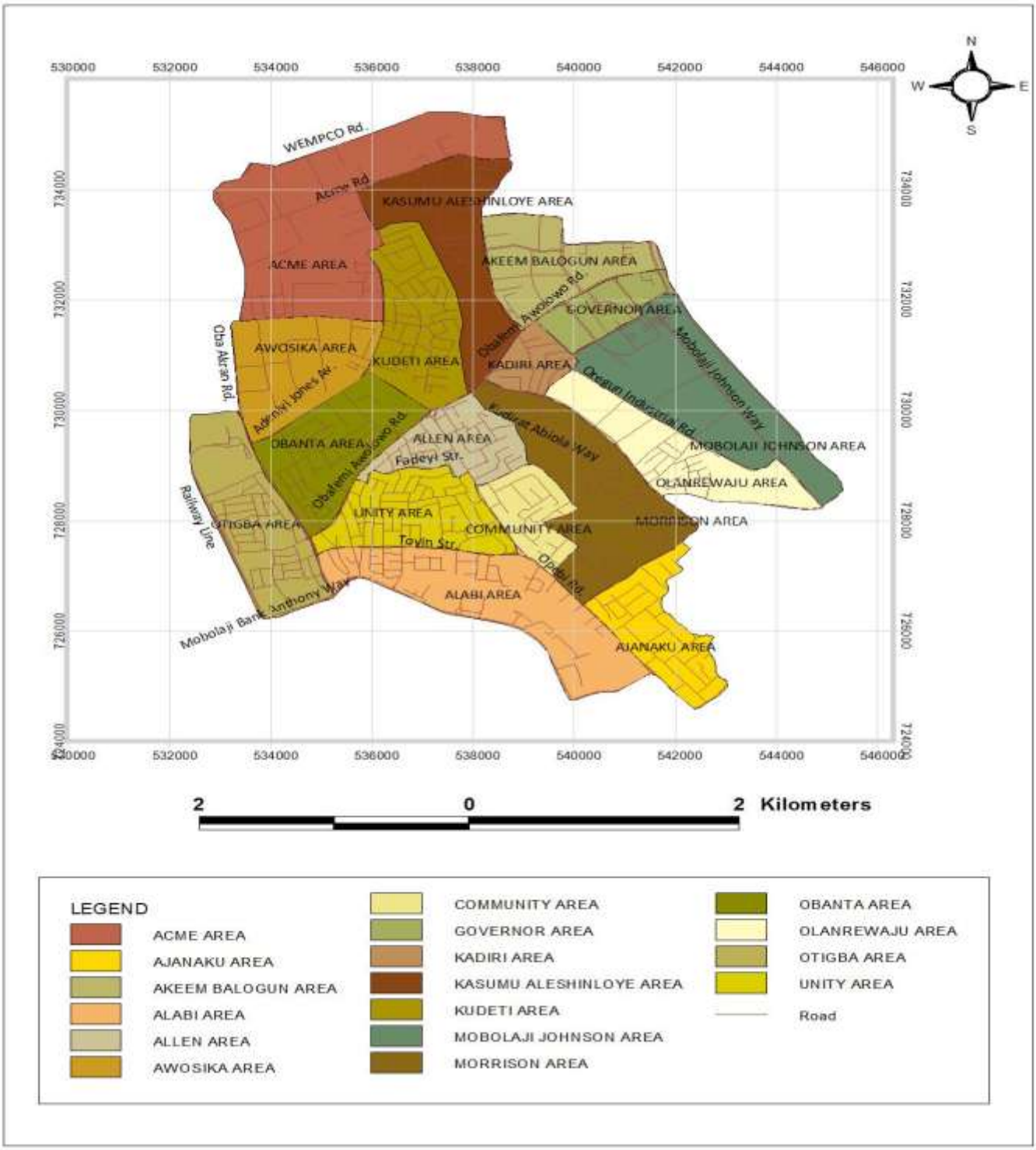

Figure 4.4: Map of the Study Area.

Source: Field survey, 2009.

4.3 LAND USE PATTERN IN THE STUDY AREA

Trips are embarked upon in cities for several reasons, and landuse analysis is a convenient way to study the activities that provide the basis for urban transport components (that is trip generation, trip distribution, modal split and traffic assignment) discussed in chapter two.

Travel activity patterns are greatly influenced by urban morphology or the general land use arrangement. The travel volume of an area therefore depends on the numbers of trips that starts or end there. The land uses of the study area were discussed under the following classifications.

(i) Residential Landuse
(ii) Industrial Landuse
(iii) Commercial Landuse
(iv) Social Infrastructure

4.3.1 Residential Landuse

Residential landuse is predominant in the study area. Due to the high level of commercial and industrial activities in Ikeja, one might not notice the predominance of residential landuse. Ikeja is made of planned and unplanned residential area. The buildings are engulfed by urban land development. Housing layout patterns are of both close and open types with most compounds containing more than two buildings. Most of these buildings are of Brazilian type and some are bungalows with rectangular shapes. The layout shows little regard for modern planning standards because majority of the houses do not have access roads. This is common in some parts of Otigba Area, Obanta Area, Unity Area, Alabi Area, Awosika Area and in the core area of Ikeja.

The core areas of Ikeja are now covered and surrounded by new buildings that are made up of residential and commercial developments with modern designs. These developments are found along Kodesoh Road, Obafemi Awolowo Way, Olowu Road, Opebi link, Oba Akran Avenue, Aromire Street, Adeniyi Jones Avenue, Opebi Street,

Allen Avenue, and Toyin Street amongst others. Generally, residential buildings in the study area feature all categories of buildings except the non-use of multi-storey blocks of more than six floors for residential buildings. However, there are commercial and hotel buildings of more than six floors in the study area.

Ikeja has modern government and private residential estates. Such estates are located along Kodesoh Road, Obafemi Awolowo way, Central Business District, Adeniyi Jones, Opebi, Shonibare Estate, WEMA Board Estate, Omole Estate and Government Reservation Area (GRA).

The main factors that contributed to the expansion of Ikeja into an important residential area was the establishment of Government Reservation Areas in the 1930s, the establishment of industrial estate in the late 1950s, the establishment of many estates in early 1960s, and the provision of houses for low-income industrial workers by the then Western Nigeria Housing Corporation (Aluko, 2004).

Different types of housing units can be found in the study area. The residential landuse comprises of both high and low income group. The higher income group live in areas of low density residential areas and are characterised by tracts of open land with detached buildings and single family units. Figure 4.5 show land use pattern in in the study area as obtained from Lagos State Physical Planning and Urban Development.

In recent times, private developers are actively engaged in erecting more houses in Ikeja to meet the increasing demand arising from the rapid growth of the city and Lagos metropolitan area. Also, areas that were strictly residential are now being used as religion, trading, industrial, financial, and commercial centres.

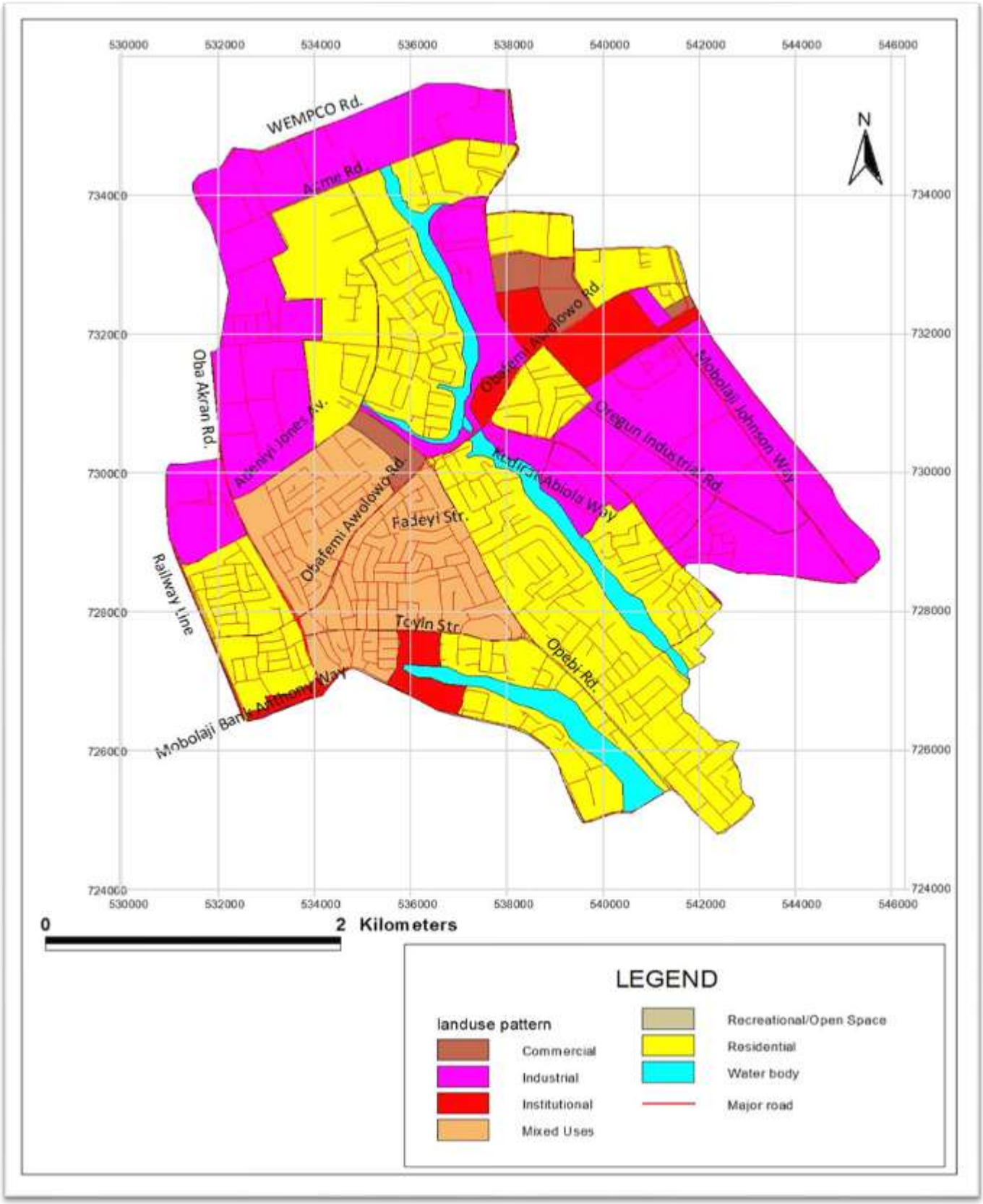

Figure 4.5: Land Use Map of the study area.

Source: Lagos State Physical Planning and Urban Development (2008).

4.3.2 Industrial Landuse

Industrial land uses are prominent especially in the form of industrial streets in many part of the study area. Ikeja is a leading industrial area not only in Lagos state but in Nigeria in general.

The most prominent industrial estate is Ikeja Industrial Estate located along Oba Akran Avenue. Other industrial areas within Ikeja are in Ladipo Oluwole Road, Henry Carr Street, Metal Box Road Acme Road, Acme Crescent, Akanni Doherty, Cocoa Industrial Road, Akilo Road, Dampson Street, Vanni Close, Universal Metal Crescent, Surulere Industrial Road, Lateef Jakande Road, and Adeniyi Jones Avenue. These industries are made up of large, medium and small scale industrial complexes. Sapara Street, is involve in textile, glass and metal fabrication, food processing company, pharmaceutical , publishing, plastics and construction materials (see Table 4.1) for details.

Blue chip industries that are located in the seventeen zones in and around Ikeja include Guinness, Nigerian Textile, Niger Paints, Hagemeyer, Specomills Plc, Dunlop Plc (now focus in marketing the product and also divest into properties), WAHUM, West African Distillers, Melta Box, Tower Aluminium, Cadbury, 7-Up and Coca-Cola. Other areas of industrial activities are Oregun road corridor, where there are many publishing companies which include Newswatch Magazine, Prime People, Quality Magazine and Clay processing industries.

4.3.3 Commercial Landuse

With respect to commercial activities, Ikeja is next to Lagos Island (Balogun, Odumosu and Ojo, 1994). Like Industrial landuse, many streets in Ikeja are commercial streets. Its commercial activities range from banking, finance, shopping complexes, hotels, pharmaceutical stores, canteens, books-shops, auto-sales, electronics, textiles, decoration, gift-items, clinic and hospitals, professional services and business centres. These activities are well represented in the zones understudy. Table 4.1 shows some of these activities.

Table 4.1: Estimated Number of Economic / Land Use Activities in the Study Area.

Zones	***Zones Name***	***Number of Economic/Land Use Activities***								
		HOSP	**INDU**	**HRES**	**GNGA**	**FINI**	**SCHL**	**SHPM**	**FAST**	**RTAIL**
1	Otigba Area	2	28	15	18	16	7	2	6	2673
2	Awosika Area	6	5	4	25	8	8	2	2	654
3	Obanta Area	4	5	4	8	6	5	3	2	786
4	Kudeti Area	7	25	3	28	18	18	1	8	124
5	Akeem Balogun Area	2	10	5	20	16	3	1	2	20
6	Ajanaku Area	3	11	9	25	20	11	1	12	212
7	Governor Area	2	10	2	8	2	3	0	0	106
8	Kadiri Area	2	3	12	18	2	8	1	0	121
9	Olanrewaju Area	3	17	1	22	18	4	0	4	24
10	Mobolaji Johnson Area	2	10	2	48	10	6	0	2	28
11	Kasumu Aleshinloye Area	2	5	8	16	8	10	0	4	236
12	Morrison Area	2	22	5	24	10	16	0	4	258
13	Allen Area	6	6	18	29	16	12	1	10	269
14	Unity Area	3	5	15	18	8	8	0	2	1047
15	Alabi Area	3	3	16	8	10	16	0	6	325
16	Community Area	2	9	3	6	4	10	0	1	109
17	Acme Area	2	9	6	8	2	8	1	1	848
	Total	53	183	128	329	174	153	13	66	7220

Source: Field Survey, 2009.

Note: **HOSP** = Hospitals, **INDU** = Industries**, HRES** = Hotel and Restaurants, **GNGA** = Governmental and Non-Governmental Agencies, **FINI** = ***Financial Institutions,*** **SCHL** = Schools, **SHPM** = Shops and Shopping Malls**, FAST** = Fast Food Points, **RTAIL** = Retail Activities.

Banks are well represented in the zones understudy in Ikeja. These Banks are located along Oba Akran Avenue, Awolowo Way, Simbiat Abiola Road or Medical Road, Toyin Street, Allen Avenue, Aromire Avenue, Adeniyi Jones Avenue, Lateef Jakande Road, ACME Road, Opebi Road, Opebi Link, Kudirat Abiola way, Billings' Way, to mention but a few. There are also several micro-financial institutions in the seventeen zones in Ikeja and these include Micro-Finance banks, Bureau De Change and finance houses.

Trading, shopping and markets are some of commercial activities found in the study area. Daily and nights markets in the study area include Ipodo, Afariogun, Alade and Ashade markets. Modern shopping complexes in the study area include Shoprite, Ikeja Plaza, Oshopey plaza, Rodeo Shopping Mall, Obafemi Awolowo Plaza, UTC, Juli Pharmacy, Masco Supermarket, and Cash 'N' Carry.

It is also important to note that some of the major roads have grown into full scale shopping streets. Such streets include Obafemi Awolowo way, Allen Avenue, Adeniyi Jones, Oriyomi Street, Otigba Street, Olowu Street, Ola-Ayinde Street, Unity Road, Oba Kodesoh Street, Opebi Street, Opebi link and some part of Kudirat Abiola way. Other streets are Billing's way, Toyin Street and entire streets in Otigba Area (1) of the study area popularly known as *'computer village'*. Generally many other collector and access roads in the study area have been engulfed by commercial activities and this generates pedestrian movement in and around the city.

Another commercial land use in the study area are hotels and restaurants. Hotels of international standards are available in the study area. The hotels in the study area include Sheraton Hotel and Towers, Airport Hotel, Ikeja Federal Palace Hotel, De Renaissance Hotel, Water Park, Jabita Hotel and Base Water Hotel. There are also many Canteens and Restaurants in the subunits. Some of the residences in the subunits have been converted into restaurants. The number of hotels and restaurants observed in the study area is as shown in table 4.1. However, figure 4.6 shows observed land use types in the study area.

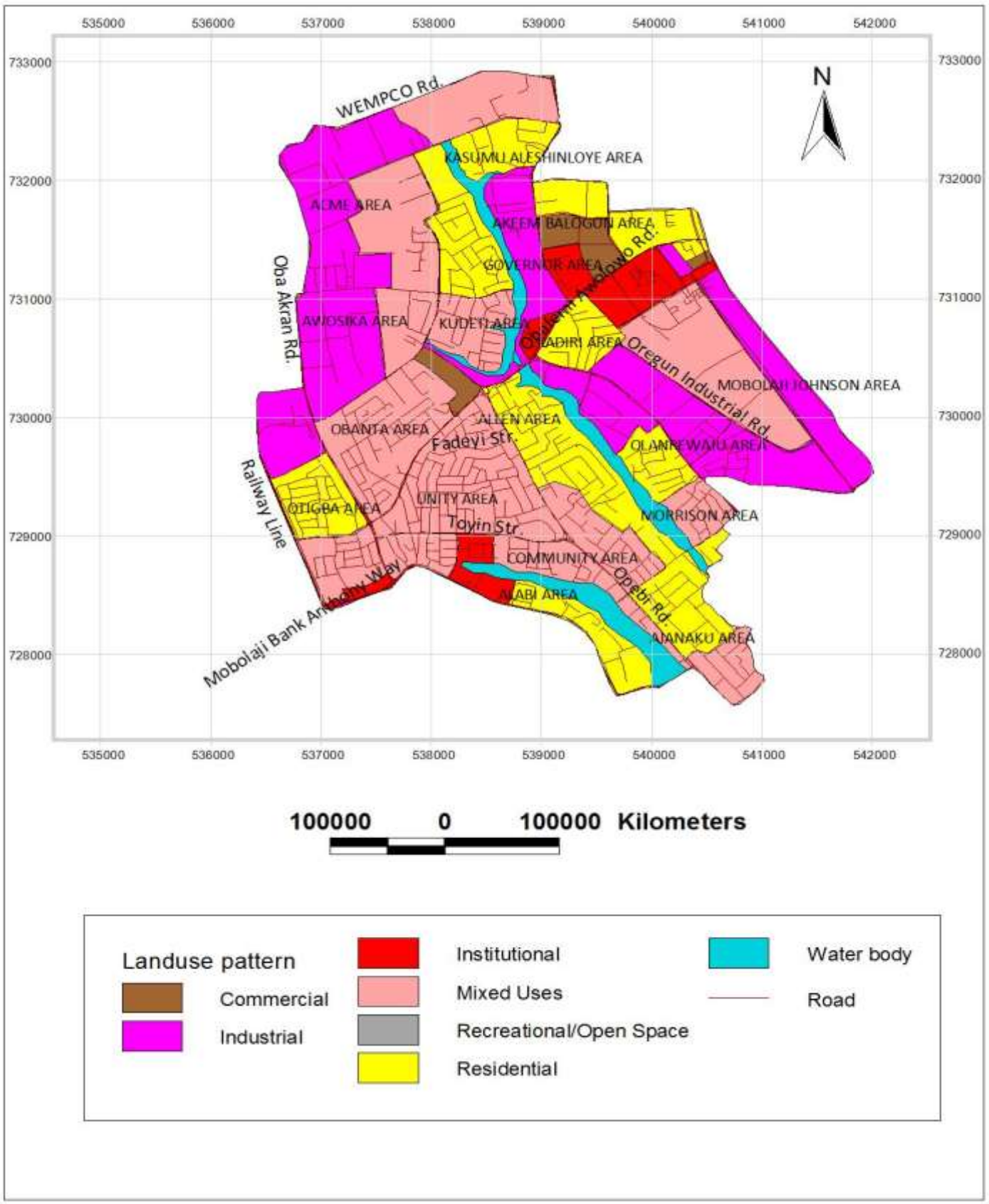

Figure 4.6: Observed Land Use Types in the study area.

Source: Field Survey, 2009.

4.3.4 Social Infrastructure

Social infrastructure also referred to as community facilities and services is one of the landuse activities observed in the study area. Some of these facilities are institutional, educational, health, religious and recreational.

There are many institutional facilities that are of public and semi-public landuse. These institutional facilities include administrative buildings for Federal, State and Local Governments. The State Government Permanent Secretariat is located at Alausa along Obafemi Awolowo Way; the former State Government Secretariat is along Oba Akinjobi Street. The secretariat still accommodates many state government functions. Some of the Federal Government Establishments in Ikeja are Power Holding Company Nigeria Plc., offices, Nigeria Postal services, Ministries, Judiciary Buildings, Police College, Department of Customs and Excise Training School, Army Barracks, Nigerian Air Force Base, the State secretariat and Ikeja Local Government Secretariat both located along Obafemi Awolowo Way.

Regarding educational facilities, there are over one hundred and twenty five secondary schools and over one hundred primary schools in Ikeja. There is also a Women Training Centre, and over fifty Adult Literacy Centres. The Police College at Ikeja is famous for the training of police officers. The state main library is located at Ikeja while there is a mobile library at the old secretariat. At Ayo-Alabi Street, there is training centre for Customs officials. Lagos State University Teaching Hospital meant to train Doctors, is also located in Ikeja.

There are private and public health facilities in the study area. The Specialist Hospital (Eko Hospital) is located along Mobolaji Bank Anthony Way. Lagoon hospital is located along Obafemi Awolowo Way. The two hospitals are perhaps one of the best private hospitals in the country. Ikeja Local Government Area operates over 47 clinics out of which six of them are primary health centres. There is also a State General Hospital in Ikeja. The State Hospital Health Services are being complemented by many privately owned clinics and hospitals among which are Holy Trinity Hospital, Eko Hospital, Nene Clinic, Unity Hospital, Maritol Hospital, Dolapo Clinic, Soleye Hospital and several ones.

Various religious groups peacefully co-exist in and around the study area. These religious groups include Muslims, Christians and Traditional Religious worshippers. Many churches in Ikeja comprise of both orthodox and pentecostals. These include Catholic Church, Anglican Church, Methodist Church, Baptist Church and many Spiritual Churches. Many residential areas are currently being used for fellowship and some floors in multi-storey buildings accommodate religious functions. This attribute is common among the Pentecostal Churches and they include Winner's Chapel, Redeemed Christian Church of God, Believer's World, The Redeemed Evangelistic Ministry and host of others.

Different Islamic denominations among which include Ansar-Ud-Deen, Nawarudeen, Ahmadiyah, Nasfat and many others are also present. The use of many of the residential areas in the study area for religious activities has led to increasing pedestrians' movement along many of the streets on daily basis.

Recreational facilities flourish in the subunits. These recreational facilities are of passive and active types. They are passive because some of the facilities generate pedestrian traffic during festive periods, and are active because some of the facilities generate pedestrian traffic on daily basis. Some of these facilities are available in individual homes, hotels, public places and schools.

Places with good recreational facilities such as lawn tennis and swimming pools, table tennis, and video viewing centres are Lagos Country Club, Ikeja Club, Water Park, Sheraton Hotel, Ikeja Federal Palace hotel and Airport hotel. Other recreational areas are Lagos State Television Complex, Muhri International Television Complex, Water Parks, Fela Anikulapo Kuti Shrine (African Shrine), The Golf Course located near the Government Reservation Area and various public places.

The study showed that the study area consists of different land uses. Ikeja is positioned as the state capital, seat of Lagos state government, headquarter of the local government, location of both Local and International Airports, encourage pedestrians activities and movement in and around the city. Table 4.2 shows the mixed land use types in Ikeja and the distinctive characteristics.

Table 4.2: Landuse Types of the Seventeen Zones Understudy.

				Percentage of Land Use Activities in the Zones					
Zones	**Name of Zones**	**Land use Type**	**Classified Name**	**Residential**	**Commercial**	**Religious**	**Financial**	**Institutional**	**Industrial**
1	Otigba Area	Mixed	Resido-Commercial	26	48	10	13	3	-
2	Awosika Area	Mixed	Resido-Commercial	31	43	13	8	3	2
3	Obanta Area	Mixed	Resido-Industrial	29	10	15	18	2	26
4	Kudeti Area	Mixed	Resido-Commercial	35	28	16	20	1	-
5	Akeem Balogun Area	Mixed	Resido-Institutional	21	16	14	5	41	3
6	Ajanaku Area	Mixed	Resido-Commercial	21	46	12	18	3	-
7	Governor Area	Mixed	Resido-Institutional	38	16	18	2	26	-
8	Kadiri Area	Mixed	Resido-Commercial	38	27	13	6	10	6
9	Olanrewaju Area	Mixed	Resido-Industrial	17	12	14	7	15	35
10	Mobolaji Johnson Area	Mixed	Resido-Institutional	21	5	16	10	36	12
11	Kasumu Aleshinloye Area	Mixed	Resido-Commercial	31	30	16	6	15	2
12	Morrison Area	Mixed	Resido-Commercial	37	33	18	8	4	-
13	Allen Area	Mixed	Resido-Commercial	31	41	9	13	5	1
14	Unity Area	Mixed	Resido-Commercial	26	48	11	13	2	-
15	Alabi Area	Mixed	Resido-Commercial	33	36	11	16	4	-
16	Community Area	Mixed	Resido-Commercial	22	30	12	16	17	3
17	Acme Area	Mixed	Resido-Industrial	21	2	16	6	9	46
	Total Average			**28.1**	**27.7**	**13.8**	**10.9**	**11.5**	**8.0**

Source: Field Survey, 2009

The mixed nature of landuse and their trip generating capability in Ikeja LGA and the subunits attract both vehicular and pedestrian traffic. Trip generation involves trip production and trip attractions for individual zones which are related primarily to the type of land use. Theories of urban spatial structure {Concentric Zone Theory (Burgess, 1925); Sector Theory (Hoyt, 1939) and Multiple Nuclei (Harris and Ullman, 1945)} discussed in chapter two of the thesis, provide basis for mobility in the study area. The subunits into which the study area was divided show the characteristics of sector model of axial growth along transport routes with few income groups tend to live in distinct area. Areas where such 'distinct area' can be found in the subunits are Allen Area (13), Alabi Area (15) and Kudeti Area (4). Subunits that show similar characteristics of multiple nuclei model include Otigba Area (1), Governor Area (7), Awosika Area (2), Obanta Area (3), Akeem Balogun Area (5), Ajanaku Area (6), Kadiri Area (8), Olanrewaju Area (9), Secretariat Area (10), Kasumu Aleshinloye Area (11), Morrison Area (12), and Unity Area (14), Community Area (16) and Acme (17). In these subunits, a Central Business Districts (CBD) exists in each of the zones.

Commercial and business activities are concentrated in the Central Business District where jobs, office buildings and especially stores are located as observed in the classical models. However, some small business activities that cannot pay the high rent are found along the street corridors of the Central Business District (CBD) in the study area.

The activities of these small businesses along the street corridors of the CBD is in variance with one of the characteristics of multiple nuclei model that states that '*certain activities unable to generate enough income to pay for high rent in particular location are forced to locate at the site with low rents'* Section 4.4 of the study thus focused on the movement of people in and around Ikeja, with emphasis on pedestrian movement and their pattern of flow in the study area.

4.4 PATTERN OF PEDESTRIAN MOVEMENT IN THE STUDY AREA

The needs of people lead to engagement in activities such as work, markets, business, shopping centres, religious camps, recreations and schools. These activities necessitated day to day movement of people. As indicated in chapter two of the thesis,

an input to an urban transport system is the demand for the movement of people and goods between urban activity centres as provided by Ullman (1956) spatial interaction theory. Furthermore, concentration of businesses, availability of industries, commercial activities, institutional and recreational facilities, local and international airports and other landuse and economic activities, contribute to increasing number of vehicles and people found in Ikeja on daily basis. These landuse and economic activities enhance trip generation by attracting people and vehicles and as well produce people's movement in and around Ikeja. This section therefore discusses movement of people in Ikeja with respect to transport activities and pedestrians' movements. The section also examines the flow pattern of pedestrian along the road networks.

4.4.1 Transport Activities

The dominant mode of transport in Ikeja is road transport, and the players managing transport system in the city are government and private individuals. There are different types of road networks in Ikeja. These roads include six federal roads, thirty state roads and over hundred local government roads. Many of these roads are tarred and the means of transporting people include taxi cabs, tricycles, motorcycles, buses of various types and walking.

Other forms of transportation in and around the study area include railway, with its line running along the western boundary of Ikeja and one of its terminals located at Ikeja. Agege Motor Road which is parallel to the railway lines splits into two with one carriageway connecting Agege Area and the dual lanes connecting Ota area in Ogun State. The Lagos-Ibadan expressway also runs along the eastern boundary of the city (see Figure 4.7).

The roads helped in carving out the subunits (the study area) in Ikeja, and as well delineating the study area into zones. Walking is common not only because there is limit to vehicular movement within the city but, being the oldest form of transport, transit activities and economic activities of people in the study area are achieved by walking to points of activities.

Furthermore, the zones not only act as transit point to commuters but also serve as point of origins and destinations to people that walks or trek from their homes and end their trips respectively in the nooks and crannies of streets in the seventeen zones. The road map of the study area in Ikeja local government area is presented in Figure 4.8 and that of Figure 4.9 clearly shows the road network of the study area.

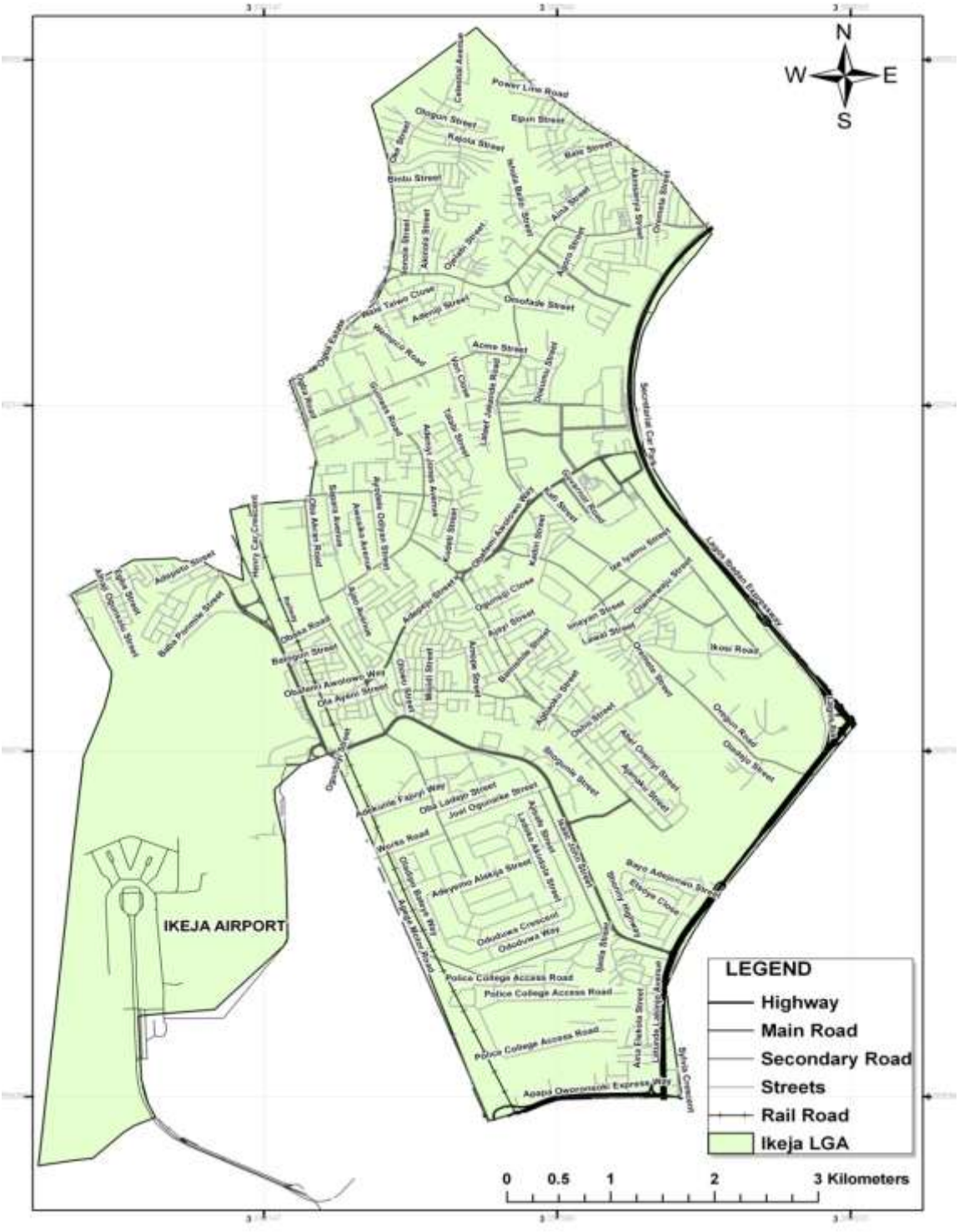

Figure 4.7: Road Network Map of Ikeja Local Government Area.

Source: Lagos State Metropolitan Transport Authority (2008).

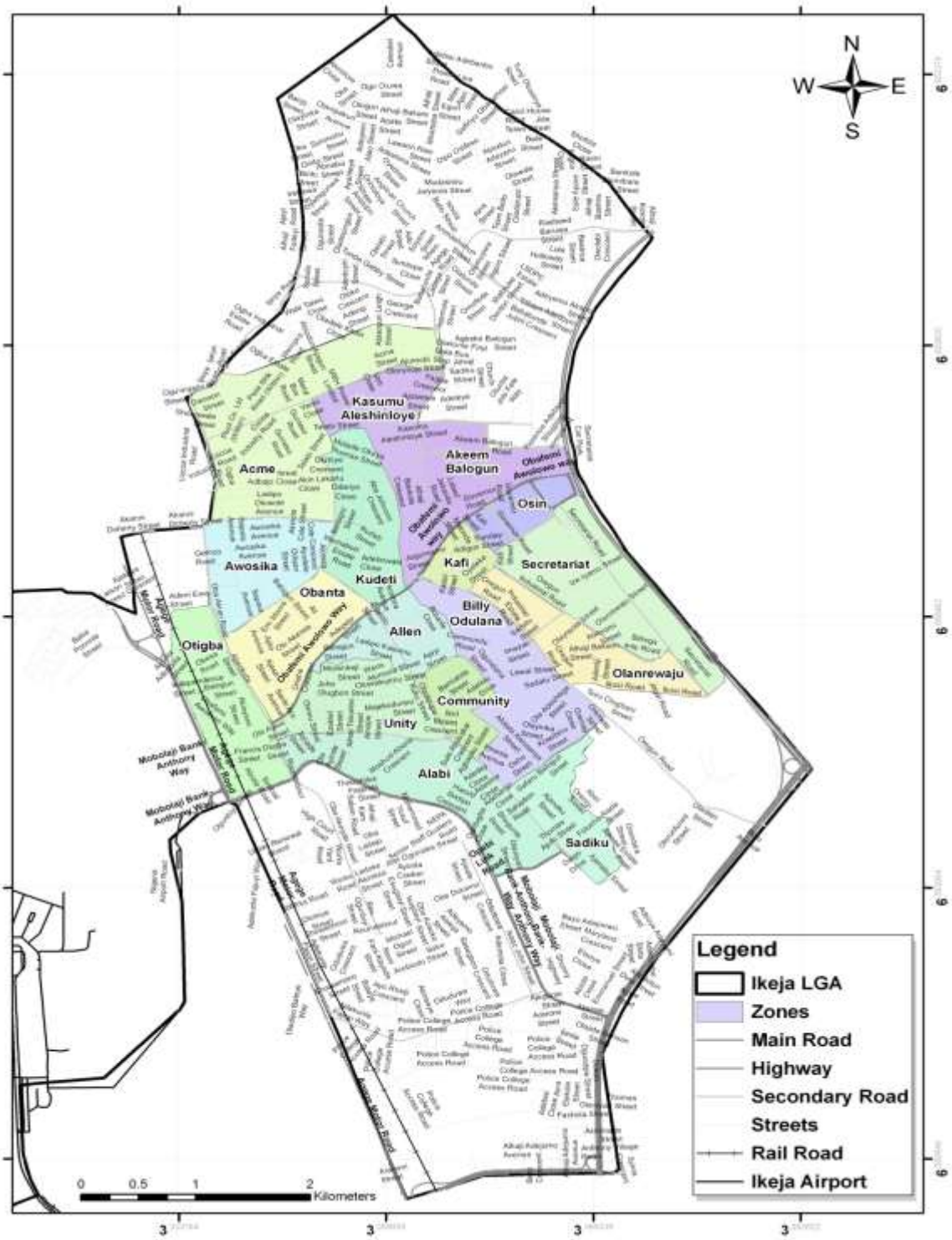

Figure 4.8: Road map of the study area in Ikeja Local Government Area.

Source: Field Survey, 2009.

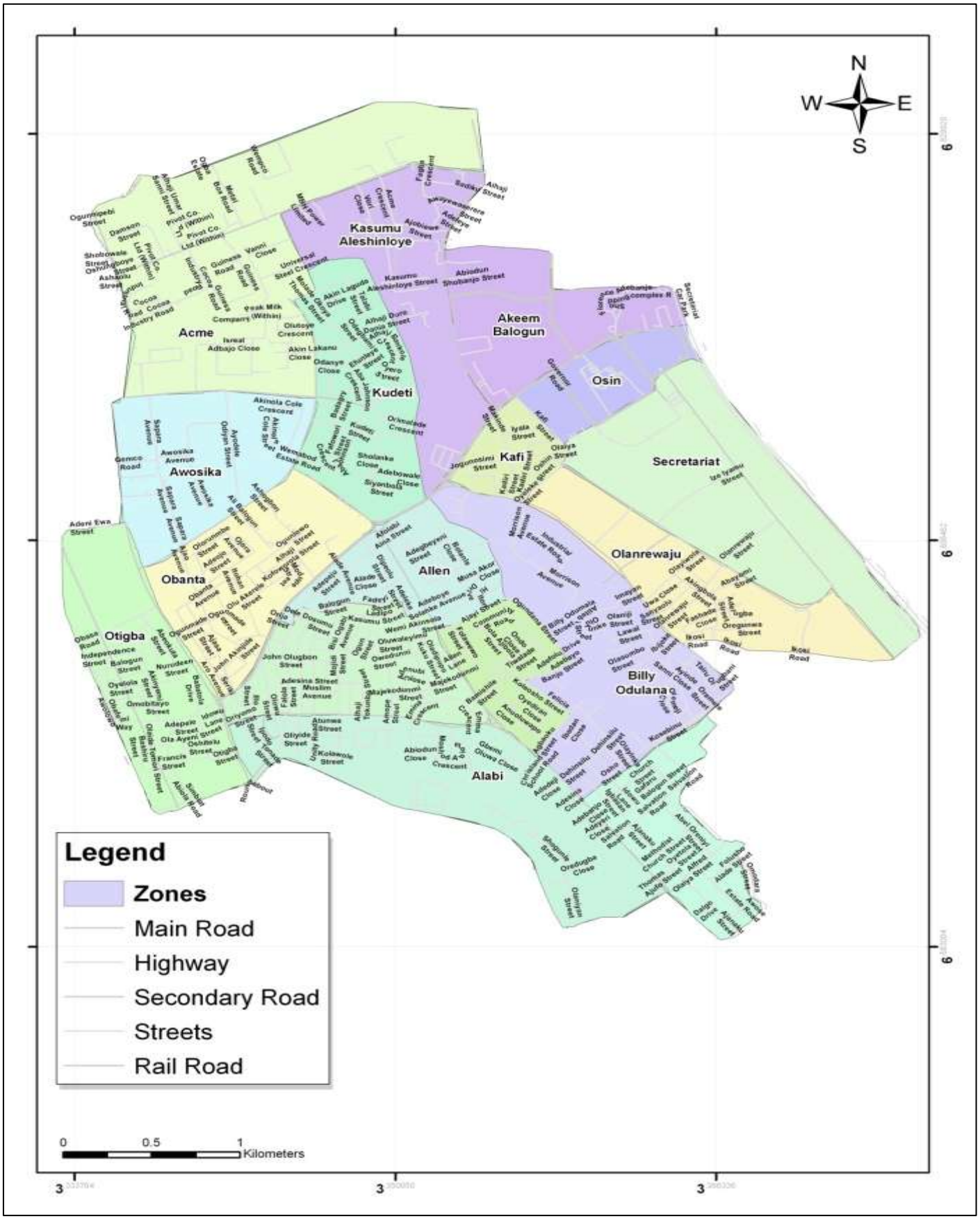

Figure 4.9: Road map of the Study Area.

Source: Adapted from figure 4.8.

4.4.2 Pedestrian Movement in the Study Area

Generally, roads in Ikeja were laid when the city had a single centre and before rapid growth in personalised forms of motorised transport. The primary road network radiates from the city centre to the surrounding areas, but orbital or circumferential links was missing. Some of the roads have one lane in each direction, where the roads are wide; a lane is often occupied by parked vehicles. Where they are narrow, they are often occupied by traders, private vehicles, motorcycles, commercial vehicles, and pedestrians have no choice than to walk in the middle of the road as shown in plate 4.1, and plate 4.2.

About two hundred and thirty-four, (97.1%) of roads in the study area lack pedestrian facilities. Sidewalks are missing in most parts of Ikeja road network, so pedestrians and vehicles share available space and this leads to unguided movement of pedestrians on the road network (see Plates 4.3 and 4.4). The implication is the frequent conflict between pedestrian and vehicular traffic; in order words, pedestrians are exposed to road traffic accidents.

Where pedestrian sidewalks do exist, such as WEMCO Road, Lateef Jakande Road, Awolowo Way and Mobolaji Bank Anthony Way, they are poorly maintained, contain open drainage, grown with weeds or they are taken over by tricycles, or on-street traders or by the adjoining properties. Examples of these menaces can be found in Oriyomi, Afariogun, Ipodo, Unity road, Ola-Ayinde streets to mention but a few (see Plates 4.5, 4.6 and 4.7).

Major problems of road transportation in the study area and the entire Ikeja LGA include high vehicular traffic, traffic congestion, non-availability of defined bus stops, inadequate pedestrian walkways and pedestrian crossings and the absence of car parks (see Plate 4.8).

Plate 4.1: Pedestrians Walking in the Middle of Ola-Ayeni Street in Ikeja.

Source: Field Survey, 2009.

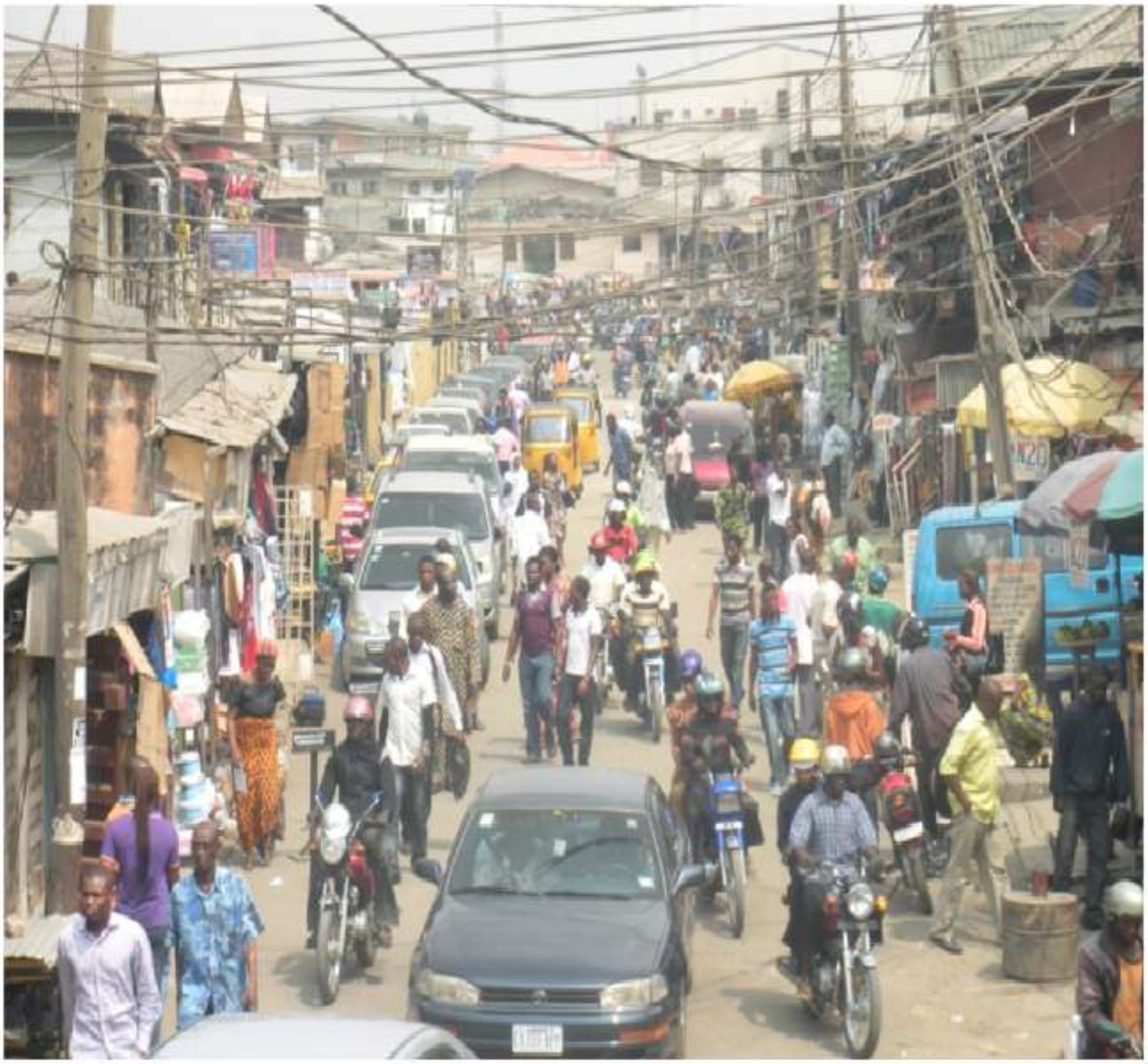

Plate 4.2: Parked Vehicles and Trading Activities characterise Oriyomi Street.

Source: Field Survey, 2009.

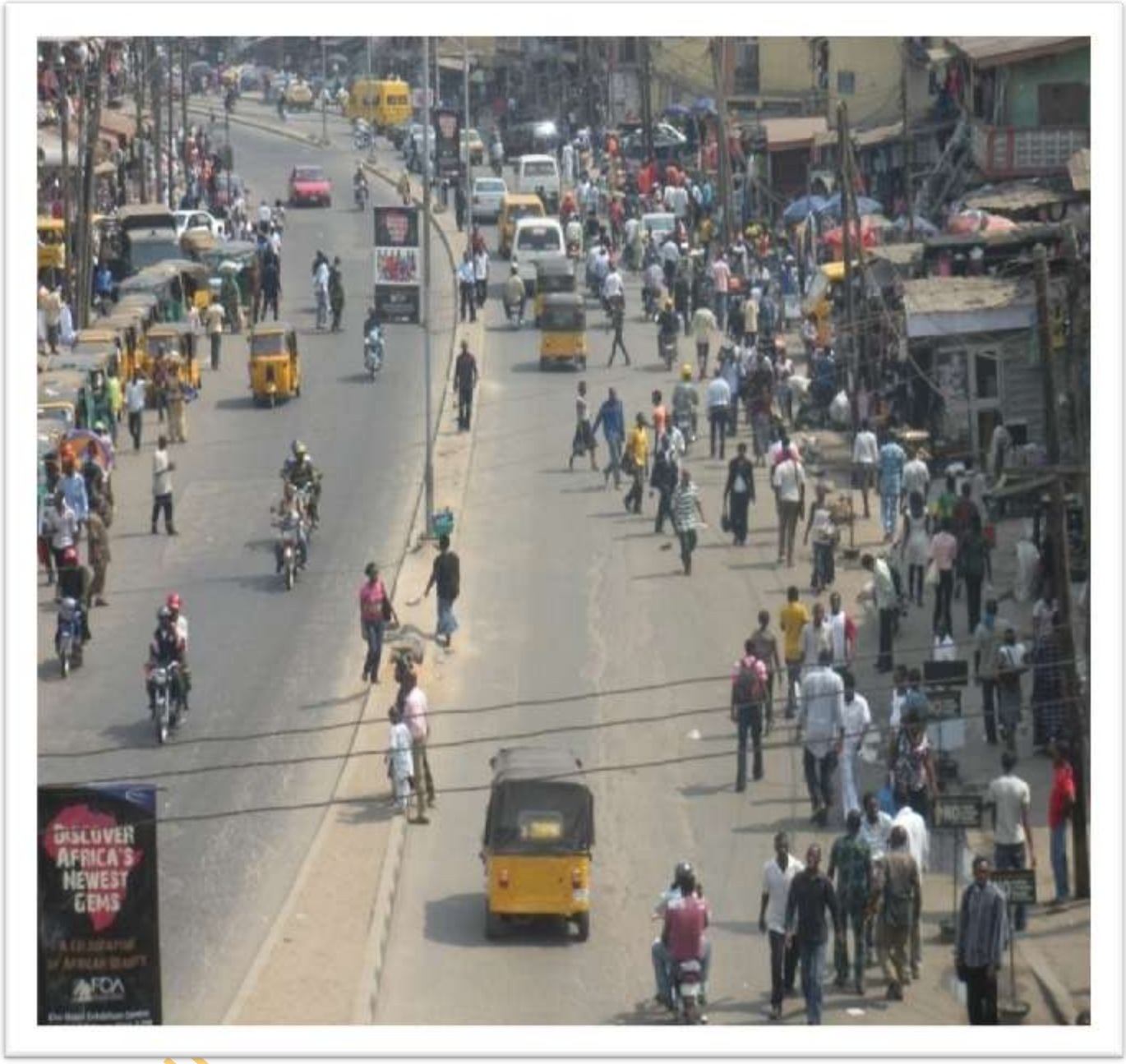

Plate 4.3: Unguided Movement of Pedestrians at a section of Awolowo Way

Source: Field Survey, 2009.

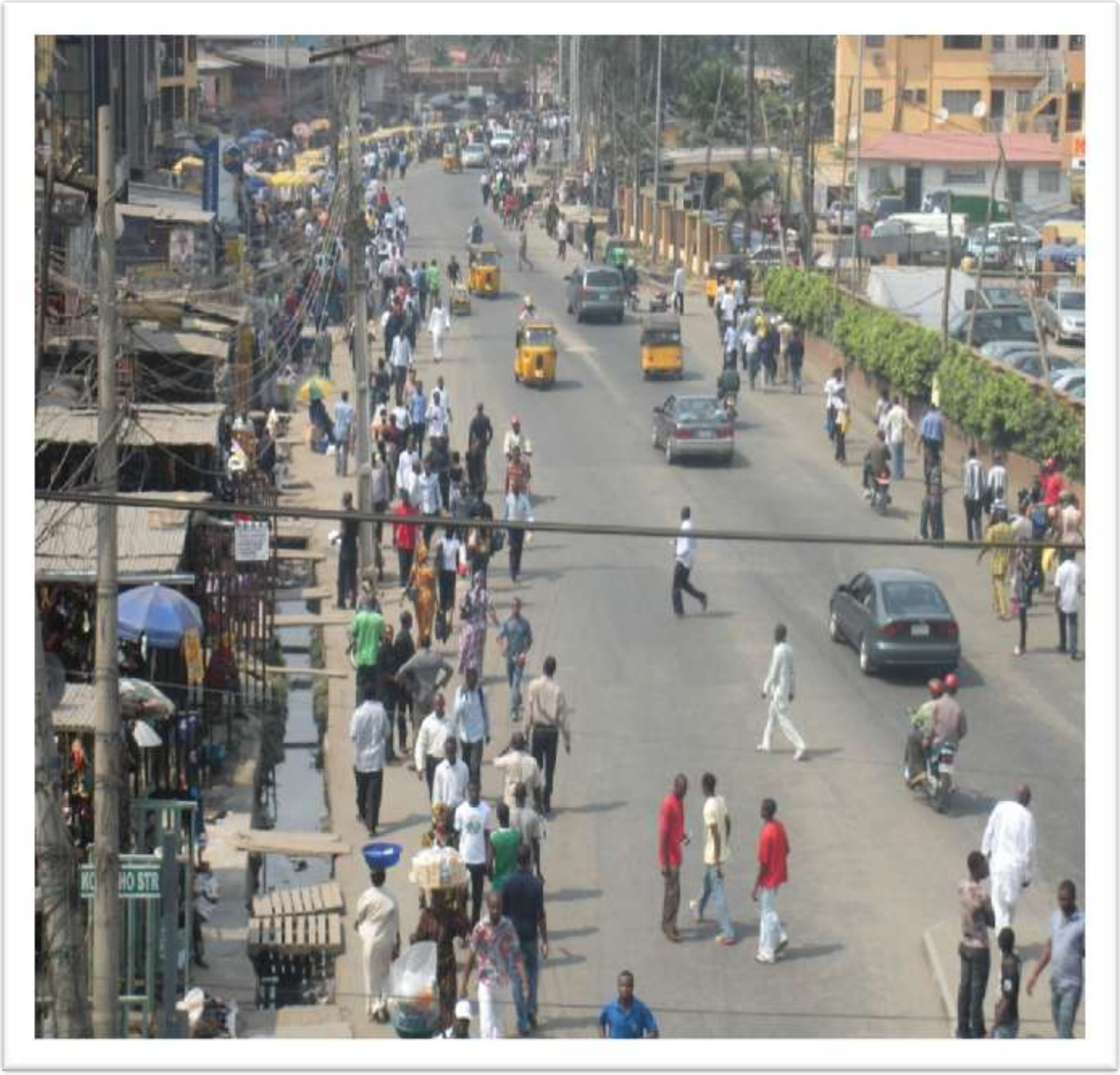

Plate 4.4: Pedestrians Walking by the Roadside along a Section of Awolowo Way

Source: Field Survey, 2009

Plate 4.5: Walkway with Grown Weeds along WEMPCO Road.

Source: Field Survey, 2009

Plate 4.6: Covered Drainage Used for Pedestrian Walkway along Lateef Jakande Road.

Source: Field Survey, 2009

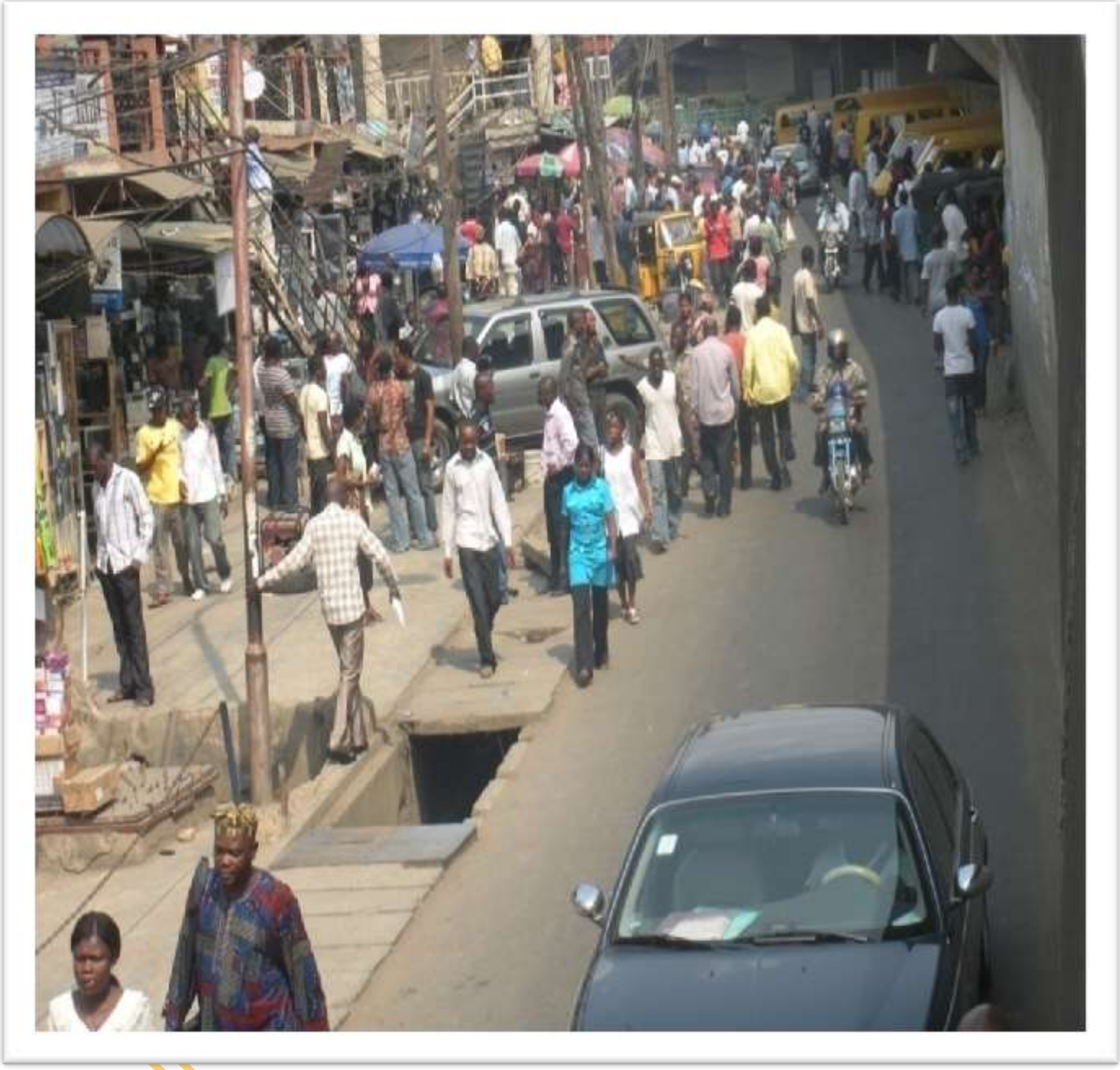

Plate 4.7: Pedestrians Avoiding Uncovered Drainage Used as Walkway along Oba Kodesoh Street.

Source: Field Survey, 2009

Plate 4.8: Congested Otigba Street with Pedestrians Competing with Vehicles[1]

Source: Field Survey 2009.

[1]Plate 4.1 - Plate 4.8 show roadway situations in the study area – Uncovered drainage, congested roadways, and walkways grown with weeds. A roadway where vehicles and pedestrians claim right -of -way by competing with available road space.

4.4.3 Pedestrian Flow Patterns in the Study Area

The flow of people along the streets in the study area was captured through direct observation and counting. The observation and counting lasted for 8 weeks with the help of 35 field assistants between 7:00 am to 7:00 pm. The numbers of pedestrian passing through both side of the road network were counted by two field assistants at selected points on each road network in the study area for every one hour. Table 4.3 shows aggregate data of pedestrian flow and figure 4.10 shows the map of average flow pattern of pedestrian in the study area. Details of the data of pedestrian flow pattern along the road networks of the seventeen zones are presented in appendix III.

Table 4.3: Pedestrian Circulation in the Study Area

Zones Code	*7am – 8am*	*8am – 9am*	*9am-10am*	*10am-11am*	*11am-12pm*	*12pm-1pm*	*1pm-2pm*	*2pm-3pm*	*3pm-4pm*	*4pm-5pm*	*5pm-6pm*	*6pm - 7pm*	*Zone Total*	*Zonal Average Flow*	*Standard Deviation*	*Average Street Flow*
1	9178	16081	20224	19315	15644	15233	14005	16068	21254	26988	29670	21837	225497	18791	5445.59	6833
2	5172	7905	2234	1402	1600	2524	1995	1038	930	5857	7378	1871	39906	3326	2425.22	4988
3	889	2001	1781	1369	1313	1575	1349	1168	2160	4050	3028	1983	22666	1889	845.87	1133
4	526	3353	2389	1368	1463	2615	1306	1303	1587	2858	4739	3038	27551	2212	1123.04	1148
5	692	1074	1447	1484	1002	815	367	376	578	3277	3593	2052	16757	1396	1027.38	3351
6	601	1289	1334	858	895	577	555	525	1063	1824	1972	1201	12694	1058	466.91	604
7	856	3540	3596	1613	1506	1195	1093	723	691	3394	5440	2898	26545	2212	1457.16	6636
8	540	1900	1767	1357	757	632	495	439	384	2808	5000	3167	19246	1604	1368.41	1375
9	507	821	1039	871	947	688	671	553	593	917	1187	801	9595	800	197.18	600
10	212	421	620	605	599	397	419	347	288	685	863	657	6113	509	182.46	873
11	513	2609	983	917	1467	1898	372	475	499	1531	3156	790	21057	1268	860.93	1914
12	791	1373	1597	1588	1125	875	806	615	771	2439	3730	2632	18342	1529	912.41	764
13	1479	4253	4551	2167	2106	3297	1411	1503	1790	4550	5959	3741	44807	3734	1464.96	1948
14	4171	8789	9361	7851	7298	6302	4726	5799	8607	14399	15639	8578	101520	8460	3336.20	2820
15	2442	5054	4915	4021	3578	3287	2307	2517	4255	7627	9149	4954	54106	4509	1992.98	2459
16	587	1939	2586	810	671	1018	472	393	750	1997	1872	681	13776	1148	708.01	984
17	1234	4443	2214	1444	2105	3069	758	703	742	2591	4951	2356	26610	2218	1338.16	1401
Total	30390	66845	62638	49040	44076	45997	33107	34545	46942	87792	107326	63237	679935	56663		
H. Average	1788	3932	3685	2885	2593	2706	1947	2032	2761	5164	6313	3720				
S. Deviation	2277.72	3806.91	4608.68	4435.33	3610.29	3455.16	3189.25	3735.02	5029.51	6295.79	6765.04	4905.74				

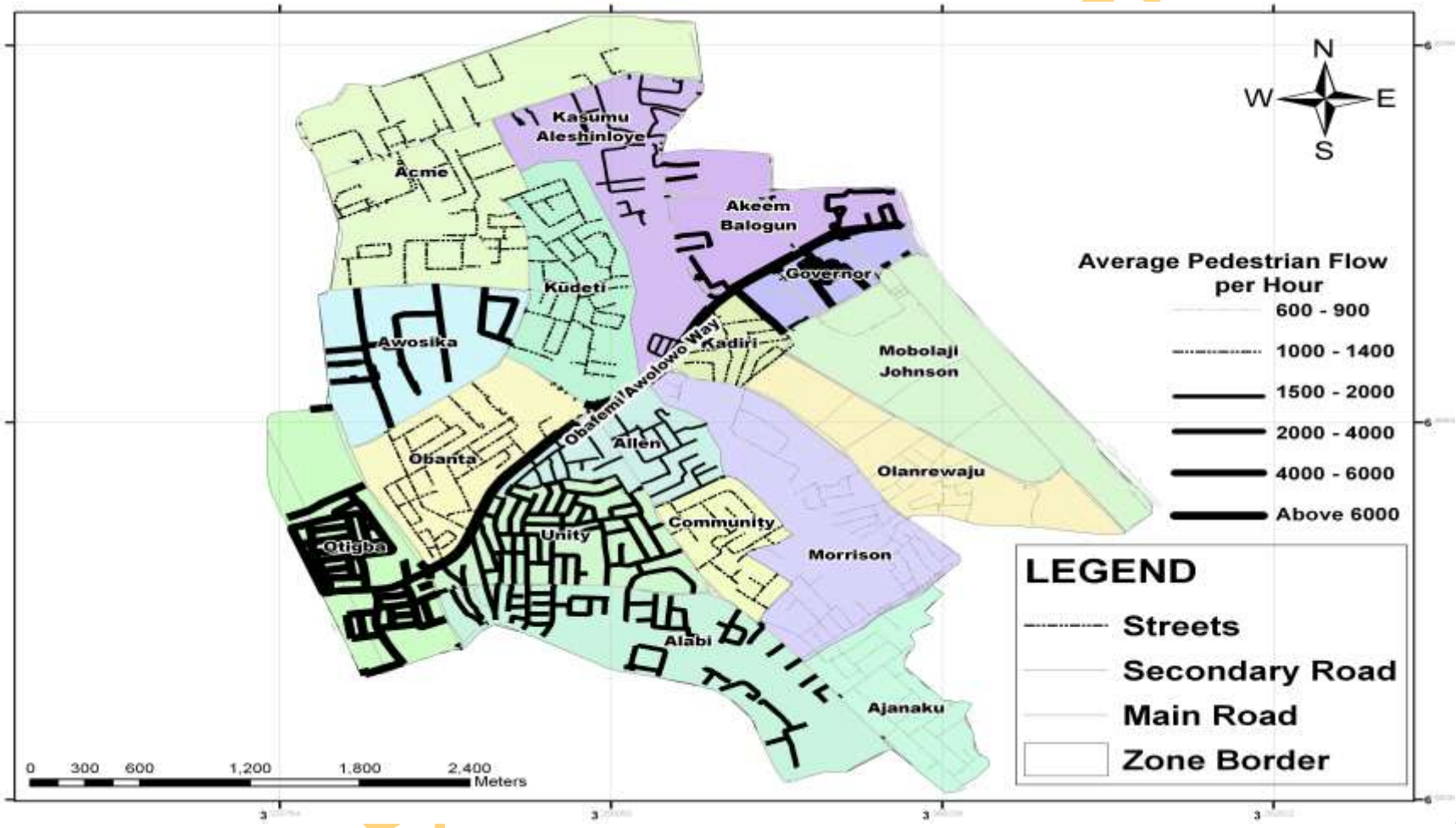

Figure 4.10: Average Pedestrian Flow per Hour along the Road Networks in the Study Area.

Source: Field Survey, 2009

Column sixteen and Figure 4.11 show average zonal flow of pedestrians in the study area. From figure 4.11, Otigba Area (1) has the highest (18,971) average pedestrian flow for the 12 hour period in the seventeen zones. Unity Area (14) is next to Otigba Area with an average pedestrian circulation of 8,460 people from 7am to 7pm.Coincidentally, Otigba Area and Unity Area are very close to each other and the two zones are zones of mixed land uses as presented in figure 4.6. Kudeti Area (4) and Governor Area recorded equal number (2,212) of pedestrian flow. Pedestrians average zonal flow from 7am to 7pm in order of magnitude include Alabi Area (15), Allen Area (13), Awosika Area (2), Acme Area (17), Obanta Area (3), Kadiri Area (8), Morrison Area (12), Akeem Balogun Area (5), Kasumu Aleshinloye Area (11), Community Area (16), Ajanaku Area (6), Olanrewaju Area (9) and Mobolaji Johnson Area (10)with values (4,509), (3,734), (3326), (2218), (1,898), (1,604), (1,529), (1,396), (1,268), (1,148), (1058), (800) and (509) pedestrians respectively.

Figure 4.12 shows average pedestrian flow along the road networks in each zone. From figure 4.12, Otigba Area with thirty three road networks has an average flow of (6, 833) pedestrians between 7am and 7pm in each of the street. Governor Area with four road networks is next to Otigba Area. An average flow of pedestrians in each of the four streets is 6,636 pedestrians. Awosika Area with an average flow of 4,988 pedestrians along each road network is next to Governor Area, and it has eight road networks. Figure 4.12 further shows that Akeem Balogun Area with five road networks recorded an average flow of 3,351 pedestrians along each of the road network between 7am to 7pm. Unity Area has the highest road networks among the zones. With thirty-six road networks, Unity Area has an average flow of 2,820 pedestrians walking on each of the road networks between 7am and 7pm of the study.

Average pedestrian flow along the road networks in other zones in the study area in order of magnitude include Alabi Area, Allen Area, Kasumu Aleshinloye Area, Acme Area, Kadiri Area, Kudeti Area, Obanta Area, Mobolaji Johnson Area, Morrison Area, Ajanaku Area and Olanrewaju Area with (2,459), (1,948), (1,914), (984), (873), (764), (604) and (600) pedestrians respectively.

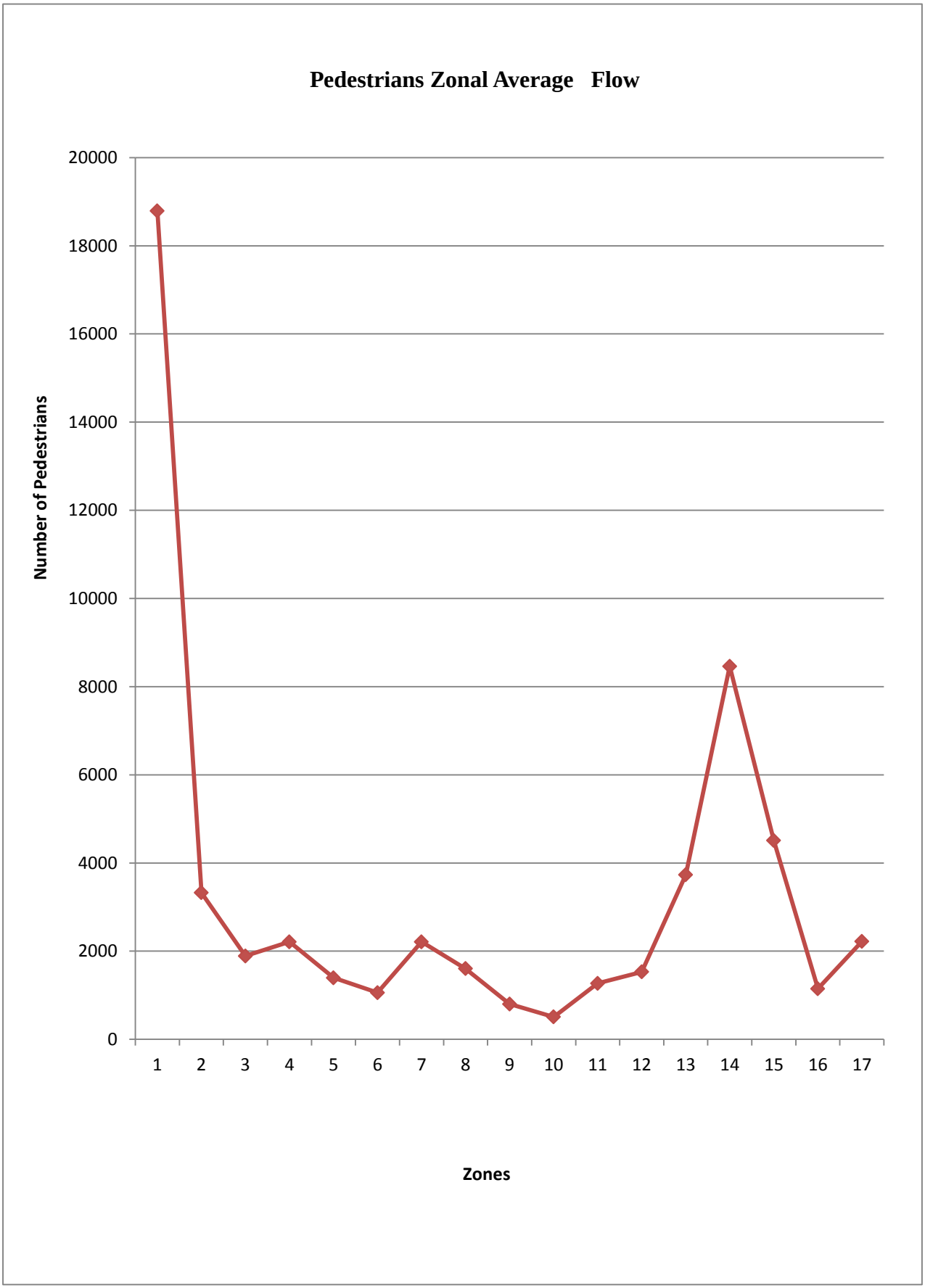

Figure 4.11: Pedestrians Zonal Average Flow in Ikeja.

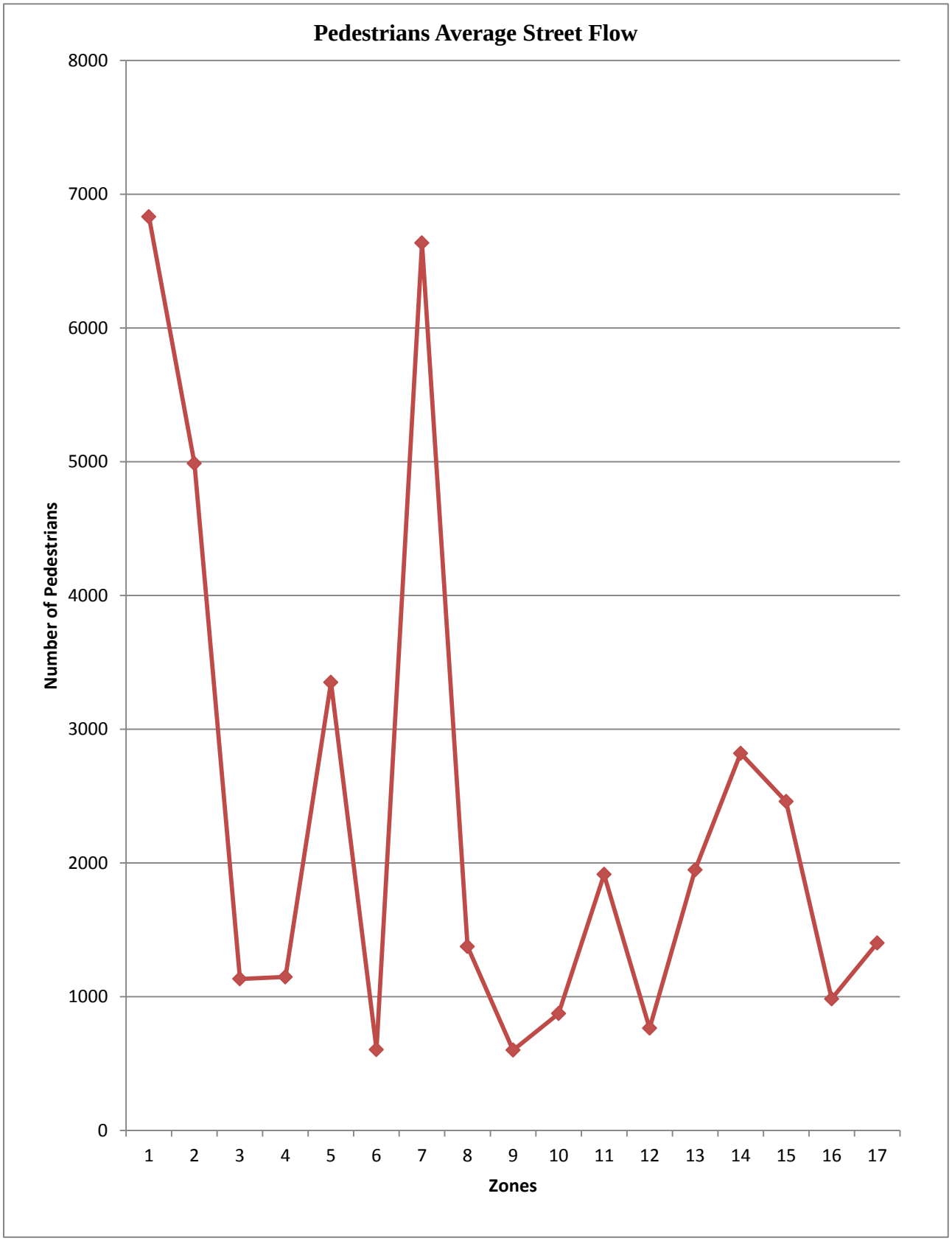

Figure 4.12: Pedestrian Average Street Flow in Ikeja.

Figure 4.13 shows pedestrians' hourly flow across the seventeen zones and figure 4.14 shows average hourly flow of pedestrians in the study area. Regarding the period of highest pedestrian flow in the study area, figure 4.13 shows that pedestrian flow is very high between 5pm and 6pm in fourteen zones. These zones are Otigba Area, Kudeti Area, Ajanaku Area, Governor Area, Kadiri Area, Olanrewaju Area, Mobolaji Johnson Area, Kasumu Aleshinloye Area, Morrison Area, Allen Area, Unity Area, Alabi Area, and Acme Area with (29,670), (4,739), (3,593), (1,972), (5,440), (5,000), (1,187), (863), (3,156), (3,730), (5,959), (15,639), (9,149) and (4,951) pedestrians respectively. In Awosika Area, the highest flow (7,905 pedestrians) was recorded between 8am and 9am.Between 4pm and 5pm, the highest pedestrian flow (4,050 pedestrians) and (1,997 pedestrians) was recorded in Obanta Area and Community Area respectively.

Concerning the lowest period of pedestrian circulations in the study area, the lowest pedestrian flow in Otigba Area (9,178 pedestrians), Obanta Area (889 pedestrians), Kudeti Area (526 pedestrians), Olanrewaju Area (507 pedestrians), Mobolaji Johnson Area (212 pedestrians) and Unity Area (4,171 pedestrians) was recorded between 7am and 8am.In Akeem Balogun Area, Kasumu Aleshinloye Area, Allen Area, and Alabi Area, the lowest pedestrian flow (367 pedestrians), (372 pedestrians), (1,411 pedestrians) and (2,307 pedestrians) was recorded between 1pm and 2pm. Zones with lowest pedestrian flow between 2pm and 3pm are Ajanaku Area (525 pedestrians), Morrison Area (615 pedestrians), Community Area (393 pedestrians) and Acme Area with 615 pedestrians. Between 3pm and 4pm, the lowest pedestrian flow was recorded in Awosika Area, Governor Area and Kadiri Area with 930, 691 and 384 pedestrians respectively.

Figure 4.14 on the other hand shows an average hourly flow of pedestrians at aggregate level. As expected based on the results in figure 4.13, the results in figure 4.14 indicates that the lowest average hourly pedestrian flow in the study area was recorded between 7am and 8am and the highest flow was recorded between 5pm and 6pm with flow rate of 1,788 and 6,313 pedestrians respectively. Between 7am and 8am, there is 54.5% increase in pedestrian flow. Between 9am and 10am and 3pm and 4pm pedestrian flow in the study area decreases by 25.6% and increases by 46.5% between 3pm and 4pm and 4pm and 5pm. Furthermore, between 4pm and 5pm, and 5pm and 6pm pedestrian flow increases by 18.2%.

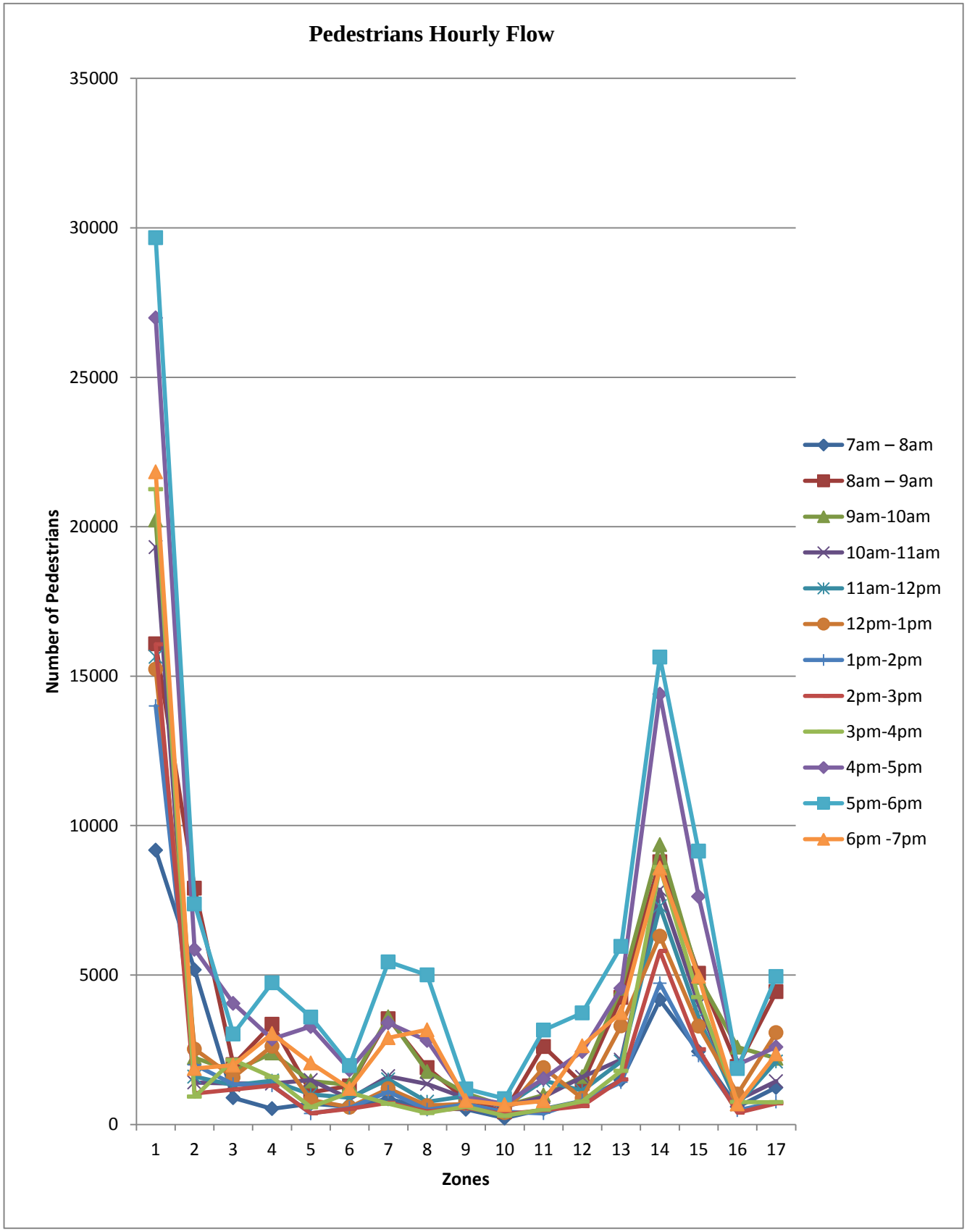

Figure 4.13: Pedestrians Hourly Flow in Ikeja

Figure 4.14: Pedestrian Average Hourly Flow in Ikeja.

Figure 4.14 also revealed that there is a reduction of 41.1% in the average number of pedestrians recorded between 5pm and 6pm and 6pm and 7pm. Figure 4.14 also showed that between 7am and 8am and 6pm and 7pm of the study, there is 51.9% increase in pedestrian flow in the study area. The percentage increase in pedestrian flow from 7am to 7pm in the study area can be attributed to the variations in the hourly flow pattern of pedestrian across zones as shown in table 4.4.

Table 4.4: Variations in Pedestrian Hourly Flow across Zones

Source of Variations	*Sum of Square*	*Degree of Freedom*	*Mean Square*	*F-Ratio*	*F-Ratio at 5%*
Between Groups	3733689246.578	16	233355577.911	56.76	1.52
Within Groups	767713908.417	187	4105421.970		
Total	4501403154.995	203			

Source: Field Survey, 2009.

Using analysis of variance, the result in table 4.4 shows that the calculated F-Ratio ($F_{187}^{16} = 56.76$) is greater that critical value of F-Ratio($F_{187}^{16} = 1.52$). The analysis in table 4.4 shows that at 5% level of significant, there is a significant variation in the hourly flow of pedestrians across the zone.

From the study, the volume of vehicular traffic and pedestrian trips generated daily in the study area have made vehicular congestion and parking problem a regular problem and the consequence is indiscriminate parking on roadside or walkways meant for pedestrians as shown in plates 4.1, 4.2 and 4.3. With little attention been paid to pedestrian needs, such as bus stops, bus shelters, pedestrian crosswalks and sidewalks in the study area and entire Ikeja LGA; vehicular and pedestrian conflict occurred frequently and pedestrians are the most affected.

4.5 SUMMARY

This chapter examines the socioeconomic activities and physical characteristics of Ikeja and the subunits that constitute the study area. The study shows that there are various socio-economic activities in Ikeja, and these activities are vibrant due to availability of different land uses. As the capital city of Lagos, and the headquarter of one of the twenty local governments in Lagos, Ikeja is not only an administrative and political capital but also serves as one of the commercial nerve centres of Lagos state due to concentration of industries, shopping malls, hotels and trading activities.

The chapter also examines transport activities, pedestrian movements and flow pattern along the streets in the study area. These movements have shown that landuse and economic activities in the study area are pull factors and thus have the capability in generating both vehicular and pedestrian trips and flow at different time of the day.

In Ikeja, pedestrian movements are clearly visible. However, pedestrian facilities such as walkways or sidewalks and sheds are lacking. The chapter showed that within the congested road ways, pedestrians and motor vehicle drivers do claim right of way. This occurs simply because pedestrian walkways are inadequate and where they are available, are few and in form of half-covered drainage, which are rarely used. At times; they are not used because they are occupied by parked vehicles, traders,

commercial motorcycles and tricycles. Pedestrians thus, jaywalked. The consequence of which may result into pedestrian-vehicular conflict and road traffic accidents which may also result into either disability or loss of life on the part of pedestrians.

The chapter also examines the flow pattern of pedestrians along road networks in the subunits. There was a spatio-temporal variation in pedestrian flow across the zones understudy. The flow patterns along the streets start to increase as early as 7:00am in the morning and tend to decrease around 7:00pm in the night. Between 7:00am and 7:00pm, the total average flow of pedestrian along the road networks in the study area is 56,663 pedestrians and the pattern of flow varies significantly ($F_{187}^{16} = 56.76, p \leq 0.05$) across zones. The variations of pedestrian flow observed across the zones can be attributed to the variations in landuse activities within the zones.

Availability of different landuse and places of economic activities in Ikeja explain the volume of pedestrian traffic generated and the flow pattern observed along the road networks. The volume and flow pattern of pedestrians are for different purposes and as well for tolerable walking distances to either bus terminals or places of economic activities. In line with the aim and objectives of the study, pedestrian walking distances and volume trips generated to various activities were discussed in the chapter that follows.

CHAPTER FIVE

PEDESTRIAN WALKING DISTANCES AND TRIPS GENERATED IN IKEJA

5.1 INTRODUCTION

Spatial imbalance as observed by Ullman (1956) in geographical regions produces spatial interaction in terms of movements. Pedestrian movements in the study area can be attributed to the spatial imbalance in terms location of facilities and landuse activities. People thus move from one location to another in order to access available facilities and landuse activities. The movement of people along road networks as pedestrian and the observed flow patterns in the study area is based on different purposes and for varying walking distances.

This chapter therefore examines household heads and on-street persons' pedestrian trips frequency by gender, trip purposes and walking distances to bus stations or public transport pick-up points and places of economic activities. Furthermore, the chapter assesses maximum walkable distances of household heads and on-street persons to bus stations and landuse activities in the study area. The hypotheses which state that: (i) The maximum distance people are ready to walk to bus stations, various functions and services do not vary; and (ii) the number of pedestrian trips made by household heads' and on-street persons' in urban centres which is assumed to be the function of their trip types, number of economic activities engaged in and level of accessibility were also tested

5.2 INCIDENCE OF PEDESTRIAN TRIPS

Examining the frequency of household heads and on-street persons walk trips in the study area, respondents were asked if they do walk frequently as pedestrians. The results of the survey showed that out of 978 household heads, a high proportion (60.7%) of the respondents (see Figure 5.1) do walk frequently as pedestrians in and around Ikeja, and 39.3% of the respondents do not walk frequently as pedestrians.

This result does not necessarily mean that household heads in Ikeja are mostly pedestrian, but shows how frequently household heads walk.

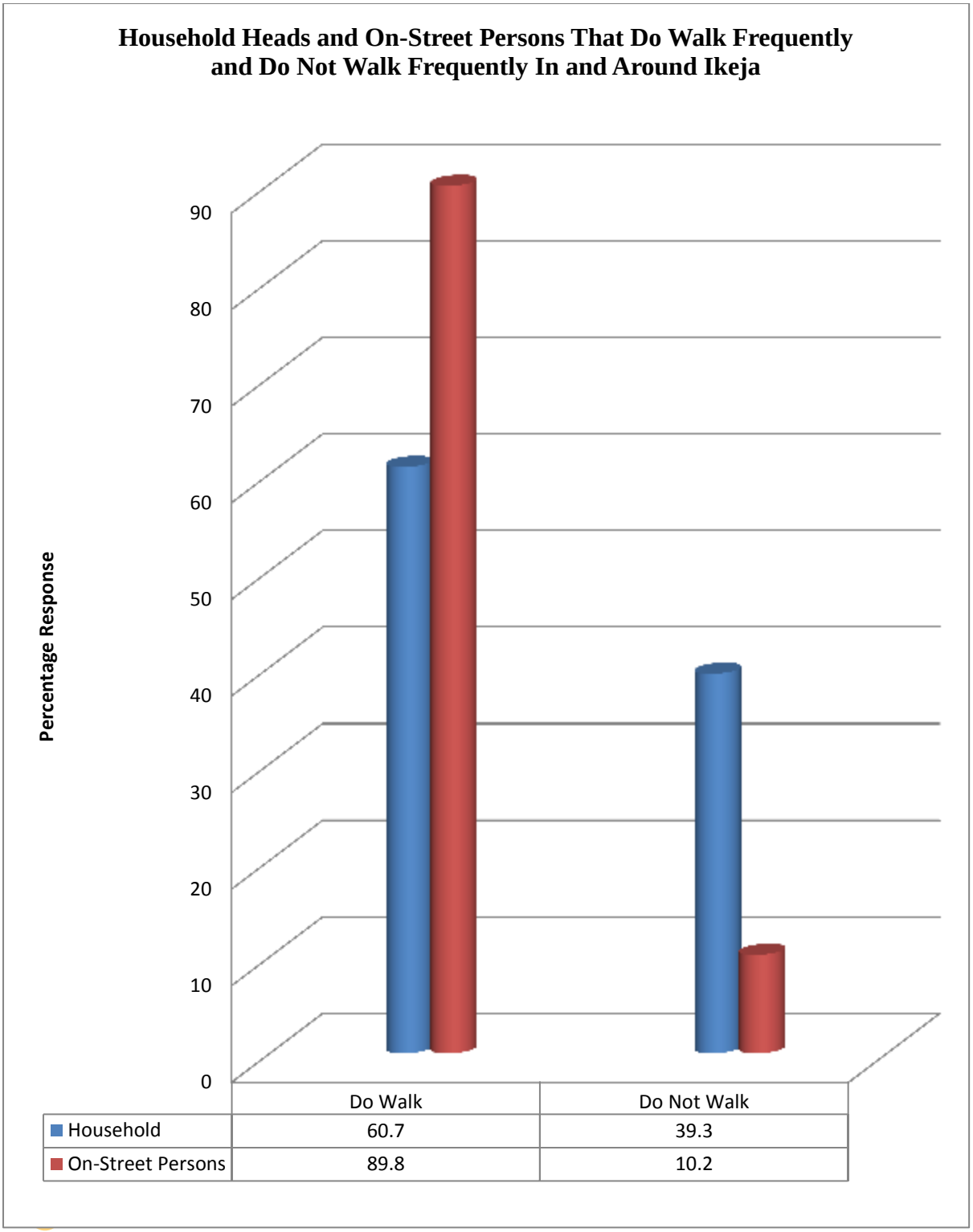

Figure 5.1: Household Heads and On-Street persons' Walk Trip Frequency in Ikeja.

Source: Field Survey, 2009

Table 5.1: Male and Female Household Heads and On-Street Persons that Walk and Do Not Walk Frequently in the Study Area.

Variable	*Do Walk Frequently*		*Do Not Walk Frequently*	
	Male	Female	Male	Female
Household Heads	270 (45.5)	324 (54.5)	336 (87.5)	48 (12.5)
On-Street Persons	72 (39.3)	112 (60.9)	12 (57.1)	09 (42.9)

Source: Field Survey, 2009.

Table 5.1 shows that out of 594 household heads that walk frequently as pedestrian, 45.5% of the respondents are male and 54.5% are female. Of the 384 household heads that do not walk as pedestrians, 87.5% respondents are male and 12.5% are female.

The results of the response of (205) on–street persons sampled as shown in figure 5.1 and table 5.1, about (189) respondents representing (89.8%) on-street persons do walk frequently as pedestrians in and around Ikeja while (21) respondents representing (10.2%) on-street persons do not walk as pedestrians.

Table 5.1 further shows that, out of (189) on-street persons that walk frequently as pedestrian, (39.1%) of the respondents are male and 60.9% of the respondents are female. Out of (21) on-street persons that do not walk frequently as pedestrians in and around Ikeja, (57.1%) are male respondents and (42.9%) are female. The results of the respondents (household heads and on-street persons) sampled (see table 5.1) showed that larger percentage of the household heads and on-street persons do walk frequently as pedestrians.

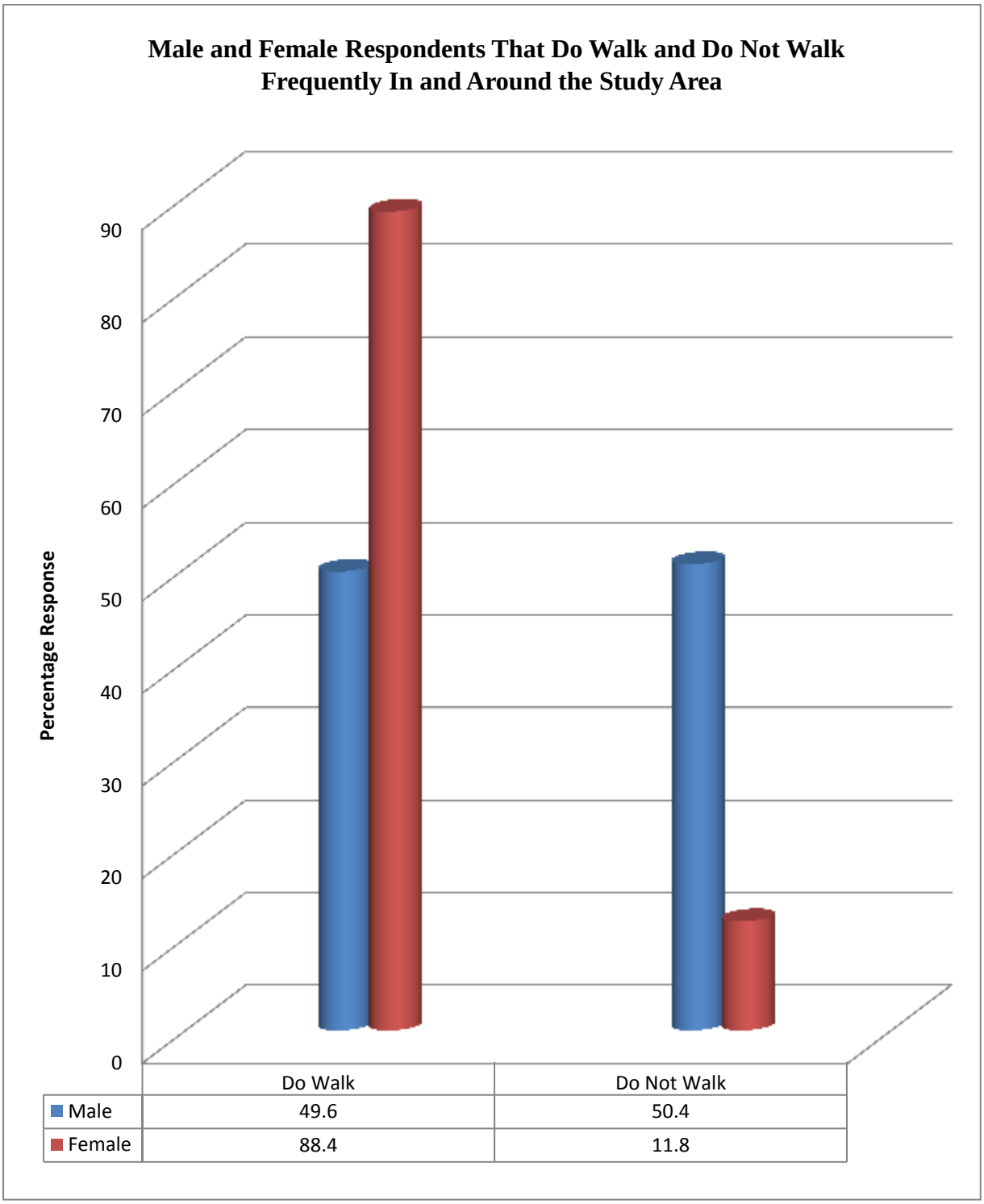

Figure 5.2: Male and Female Respondents that do walk and do not walk frequently in Ikeja.

Source: Field Survey 2009

The findings in figure 5.2 further revealed that high proportion of female respondents (household heads and on-street persons) representing (88.4%) do walk frequently as pedestrians compare with their male respondents with (49.6 %) response rate. The difference in the response rate of male and female respondents sampled on 'how frequent they walk as pedestrian' showed that women sampled have propensity to walk than men and the difference may be attributed to the difference in their travel needs. Therefore, the demand for transportation mode such as airplanes, trains, cars, buses, tricycles, bicycles as well as walking varies and for different purposes. Thus, the purpose, for which household heads and on-street persons' travel as pedestrian is presented in the section that follows.

5.3 PEDESTRIAN TRIP PURPOSES

One key element of pedestrian trips is the creation of mobility by providing accessibility to different important activities such as work, education, services, social functions, sport and as well as creating enhanced work-related mobility to public transportation (SOU,2001; Weststrand, 2003; TRB, 2006; Raji , 2010).

Trip purposes in urban areas can be achieved through different means of transport including walking. Responding to trip purposes, 94.6% of household heads and on-street persons sampled walk trips (pedestrian trips) start from home between the hours of (5:30am-6:00am) in the morning and 86.7% of the trips end at home between the hours (6:00pm-8:00pm) on daily basis.

Pedestrian trip purposes embark upon by the household heads and on-street persons involve ***obligatory trips*** and **discretional *trips***. Obligatory trips (regular trips) include activities such as journey to work, businesses and schooling. Discretional trips (voluntary trips) include activities such as recreation, religious function, shopping, social functions, visiting friends and exercising. Table 5.2 presents household heads and on-street persons' pedestrian trip purposes in the study area.

Table 5.2: Pedestrian Trip Purposes in Ikeja.

Purpose of Walk Trips	*Total Walk Trips*		*Household Head Walk Trips*		*On- Street Persons Walk Trips*	
	Frequency	%	Frequency	%	Frequency	%
Work	1162	30.4	985	30.6	177	29.6
Recreation	257	6.7	251	7.8	06	1.0
Religious Function	784	20.5	619	19.2	165	27.6
Business	353	9.2	259	8.0	94	15.7
Schooling	284	7.4	246	7.6	38	6.4
Shopping	666	17.4	637	19.8	29	4.9
Social Function	128	3.3	88	2.7	40	6.7
Visiting Friends	48	1.3	0	0.0	48	8.0
Exercising	139	3.6	139	4.3	0	0.0

Source: Field Survey, 2009

Table 5.2 shows that (985) of household heads with (30.6%) response rate and (177) on-street persons with (29.6%) response rate, walk as pedestrians for work purpose. The result shows that work accounted for the highest proportion of household heads and on-street persons' trip purposes. Afterwards, 19.8% of household heads walk as pedestrian for shopping purpose while 27.6% on-street persons walk as pedestrian for religion functions.

Religion function, with (19.2%) of the respondents is next to shopping in household heads' response to purpose of walking in Ikeja. About 15.7% of on-street persons walk as pedestrians in Ikeja in order to engage in business activities. Both household respondents and on-street person's purpose of walking as pedestrians in Ikeja also include recreation, visiting friends, and social functions. None of the household heads' walk as pedestrian to visit friends and none of the on-street persons walk as pedestrians for the purpose of exercising. Results of the study in figure 5.3 further shows that out of 1,183 respondents sampled, high proportion of the respondents, (30.4%) walk as pedestrians for work purpose.

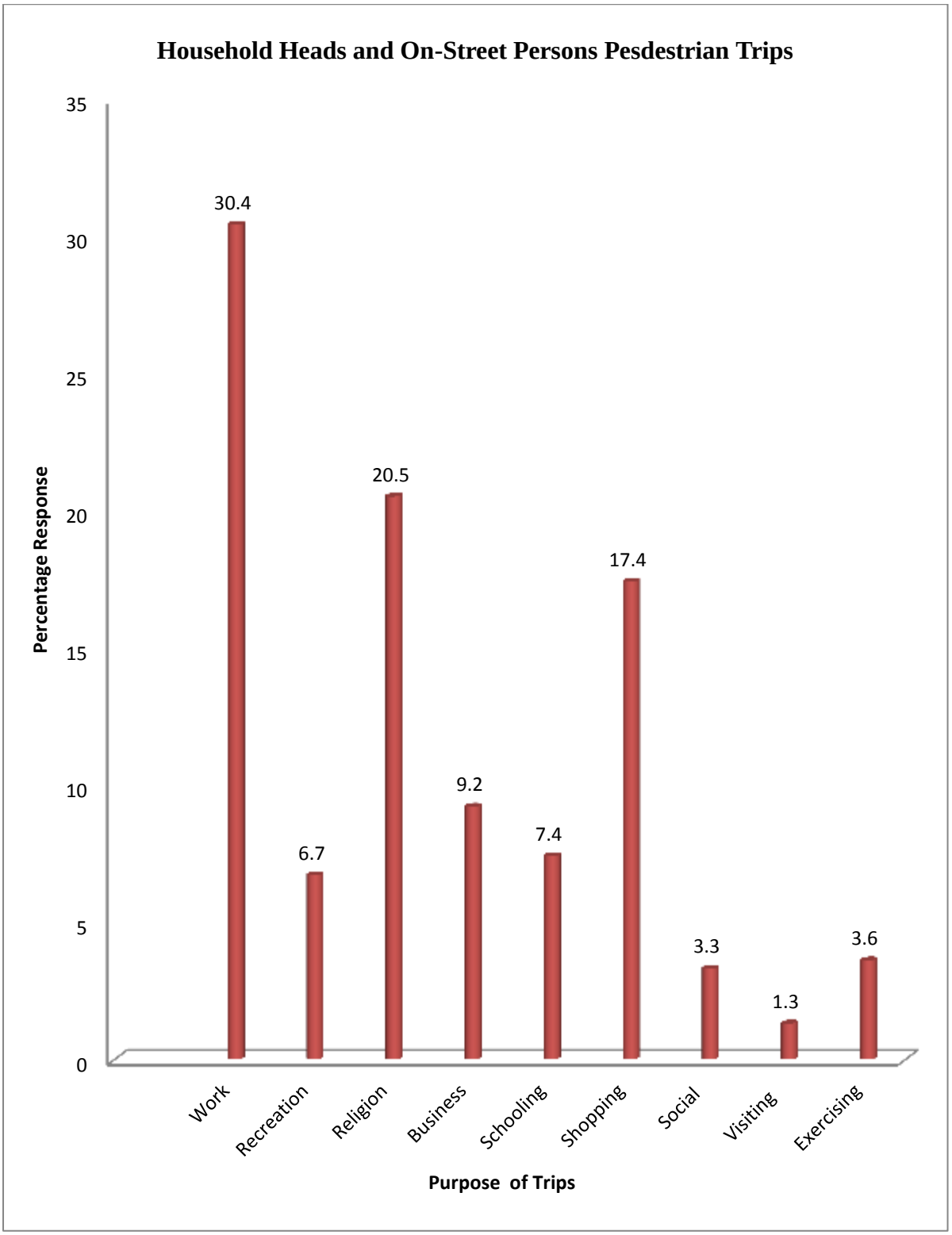

Figure 5.3: Household heads and On-Street Persons Walk Trips in Ikeja.

Source: Field Survey, 2009

The purpose of walking as pedestrian in order of importance by household heads and on-street-persons in figure 5.3 include religious function with 20.5% respondents, shopping with 17.4% respondents, business with 9.2% respondents, schooling with 7.4% respondents, recreation with 6.7% respondents, exercising with 3.6% respondents, social function with 3.3% respondents and visiting friends with 1.3% respondents.

From the results of the study, it was observed that household heads and on-street persons' work and school activities span from Monday to Friday, in some cases spill to Saturday. While Monday to Friday work activities last between the hours 07:00am to 4:00pm daily, Saturday work activities last between 08:00am to 12:00pm in the afternoon.

Recreation activities of respondents extend from Monday to Sunday but at varying time period. Monday to Friday recreation activities last between 6:00 pm to 9:00pm, Saturday recreation activities last between 12:00 in the afternoon to 2:00pm and Sunday recreation activities last between 1:00pm to 2:00pm. Monday to Friday recreation activities according to the respondents are made to avoid being stocked in traffic congestion.

Religious activities also spans from Monday to Sunday. Monday to Friday activities, last between 4:00pm to 6:00pm except Tuesday and Wednesday that respondents indicated that their church programme do spill to 8:00pm.Saturday activities start from 4:00pm and end by 10pm and Sunday activities last between 10:00am to 4:00pm.

Business activities of household heads and on-street persons extend from Monday to Sunday and their pedestrian trip has no time bound. Shopping activities is daily and spans from Friday to Sunday with concentration on weekend (Saturdays and Sundays).While week days shopping activities last between 4:00pm to 6:00pm, weekend shopping activities last between 9:00am to 2:00pm.

Social activities of household heads and on-street persons span for Thursday, Friday, Saturday and Sunday. This activity last between 8:00am to 2:00pm on Thursday and

10:00am to 6:00pm on Saturday and Sunday. Friend visit are on weekends (Saturday and Sunday). On walk trip as exercise, respondents were of the opinion that they do embark on walk trip as pedestrian during weekends (Saturday and Sunday) and this activity last between 6:00 am to 9:00 am.

All activities discussed involve households and on-street persons' movement from different origins to different destinations and these movements demand household heads and on-street persons covering varying distances. Section 5.4 examines walking distances covered by household heads and on-street persons' to bus stations or public transport pick up points, land use and places of economic activities as pedestrians.

5.4 PEDESTRIAN WALKING DISTANCES

Walking distance concept has its origin in the neighbourhood design concept. It is important in determining the level of accessibility of commuters and pedestrians to transport facilities. Public transport services are expected to be provided within walking distances. Walking distance can be measured in units of time and also in spatial terms. For example, 5 minutes walking distance or 100m walking distance. Interest in walking distance stems from the fact that public transport is more attractive with a shorter average walking distance. The shorter the walking distance, the more attractive the public transport.

Walking distance has been employed since mid-sixties as a criterion required in the planning of facilities and landuse activities in new urban sub-divisions. Walking distance to and from home; to the bus stops and other public transport pick up points, landuse and places of economic activities can be covered either at the origin of a trip , at transit or at the destination of the trip.

Walking distance therefore, is the distance which people especially those without a car, should be expected to walk to public transport stops as well as to locations of local facilities. For instance, in the UK, fifteen minutes is assumed to be the minimum average walking distance for persons who do not readily have the use of a private car, and 5 minutes is the expected average distance for car owners to walk to local facilities or public transport pickup points without using a car (Adeniji, 1988; Okoko,

2006).The results of the study on walking distances of households and on-street persons' to bus stations or public transport pick-up points, landuse and places of economic activities and pedestrian maximum walking distances is discussed in sections 5.4.1 and 5.4..2 and 5.4..3 respectively.

5.4.1 Walking Distances to Bus Stations

In the study, individual household heads and on-street persons in the study area were asked on the distance they walk to bus stations or public transport pick-up points. Individual response of 978 household heads and 205 on-street persons' sampled are presented in appendix IV. However; table 5.3 presents the mean walking distance of household head and on-street person based on seventeen subunits in which the study area was delineated.

Table 5.3: Average Walking Distances of Household heads and On-Street Persons to Bus Stations in Ikeja.

Zone Codes	*Name*	*Household head Mean Walking Distances (m)*	*On-Street Person Mean Walking Distances (m)*	*Aggregate Mean Walking Distances (m)*
1	Otigba Area	206	269	238
2	Awosika Area	195	263	229
3	Obanta Area	203	312	258
4	Kudeti Area	183	258	221
5	Akeem Balogun Area	196	264	230
6	Ajanaku Area	233	293	263
7	Governor Area	158	333	246
8	Kadiri Area	211	335	273
9	Olanrewaju Area	209	300	255
10	Mobolaji Johnson Area	260	283	272
11	Kasumu Aleshinloye Area	205	310	258
12	Morrison Area	165	327	246
13	Allen Area	178	278	228
14	Unity Area	143	200	172
15	Alabi Area	163	321	242
16	Community Area	159	323	241
17	Acme Area	246	293	270
Mean Trip Length		195	292	244
Range		117	135	98
Standard Deviation		31.37	33.78	23.79

Source: Field Survey, 2009

The distances household heads and on-street persons walk to bus stations or public transport pick-up points varies in Ikeja. In column three of table 5.3 household head in Mobolaji Johnson Area (10) walks about 260metres to bus stations. The result of 260 metres walking distance by household head in Mobolaji Johnson Area (10) shows that household head in Mobolaji Johnson Area (10) walks more distances than any household heads in Ikeja. Household head walking distance to bus station in Mobolaji Johnson (10) is similar to that of on-street person in Kadiri Area (8) where on-street person mean walking distance to bus station is 335metres. The result of walking distance of on-street person in Kadiri (8) shows that on-street person in Kadiri Area (8) walk more distance to bus stations than any on-street persons and household heads in Ikeja.

Furthermore, the shortest walking distance to bus stations in Ikeja was made by household head in Unity Area (14). Coincidentally, the shortest walking distance made by on-street person in Ikeja was made by on-street person in Unity Area (14).Unlike, Mobolaji Johnson Area (10) and Kadiri Area (8) where bus stations are located far away from respondents (household heads and on-street persons), in Unity Area (14), household head and on-street person walk little distance to bus stations because of the concentration of public transport pick-up points in and around the area. In Unity Area (14), it is significant to note that household heads find it easier to board different types of vehicles by stepping out of their various homes. This is because many residential areas in Unity Area (14) are surrounded by ever busy streets or roads.

Column five of table 5.3, examines mean walking distances of respondents (both household heads and on-street persons) and this is presented in figure 5.4. From figure 5.4, respondents in Unity Area (14) walk less distance (172metres) to bus stations while respondents in Kafi Area (8) walk more distance (273 metres) to bus stations in Ikeja.

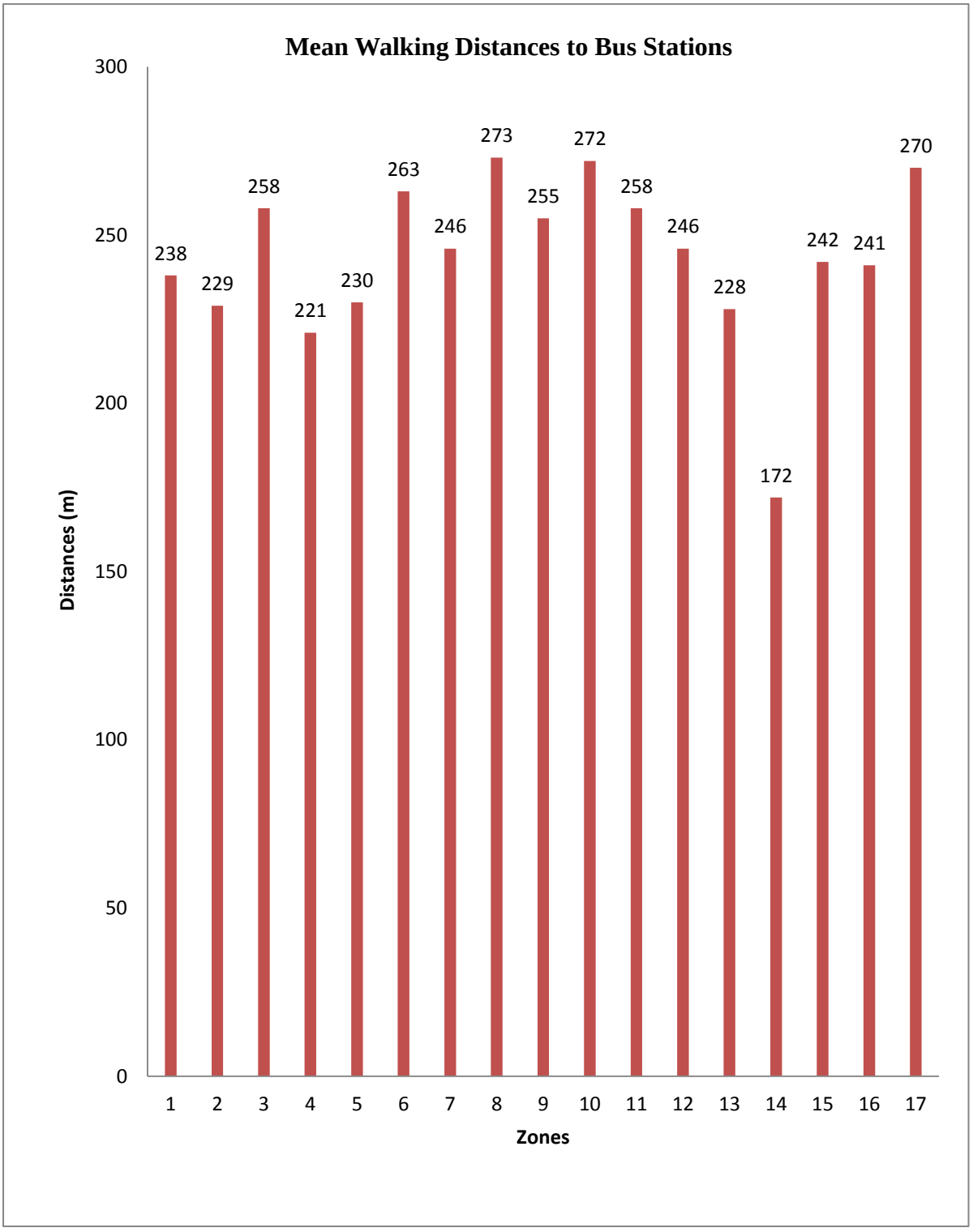

Figure 5.4: Household Heads and On-street Persons Mean Walking Distances to Bus Stations in Ikeja.

Source: Field Survey 2009

The results showed that respondents in Unity Area (14) walk less distance to bus stations than respondents in Kadiri Area (8). Nonetheless, in row nineteen of table 5.3, household heads in Ikeja walk fewer distances with mean trip length of 195metres to bus stations than on-street persons who walk more distances to bus stations with mean trip length of 292 metres. Section 5.4.2 discusses household heads and on-street persons walking distances to landuse and places of economic activities in Ikeja.

5.4.2 Walking Distances to Landuse Activities.

Apart from assessing household heads and on-street persons walking distances to bus stations in Ikeja, household heads and on-street persons walking distances to landuse and places of economic activities was also examined. In terms of distance cover, the study revealed that household heads and on-street persons walking distances to landuse and places of economic activities in Ikeja differs from walking distances of household heads and on-street persons to bus stations. In the course of the study, it was equally observed that household heads and on-street persons walking distances to landuse and places of economic activities' vary among respondents and as well across zones in which the study area was divided.

Table 5.4 shows that household heads in Otigba Area (1), Ajanaku Area (6), Mobolaji Johnson Area (10), Alabi Area (15) and Community Area (16) walk a distance of 1.52kilometre to landuse and places of economic activities in Ikeja. This means that there is equidistance in household heads walking distance to landuse and places of economic activities in Ikeja. Similarly, in Kudeti Area (4), Kadiri Area (8) and Acme Area (17) the mean walking distances of household heads to landuse and places of economic activities is 1.67kilometre.

Furthermore, in Akeem Balogun Area (5) and Olanrewaju Area (9), household heads walk a distance of 1.44kilometre to landuse and places of economic activities. The similarities in the distance cover by foot to landuse and places of economic activities in (Otigba Area, Ajanaku Area, Mobolaji Johnson, Alabi Area, and Community Area), (Kudeti Area, Kadiri Area and Acme Area) and (Akeem Balogun Area and Olanrewaju Area) by household heads may have been connected with widespread of

landuse and places of economic activities that require varying distances. Walking distances of household heads to landuse and places of economic activities in Awosika Area (2), Obanta Area (3), Governor Area (7), Kasumu Aleshinloye Area (7), Morrison Area (12), Allen Area (13) and Unity Area (14), are 1.34kilometre, 1.49kilometre, 1.55kilometre, 1.40kilometre , 1.68kilometre , 1.63kilometre and 1.41kilometre respectively.

Table 5.4: Average Walking Distances of Household heads and On-Street Persons to Landuse Activities in Ikeja.

Zone Codes	*Classified Name*	*Household Head (km)*	*On-Street Person (km)*	*Aggregate Mean Walking Distances (km)*
1	Otigba Area	1.52	2.31	1.92
2	Awosika Area	1.34	2.48	1.91
3	Obanta Area	1.49	2.45	1.97
4	Kudeti Area	1.67	2.47	2.07
5	Akeem Balogun Area	1.44	2.38	1.91
6	Ajanaku Area	1.52	2.53	2.03
7	Governor Area	1.55	2.09	1.82
8	Kadiri Area	1.67	2.78	2.23
9	Olanrewaju Area	1.44	2.49	1.97
10	Mobolaji Johnson Area	1.52	2.48	2.00
11	Kasumu Aleshinloye Area	1.40	2.79	2.10
12	Morrison Area	1.68	2.18	1.93
13	Allen Area	1.63	2.53	2.08
14	Unity Area	1.41	2.38	1.90
15	Alabi Area	1.52	2.75	2.14
16	Community Area	1.52	2.50	2.01
17	Acme Area	1.67	2.38	2.03
Mean Trip Length		1.53	2.47	2.00
Range		0.34	0.70	0.33
Standard Deviation		3.77	5.76	0.1

Source: Field Survey, 2009

Regarding walking distances of on-street persons to landuse and places of economic activities in Ikeja, table 5.4 shows that walking distance of 2.48kilometre by on-street person to landuse and places of economic activities in Awosika Area and Mobolaji Johnson Area is equal. Similarly, on-street persons in Akeem Balogun Area (5), Kadiri Area (8) and Acme Area (17) walking distance to landuse and places of economic activities is 2.38km.

In other areas such as Otigba Area (1), Obanta Area (3), Kudeti Area (4), Ajanaku Area (6), Governor Area (7), Olanrewaju Area (9), Kasumu Aleshinloye Area (11), Morrison Area (12), Allen Area (13), Unity Area (14). Alabi Area (15) and Community Area (16), the mean walking distances of on-street persons to landuse and places of economic activities are 2.31km, 2.45km, 2.47km , 2.53km, 2.09km , 2.49km, 2.79km , 2.18km, 2.53km , 2.78km , 2.75km and 2.50km respectively.

The results in table 5.4 further shows that the lowest walking distance of 1.34km to landuse and places of economic activities was made by household heads in Awosika Area and the highest walking distance (1.68km) was made by household heads in Morrison Area. In the case of household heads in Awosika Area, the result obtained may have been connected with the location of Awosika Area in Ikeja. Awosika Area is located where landuse and places of economic activities are of close proximity to respondents' residences. Unlike Awosika Area, Morrison Area is predominantly residential and this suggests that household heads will walk longer distances to landuse and places of economic activities in Ikeja.

Regarding on-street persons, table 5.4 equally shows that the lowest mean walking distance made by on-street person to landuse and places of economic activities was in Governor Area and the highest walking distance was made by on-street persons in Kasumu Aleshinloye Area with trip lengths of 2.09km and 2.79km respectively. In the case of on-street persons in Osin Area where the mean walking distance to landuse and places economic activities of on-street person is at its lowest, 38% of landuse activities are residential; 16% is commercial, 18% is religion, 2% is financial and 26% is institutional (see table 4.2). Concentration of residential activities with moderate commercial and little financial activities may have also been responsible for the observed walking distance made by on-street persons to landuse and places of economic activities in Ikeja. This means that most on-street persons' in Governor

Area sometimes result into the use of public transport to access landuse activities and places of economic activities in Ikeja.

In case of Kasumu Aleshinloye Area where walking distance of on-street persons to landuse and places of economic activities is at its highest, 31% of landuse activities are residential, 30% is commercial, 16% is religion, 6% is financial, 15% is institutional and 2% is industrial (see table 4.2). Though residential activities dominate landuse activities in Kasumu Aleshinloye Area, availability of different landuse activities at varying proportion attract people and this may have been responsible for observed walking distance in the area.

However, in the last row of table 5.4 the mean walking distances (2.47km) of on-street persons to landuse and places of economic activities is higher than the mean walking distances (1.53km) made by household heads to landuse and places of economic activities. Like the results of mean walking distances of household heads and on-street persons to bus stations in Ikeja, the results of mean walking distance of respondents to landuse activities indicates that on-street persons' walk more distances to landuse and places of economic activities than household heads in Ikeja.

Figure 5.5 on the other hand shows respondents (both household heads and on-street persons) mean walking distances to landuse and places of economic activities in Ikeja. The results from figure 5.5 shows that the lowest walking distance (1.91km) to landuse and places of economic activities in the study area was made by respondents in Awosika Area and Akeem Balogun Area. Furthermore, the highest mean walking distance to landuse and places of economic activities (2.23km) in the study area was made by respondents in Kadiri Area. Invariably, it can be concluded that respondents in Kadiri Area walk more distances to landuse and places of economic activities in Ikeja.

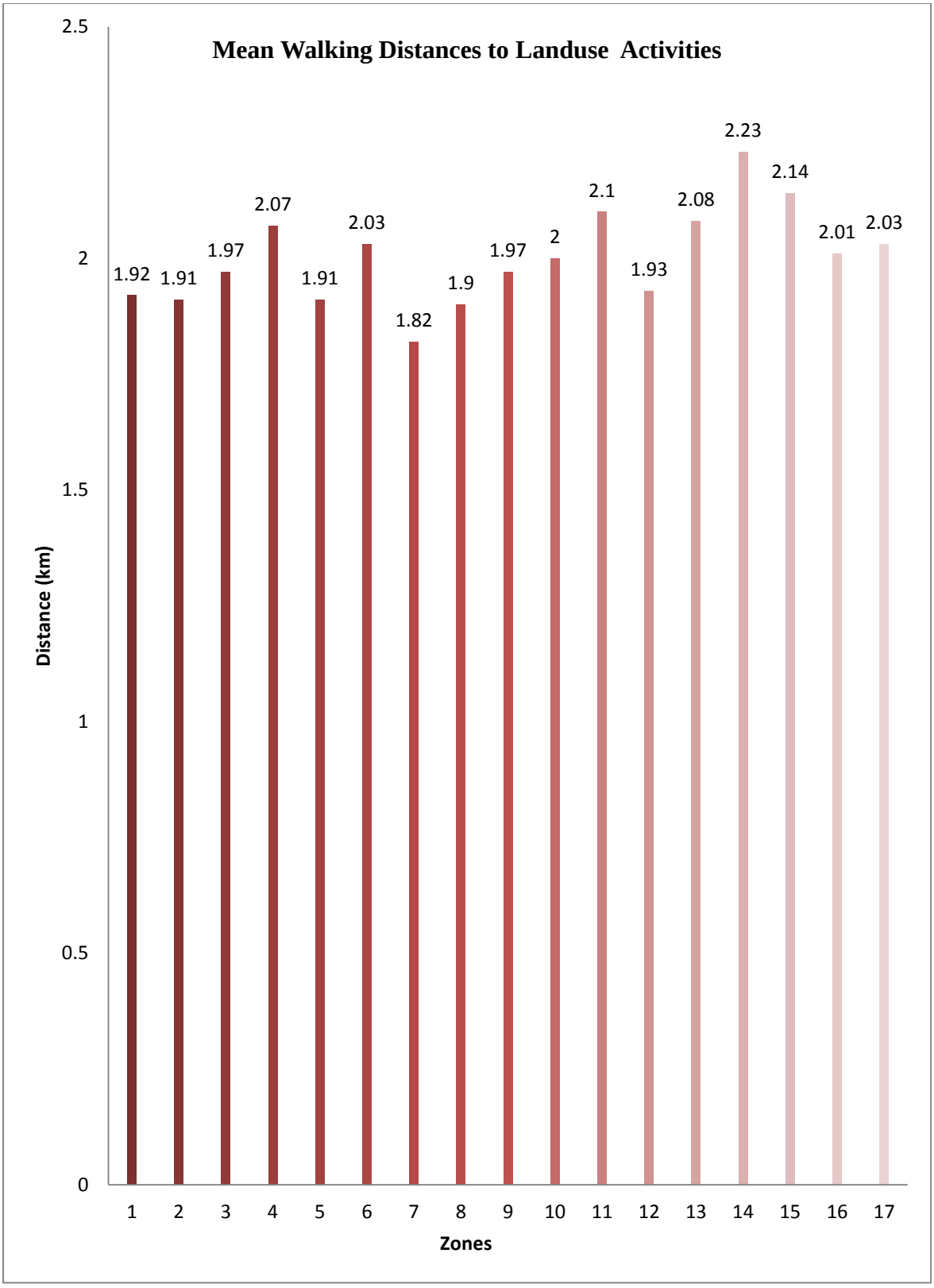

Figure 5.5: Household Heads and On-Street Persons Mean Walking Distances to Landuse Activities in Ikeja

Source: Field Survey, 2009.

In the literature, Cresswell (1973) proposed average walking distances between 300m and 900m from home to public transport pick-up points or bus stations on housing types in table 5.5. Cresswell (1976) is of the opinion that these estimates are believed to be the basis for planning in housing. He further stated that, in Abuja the Federal Capital Territory of Nigeria, without specific population or defined land area (during the time of establishment), a walking distance of 400 metres or 5 minutes' walk was proposed.

Based on Cresswell (1973) observations of 300m to 900m average walking distance from home to public transport pick-up points, the results of the study showed that the mean walking distance of the people in the study area between 143m and 335m.The result thus, falls short of Cresswell propositions.

Table 5.5: Recommended Walking Distances to Public Transport Stops and Local Facilities

Types of Building	*Walking Distances (Metres)*
Multi-Family Housing	
≥ 5 Storey	300
3 - 4 Storey	400
2 Storey	500
Single Family Housing	
Terraces Houses	500
Other Types	600 – 900

Source: Cresswell, R. W. (1976) Passenger Transport and the Environment.

From the results of the study, it can be suggested that with on-going re-construction in Lagos, an average walking distance between 300m to 900m proposed by (Ling, 1969; Pass and Fasta, 1973; Cresswell, 1976) to bus stations and public transport pick-up points may not be appropriate So, transport and urban planners need a comprehensive study of people's behaviour or incorporate a walking distance between 143m to 335m obtained in the course of the study into the scheme.

Fruin (1971) on the other hand, propounded a maximum walking distance of 3.2km in the United States of America to landuse activities such as school, market, work, stadia and so on. In this study, it was observed that the trip length household heads and on-street persons will walk to landuse and places of economic activities are on the average of 1.51km and 2.47km respectively. Furthermore, on the average, the trip length of respondents (both household heads and on-street persons) to landuse and places of economic activities is 2km.The result of the study is in variance with the proposition of 3.2km propounded by Fruin (1971) in the United States of America. Fruin (1971) proposition may not be appropriate for planning in Ikeja and other cities in Nigeria that have similar characteristics of Ikeja.

The variations observed in the mean walking distances of household heads and on-street persons in each zone of the study area; signify the limit (maximum walking distances) individual household head and on-street person will walk to bus stations and landuse activities. Establishing the significance of the variations noticed in walking distances of the respondents necessitated the explanation of the research hypothesis of the study that states that: "the maximum distances people are ready to walk to bus stations, landuse activities and various functions and services do not vary across zones in the study area". Section 5.4.3 of the study examines the significance of maximum walkable distances of household heads and on-street persons in Ikeja.

5.4.3 Pedestrians Maximum Walkable Distances

In this study, the distances people walk to bus stations, landuse and places of economic activities is presented in appendix IV and appendix V respectively. However, the results of mean walking distances for household heads and on-street persons in table 5.3 and table 5.4 show the limit respondents can walk to bus stations,

landuse and other places of economic activities across zones in which the study area was divided.

Examining the significance variations in the mean walking distances of household heads and on-street persons sampled, test for the significance of mean walkable distances of household heads and on-street persons was carried out using Analysis of Variance (ANOVA). In generating table 5.6, tables 5.3 and 5.4 were used. At disaggregate level row one to row ten of table 5.6 examines the variations in mean walkable distances of individual household head and on-street person's to bus stations and landuse activities respectively and row eleven to row fifteen of table 5.6 assesses the aggregate level of variations in the mean walkable distances of (both household heads and on-street persons) to bus stations and landuse activities in Ikeja.

Results in row one to row five of table 5.6 shows that the calculated F-Ratio is $F_{32}^{1} = 70.831$. The critical value at 5% level of significance is $F_{32}^{1} = 4.150$. From the analysis, the value of calculated F-ratio is greater than the critical value, that is, $F_{32}^{1} = 70.831 > F_{32}^{1} = 4.150$, and it can be inferred that the maximum distances household heads and on-street persons are ready to walk to bus stations do vary across zones in the study area.

Table 5.6: Variations in Pedestrian Walking Distance to Bus Stations and Land Use Activities in Ikeja.

Variation in Pedestrian Walking Distance to Bus Stations

Sources of Variance	Sum of Square of Variance	Degree of Freedom	Mean Square	F- Ratio	F-Ratio at 5%
Between Groups	79976.500	1	79976.500	70.831	4.150
Within Groups	36131.529	32	1129.110		
Total	116108.03	33			

Variation in Pedestrian Walking Distance to Land Use Activities

Sources of Variance	Sum of Square of Variance	Degree of Freedom	Mean Square	F- Ratio	F-Ratio at 5%
Between Groups	2.298	1	2.298		
Within Groups	4.516	32	0.141	16.288	4.150
Total	116108.03	33			

Variation in Pedestrian Walking Distance to Bus Stations and Land Use Activities

Sources of Variance	Sum of Square of Variance	Degree of Freedom	Mean Square	F- Ratio	F-Ratio at 5%
Between Groups	15099558	1	15099557.765		
Within Groups	3562450.1	32	111326.566	135.633	4.150
Total	1866.2008	33			

Difference in Pedestrian Walking Distance to Bus Stations and Land Use Activities

Household Heads On-Street Persons			t-test	t-test at 5%
	$X_1 = 0.244$km	$\delta_1 = 0.02$		
			71.01	2.02
	$X_2 = 2.000$km	$\delta_2 = 0.01$		

Source: Field Survey Computation, 2009.

Similarly, results in row six to row ten of table 5.6 shows that the calculated F-Ratio is $F_{32}^{1} = 16.288$. The critical value at 5% level of significance is $F_{32}^{1} = 4.150$. From the analysis, the value of calculated F-ratio is greater than the critical value, that is, $F_{32}^{1} = 16.288 > F_{32}^{1} = 4.150$. From the analysis, it can also be deduced that the maximum distances household heads and on-street persons are ready to walk to landuse and place of economic activities do vary across zones in the study area.

The variations in the mean walkable distances of household heads and on-street persons to bus stations and landuse activities in the analyses (row one to row ten in table 5.6) can be linked to the results obtained in table 5.3 and table 5.4. Table 5.3 and table 5.4 showed variations in the mean walking distances of household heads and on-street persons to bus stations and landuse activities across zones in the study area. Furthermore, table 5.3 and table 5.4 equally showed that the average walking distance or trip length of household heads to bus stations and landuse activities is less than average walking distance or trip length of on-street persons to bus stations and landuse activities in the study area. The difference in walking distances of the respondents to bus stations and landuse activities in the study area is a reflection of behavioural pattern of individual household head and on-street person in the choice of comfortable walking distance.

The results in row one to row ten of table 5.6 may also be connected with the location of individual household head and on-street person from bus stations and landuse activities that requires varying distances. Therefore, differences in walkable distances of household heads and on-street persons' to bus stations and landuse activities and the significant variations observed in mean walking distances of household heads and on-street persons to bus stations and landuse activities using ANOVA, negate the first hypothesis of the study that states that: the maximum distances people are ready to walk to bus stations, landuse activities and various functions and services do not vary across zones in the study area.

Furthermore, results in row eleven to row fifteen of table 5.6 on the other hand, revealed aggregate level of respondents (both household heads and on-street persons)

walkable limit to bus stations and landuse activities. The result showed that calculated F-Ratio is $F_{32}^{1} = 135.633$, the critical value at 5% level of significance is$F_{32}^{1} = 4.150$. From the analysis, the value of calculated F-ratio is greater than the critical value that is $F_{32}^{1} = 135.633 \succ F_{12}^{1} = 4.150$. From the analysis it means that the maximum distances household heads and on-street persons are ready to walk to bus stations, landuse activities and various functions and services differ across zones in the study area. The t-test conducted on the mean walking distance of respondents {household heads to bus stations and landuse activities ($\bar{X}$=0.244km, δ=0.02) and that of on-street persons ($\bar{X}$=2.000km, δ=0.10)} is significant at (t=71.01, p=≤0.05).The conclusion of significant variations and difference in the mean walking distances of both households and on-street persons' to bus stations and landuse activities in the study area further disprove the research hypothesis at aggregate level. The results obtained from the study has shown that at individual level as well as group level in Ikeja, the maximum distances people are ready to walk to bus stations, landuse activities and various functions and services do vary.

In various economic and landuse activities embark upon by household heads and on-street persons, there are number of times they engage in these activities weekly, monthly and even yearly as pedestrian. In the course of this research, household heads and on-street person's daily activities were recorded and the number of times these activities were generated with respect to their pedestrian trip characteristics or purpose, socio-economic activities and level of accessibility. Section 5.5 of the thesis therefore, discusses the determinants of the number of pedestrian trips generated by respondents in Ikeja.

5.5 DETERMINANTS OF PEDESTRIAN TRIPS GENERATED

Travel frequency is generally employed as one of the criteria in the analysis of travel activity patterns. In line with the second objective of the thesis and to achieve hypothesis II of the study that states that: ''the number of pedestrian trips made by households' and on-street persons' in urban centres is a function of their trip types, number of economic activities engaged in and level of accessibility.''

Household heads and on-street persons' number of pedestrian trips generated (both household heads and on-street persons' walk trip frequencies to various activities) was set against number of variables in the field study.

Analysing household heads and on-street persons' number of pedestrian trips generated, multiple regression analysis was employed. Multiple regression was employed to express the relationship between household heads' and on-street persons' number of pedestrian trips generated against explanatory variables such as trip types (work, shopping, business, social function, religious function , visiting friend, recreation, schooling and exercising); number of economic activities (industries, restaurants, shopping malls and fast food points) respondents engaged in; and pedestrian level of accessibility in each of the seventeen subunits in which the study area was divided. The explanatory variables are presented in table 5.7.

Table 5.7.: Description of Explanatory Variables Used For the Number of Pedestrian Trips Generated in Ikeja.

	Variables	**Description**
Y	Household and On-street (HO) persons Volume of Pedestrian Trips = PVT_{VT}	Number of times individual household and on-street respondents walk to each activities
	Trip Types or Purposes =T_{CT}	
$\mathbf{X_1}$	HO_WORK = WORK	Work; 1 if going to work, 0 otherwise
$\mathbf{X_2}$	HO-SPPIN = SHOP	Shopping; 1 if going for shopping, 0 otherwise
$\mathbf{X_3}$	HO-BUSNES = BNES	To take transit; 1 if going to take transit, 0 otherwise
$\mathbf{X_4}$	HO_SCIAL = SOFU	Social; 1 if going for social functions, 0 otherwise
$\mathbf{X_5}$	HO_RLIGON = RELI	Religion; 1 if going for religion functions, 0 otherwise
$\mathbf{X_6}$	HO_VISITFR = VIST	Visiting; 1 if going for visit , 0 otherwise
$\mathbf{X_7}$	HO_RCRTN = RECR	Recreation; 1 if going for recreation, 0 otherwise
$\mathbf{X_8}$	HO_SCHLNG= SCHL	Schooling; 1 if going to school, 0 otherwise
$\mathbf{X_9}$	HO_EXERCISE = EXER	Exercise; 1 if going for exercise, 0 otherwise
	Number of Economic Activities =E_{EA}	
$\mathbf{X_{10}}$	NINDU	Number of times a respondent engaged in industrial activities in the study area
$\mathbf{X_{11}}$	NHRES	Number of times a respondent visit hotels or restaurants in the study area.
$\mathbf{X_{12}}$	NFINI	Number of times a respondent engaged in financial and related institutions activities in the study area.
$\mathbf{X_{13}}$	NSHPM	Number of times a respondent visit shopping malls or retail outlet in the study area.
$\mathbf{X_{14}}$	NFAST	Number of times a respondent visit fast food points in the study area.
	Level of Accessibility =L_{LA}	
$\mathbf{X_{15}}$	Zone 1 to Zone 17	1 if there is a direct link between nodes in the street graph of respective zones, 0 otherwise
N	**1183**	

Source: Field Survey, 2009.

Note: Nodes represent junctions, round about in the study area; Link represents streets or road network in the study area. **Where,** Households and On-Street Persons Volume Pedestrian Trips = PVT_{VT} Trip Types or Purposes = $\boldsymbol{T_{CT}}$, Number of Economic Activities = E_{EA} Level of Accessibility = L_{LA}

The choice of these variables is not limited to their measurement capability in urban decision analysis but also based on the response of 1183 respondents (household heads and on-street persons) to the explanatory variables in the administered questionnaire. The regression equation is thus expressed in equation 5.1 as:

$$PVT_{VT} = \propto + b_i T_{CT} + b_j E_{EA} + b_k L_{LA} + \cdots + b_n Q_N + \mu \quad 5.1$$

Where

PVT_{VT} = Household heads' and on-street persons' number of walk trips.
T_{CT} = Household heads' and on-street persons' trip characteristics
E_{EA}= Number of times household heads and on street persons visited economic Activities.
L_{LA} = Level of accessibility in each zone.
b_i, b_j, b_k= regression coefficients
μ = random error term

Equation 5.1 is simplified into equation 5.2 with the variables expressed as:

$$PWT_{FT} = \propto + b_i(WORK + RECR + RELI + BNES + SCHL + SHOP + SOFU + VIST + EXER +) b_j(NINDU + NHRES + NFIFI + NSHPM + NFAST) + b_k(ACCESS) \quad 5.2$$

Where PWT_{FT}= Number pedestrian walk trips

Checking for collinearity among the explanatory variables, it was observed that there is a high correlation ($r \geq 0.80$) (see appendix VI) between explanatory variables (recreation and schooling) and (recreation and number of times respondent visit fast food points). Since the correlation between explanatory variables (schooling and fast food points) is not high($that\ is, r = 0.787$) , recreation variable was removed from the analysis. The summary of the regression results is presented in table 5.8.

In appendix VII, all the explanatory variables are significant at 95% confidence level except schooling, social function, number of times respondents engage in financial institutions and level of accessibility of respondents in the study area, and they are not presented in table 5.8.

Table 5.8: Relationship between Number of Pedestrian Trips Generated by Household heads and On-Street Persons' in Ikeja.

Variables	*Variables Acronym*	*Unstandardized Regression Coefficients*	*Standardized Regression Coefficients(Beta)*	*Standard Error*	*t-values*
Work	WORK	1.024	0.353	0.101	10.125
Religion	RELI	1.351	0.320	0.161	8.415
Business	BNES	0.435	0.074	0.165	2.627
Shopping	SHOP	1.042	0.258	0.146	7.138
Visiting Friends	VIST	4.284	0.076	2.324	1.843
Exercising	EXER	2.851	0.082	1.172	2.432
Industries	NINDU	0.452	0.061	0.166	2.726
Hotels and Restaurants	NHRES	0.345	0.034	0.313	1.103
Shopping Mall	NSHPM	2.897	0.047	1.836	1.577
Fast Food Points	NFAST	4.735	0.288	1.241	3.816
Constant		0.735		6.512	0.113
Model Adjusted R^2		0.792			
Model F -Ratio		189.623			
N		1183			

Source: Field Survey Computation, 2009.

From the results in table 5.8, the regression equation for number of pedestrians trips generated in Ikeja is presented in equation 53 as:

$$PWT_{FT} = 0.735 + 0.353(WORK) + 0.320(RELI) + 0.074(BNES) + 0.258(SHOP) + 0.076(VIST) + 0.082(EXER) + 0.061(NINDU) + 0.034(\mathrm{NHRES}) + 0.047(\mathrm{NSHPM}) + 0.288(\mathrm{NFAST}) \quad 5.3$$

The regression equation showed that the most significant explanatory variables that contributed to the number of pedestrian trips generated by 1183 respondents (both household heads and on street persons) in Ikeja is work. Presenting the contributions of the explanatory variables in order of importance include work, religious functions, number of times household heads and on-street persons visit fast food points, shopping, exercising, visiting friends, business, number of times household heads and on-street persons engaged in industrial activities, number of times household heads and on-street persons visit shopping malls, hotels and restaurants in Ikeja.

Ayeni (1975; 1979) , Lewis (1981) and Oyesiku (1990) observed that the standardised partial coefficient as presented in column four of table 5.8 guarantees measurement units of the independent variables when interested in relative effect of the explanatory variables. Therefore, the regression equation 5.3 presents in order of importance the independent variables using the standardised partial coefficient in table 5.8.

Work is the most significant variable in the number of pedestrian trips generated by household heads and on-street persons while friends' visit is the least in respondents' number of pedestrian trips made in Ikeja. The signs of the partial regression coefficient for all the explanatory variables are positive. This indicates an increase in household heads and on-street persons' number of pedestrian trips result in a unit increase in the explanatory variables (trip characteristics, economic activities and accessibility).

As earlier discussed in this chapter, that 'work purpose' account for the largest proportion of household heads and on-street persons' pedestrian trip purposes in Ikeja, 'going to work' happens to be the most significant of the explanatory variables that

explain household heads and on-street persons number of pedestrian trips generated in the regression analysis. Therefore, the result obtained from the regression analysis, is in line with the works of (Ayeni, 1979; Daniels and Warnes, 1980; Tanimowo, 1983; Ojo, 1990; Zeeger et al 1994; Solanke, 2005 Rahaman, 2007) where trips to work and services constitute a dominant proportion of trips generated by urban residents studied.

5.6 SUMMARY

This chapter shows that larger proportion of household heads and on-street persons do walk frequently. This does not necessarily mean that household heads and on-street persons in Ikeja are mostly pedestrians. Out of the proportions of respondents that walk frequently among household heads and on-street persons, the result shows that female respondents walk more frequently than the male respondents.

The chapter also discussed household heads and on-street persons' pedestrian trip purposes. Nine categories of household heads and on-street persons' pedestrian trip purposes were observed in Ikeja. The pedestrian trip purposes include, work, religion function, business, recreation, shopping, schooling, social function, visiting friends and exercising. As presented in table 5.2 and figure 5.3, work accounted for the highest walk trip purpose and the least is visiting friends.

Interestingly, religion function is next to work. The tendency of religion function to rank high after work may be peculiar to Nigeria in Sub-Saharan Africa countries where people place value on religion. Furthermore, outright conversion or the use of most commercial buildings and residential buildings in the study area as earlier discussed in chapter four for house fellowship, churches may also be a possibility for such ranking.

The chapter shows that walking distances of respondents varies across zones in the study area. At aggregate and disaggregate levels, there are significant variations in the mean walking distances of household heads and on-street persons to bus stations, landuse and places of economic activities. Furthermore, it was observed that household heads walk less distances to bus stations, landuse and places of economic

activities in the study area than on-street persons. This situation may be attributed to the fact that household heads take pleasure in the comfort of their vehicles, which signifies that household heads are likely to bring their vehicles as close as possible to activity centres. The implication is that where there are no parking facilities at these centres, people may decide to park along the streets or walkways meant for pedestrians (which is obvious in (plate 4.1, plate 4.2 and plate 4.8) thereby not only creating traffic congestion along the streets but also expose pedestrians to danger. Where there is enforcement regarding on-street parking, this may result to underutilisation of such facilities.

The chapter also looked at the explanatory variables that explain the number of pedestrian trips generated by household heads and on-street persons. In the results, work, religious function, and shopping, significantly explain number of pedestrian trips generated by household heads and on-street persons in that order. The level of importance of shopping activities to household heads and on-street persons and their level of patronage may have contributed to the significance of regression coefficient representing the number of times respondents engaged in shopping activities in Ikeja. The results of the regression analysis also showed a similar trend in the percentage response of household heads and on-street persons regarding their walk trip purposes as shown in table 5.2

Generally, movements of pedestrians in Ikeja at different time of the day can be attributed to the generating capability of various land uses which serves as either origins or transits or destinations of household heads and on-street persons' trips. The incidence of household heads and on-street persons pedestrian trips; the purpose of pedestrian trips; the maximum distance household heads and on-street persons are prepare to walk in achieving the trip purposes and the factors that determines the number of trips generated have been discussed in this chapter. However, the question that comes to mind is that: (i) what informs household heads and on-street persons' decision to walk? (ii) what is their level of safety when generating these trips? Providing explanations to these questions, involve examining the third and the fourth objectives of the thesis, and it requires an in-depth study of people's decision to walk and their level of safety on roadways in Ikeja.

CHAPTER SIX

PEOPLE'S DECISION TO WALK AND PEDESTRIAN LEVEL OF SAFETY IN IKEJA

6.1 INTRODUCTION

As discussed in chapter five, the purpose for which people travel, creates the demand for the use of different modes of transportation including walking. The field study also shows that the number of pedestrian trips generated by female respondents' is higher than their male counterpart. But the observed difference in the gender trips generated may not be limited to the variations in their travel needs but, can also be attributed to their decision to walk.

People decision to walk is influenced by several factors. Examining these factors require the use of logistic regression to model 1183 respondent's readiness to walk against predetermined explanatory variables that are described in this chapter. The chapter also analysed the most preferable determinants in the usage of pedestrian facilities in Ikeja using the Analytical Hierarchical Process (AHP) model.

The chapter also provides explanation to pedestrian level of safety along 56 road segments in the study area using pedestrian level of service (the threshold of pedestrians on walkways) as surrogate to pedestrian level of safety. Of the 56 road segments sampled, only 6 of the road segments have walkways or sidewalks. The chapter discusses pedestrian level of safety in relation to lateral separation (pedestrian distance from moving or passing vehicles), motor vehicle volume, motor vehicle speed and access of vehicles to adjoining properties along the road segments using multiple regression analysis. Factors influencing decision to walk is discussed in the section that follows.

6.2 FACTORS INFLUENCING DECISION TO WALK

There are several factors that influence people's decision to walk to various activities such as journey to work, shopping centres, recreation, social functions, religion centres and so on. In this study, the decision of household heads and on-street persons to walk was set on predetermined explanatory variables such as socio-economic characteristics (age, gender, marital status, education, employment, auto ownership, number of vehicle owned, monthly income and work location); preferred nature of pedestrian facilities (road traffic situation, safety, security, cleanliness, spacious); and other factors such as distance, time, season and weather. These explanatory variables or factors are presented in table 6.1.

Table 6.1: Description of the Explanatory Variables Used for Household Heads and On-Street Persons' on Decision to Walk.in Ikeja.

Explanatory Variables	*Description*
Decision to Walk	
Ready to walk Not ready to walk	Number of households and on-street persons that are: Ready to walk = 1, Not ready to walk = 0
Socio-economic Data	
Age	Age of Respondents 1 if ≻35years, 0 if ≤35years
Gender	Gender of respondents 1 if female, 0 if male
Income	Respondents monthly income: 1 if ≤ ₦7,500:00, 0 if ≻ ₦7,500:00
Marital Status Single	Marital status: 1 if single.
Married	Marital status: 0 if married.
Education Qualification Education	Respondents Education: 1 Having Secondary Education or Less, 0 otherwise.
Employment	Employment status: Government employed 1, Self-employed 0.
AUTO	Household auto ownership, 1 if having none, 0 otherwise
NVEHI	Number of Vehicle in household, 1 if less than 2, 0 if ≥ 2.
WLCT	Work Location: Within Ikeja = 1 , Outside Ikeja = 0
Nature of Pedestrian Facilities (Walkways)	
RTRFS	Traffic Situation: 1 if walkway congested, 0 walkway not congested
SAFTY	Safety: 1 if walkway is safe, 0 if walkway not safe
SCRTY	Security: 1 if walkway is not secured, 0 walkway secured
CNTNTY	Continuity: 1 if walkway is continuous, 0 walkway not continuous
CLNESS	Cleanliness : 1 if walkway is not clean, 0 if walkway is dirty
SPCIUS	Spacious: 1 if 2 or more people can walk , 0 otherwise
Other Factors	
DSTCE	Distance: 1 if journey length ≥3.2km, 0 journey length < 3.2km
TIME	Time of the day: 1 if night, 0 if daylight
SNSON	Season: 1 if rainy season, 0 if dry season
WTHER	Weather: 1 if cool , 0 if hot

Source: Field Survey, 2009.

In order to provide explanation to these variables, household heads and on-street persons response was modelled in equation 6.1 such that:

$$D_{dtw} = \omega + \beta_i X_i + \beta_j X_j + \cdots + \beta_k X_k \qquad 6.1$$

The decision to walk (D_{dtw}) is a binary dependent response variable of *'ready to walk'* and *'not ready to walk'*, X_i represent socio-economic variables, X_j represent nature of pedestrian facilities (walkways), and X_k represent other factors in table 6.1. In binary dependent variable, most assumptions of Ordinary Least Square (OLS) regression are violated; hence, Ordinary Least Square is not suitable. However, Probit and Logit analyses are appropriate for the data obtained.

Logistic regression answers similar questions as discriminant analysis. However, logistics regression is often preferred to discriminant analysis as it is more flexible in its assumptions and types of data that can be analyzed. Logistic regression can handle both categorical and continuous variables, and the predictors do not have to be normally distributed, linearly related, or of equal variance within each group (Tabachnick and Fidell 1996).

In Logistic regression, the objective is the same as Ordinary Least Square (OLS). The goal is to model dependent variable in terms of one or more independent variables (Dayton, 1997; Ananth and Kleinbaum, 1997; Adeleke and Adepoju, 2010). Logistic regression is then useful only for dependent variables that are categorical such as alive or dead, male or female, yes or no and so on.

Logistic and probit regression models are equally designed to analyse qualitative data reflecting a choice between two or more alternatives (Jones, 2007), and as well capable of transforming binomial data into linearity, which in the case of this study include '*ready to walk' and 'not ready to walk'*.

The logistic model thus represents a convenient way of quantifying the relationship between the characteristics of the household heads and on-street persons' decision to

walk. The dependent variable takes the value of 0 or 1, where 1 represents '*ready to walk'* and 0 'not *ready to walk'* or otherwise as described in table 6.1.

Although the relationship between probit model and logit model is almost indistinguishable, Finney (1952), Greene (2003), Jones (2007), Vincent (2008) were of the opinion that if we are not sure that the data are normally distributed (which may be true for the data of this study), then, they suggest the use of logit model over probit model. Thus, the study made use of logit or logistic model.

In this study, the dependent variable, decision to walk (D_{dtw}) was transformed into dichotomous response variable Y with binary outcomes taking two values such that $\{Y\epsilon[0,1]\}$ with $Y = 1$ if the respondent's response is *'ready to walk'* and $Y = 0$ if response is '*not ready to walk'*. Based on the above, the probability of the respondents ready to walk which correspond to $Y = 1$ was derived using the following linear probability model depicted in equation 6.2

$$P_i = E(Y_i = 1IX_i) = \omega + \beta_i X_i + \beta_j X_j + \cdots + \beta_k X_k \qquad 6.2$$

where $(X_i, X_j \ldots\ldots, X_k)$ are the explanatory variables described in table 8.1 and $(Y_i = 1)$ means that respondents are ready to walk. Similarly, $[1 - (Y_i = 1)]$ represent respondents are not ready to walk. If respondent is ready to walk, it is represented in equation 6.3:

$$P_i = E(Y_i = 1IX_i) = \frac{1}{1+\exp[-(\omega+\beta_i X_i+\beta_j X_j+\cdots+\beta_k X_k)]} = \frac{1}{1+\exp[-Z_i]} \qquad 6.3$$

Where $Z_i = \omega + \beta_i X_i + \beta_j X_j + \cdots + \beta_k X_k$

Equation 6.3 represent cumulative logistic distribution function, with (Z_i) ranging from $(-\infty\ to\ +\infty)$; (P_i) range between $(0\ and\ 1)$, and (P_i) is non-linearly related to the explanatory variables $(X_i, X_j \ldots\ldots, X_k)$ and $(\beta_i, \beta_j \ldots\ldots, \beta_k)$.The implication is that Ordinary Least Square Regression cannot be used to estimate the parameters.
Then probability of readiness to walk is given by:

$$P_i = E(Y_i = 1 | X_i) = \frac{1}{1 + \exp[-Z_i]}$$

Then, $(\mathbf{1} - \boldsymbol{P_i})$ is the probability of 'not ready to work', and can be written as shown in equation 6.4:

$$(1 - P_i) = E(Y_i = 0 | X_i) = \frac{1}{1+exp[Z_i]} \quad 6.4$$

The probability that a household head and on-street person is ready to walk to the probability of a household head and on-street person not ready to walk is known as (**odds ratio**), and it is represented by equation 6.5.

$$\frac{P_i}{(1-P_i)} = \frac{1+exp[Z_i]}{1+exp[-Z_i]} \quad 6.5$$

From natural logarithm of equation 6.5, the *logit model* $\boldsymbol{L_i}$ for the study is given as:

$$D_{dtw} = \ln\left[\frac{P_i}{(1 - P_i)}\right] = \text{Logit}[P(Y_i = 1)] = L_i\omega + \beta_i X_i + \beta_j X_j + \cdots + \beta_k X_k$$

Where: D_{dtw} = Decisions to walk, X_i = Socio-economic characteristics of households and on-street persons, X_j = preferred nature of pedestrian facility X_k = Other factors, $\beta_i, \beta_j, \ldots \ldots \beta_k$ = Logit regression coefficients and ω = the constant. The probability for the logit regression model for the study is presented in equation 6.6 as.

$$P(Y_i = 1) = \frac{e^{\omega+\beta_1 AGE+\beta_2 GEN+\beta_3 MAR+\beta_4 EDU+\cdots.\beta_{19} WEA}}{1+e^{\omega+\beta_1 AGE+\beta_2 GEN+\beta_3 MAR+\beta_4 EDU+\cdots.\beta_{19} WEA}} \quad 6.6$$

Based on the results obtained from the study area, table 6.2 summarises descriptively, information obtained from households and on-street persons on decision to walk based on the explanatory variables presented in table 6.1 and table 6.3 summarises logistics regression results on decision to walk by households and on-street persons' in the study area in Ikeja.

Table 6.2: Summaries of Exploratory Data of Household Heads and On-Street Persons' on Decisions to Walk in Ikeja

Response Variables	*N*	*Marginal (%)*	*Response Variables*	*N*	*Marginal (%)*	*Response Variables*	*N*	*Marginal (%)*
$_{DTW}$ **RESPONSE**			**Auto-Ownership**			**Cleanliness**		
Ready to walk	778	65.8	Own Vehicle	986	83.3	Walkway dirty	15	1.3
Not ready to walk	405	34.2	None	197	16.7	Walkway clean	1168	98.7
SOCIO-ECONOMIC CHARACTERISTICS			**Number of Vehicle**			**Spacious**		
Age			< 2	850	71.9	Walkway spacious	1045	88.3
18 – 38	308	26.0	≥ 2	333	28.1	Walkway not spacious	138	11.7
39 – 59	567	48.0	**Monthly Income**			**Continuity**		
≥ 60	308	26.0	< ₦7,500 : 00	8	0.7	Walkway continue	1085	91.7
Gender			≥ ₦7,500 : 00	1175	99.3	Walkway not continue	98	8.3
Female	493	58.3	**Work Location**			**OTHER FACTORS**		
Male	690	41.7	Ikeja	956	80.8	**Distance**		
Marital Status			Outside Ikeja	227	19.1	≥ 3.2km	342	28.9
Single	254	21.5	**PREFERRED NATURE OF PEDESTRIAN FACILITY**			< 3.2km	841	71.1
Married	929	78.5	**Road Situation**			**Time to Walk**		
Education			Walkway congested	35	3.0	Night	327	27.6
Having primary educ.	87	7.4	Walkway not congested	1148	97.0	Day	856	72.4
Having secondary educ.	226	19.1	**Safety**			**Season to Walk**		
Having post-secondary educ.	870	73.5	Walkway safe	1175	99.3	Rainy	220	18.6
Employment			Walkway not safe	8	0.7	Dry	963	81.4
Government employed	771	65.2	**Security**			**Weather to Walk**		
Self- employed	412	34.8	Walkway not secured	25	2.1	Cool	1143	96.6
			Walkway secured	1158	97.9	Hot	40	3.4

Source: Field Survey, 2009.

Table 6.3: Relationship between Household Heads and On-Street Persons' Decisions to Walk in Ikeja.

Variables	*Coeff. (β)*	*Std. Error*	*Wald-Statistics*	*df*	*P-value*	*0dd Ratio Exp (β)*	*95% C.I. for Exp (β)*	
							Lower	Upper
AGE[1]	-0.212	0.172	1.523	1	0.217	0.809	0.578	1.133
GEN[1]	0.024	0.126	0.035	1	0.852	1.024	0.800	1.311
MAR[1]	-0.080	0.152	0.279	1	0.597	0.923	0.686	1.243
EDU[1]	0.060	0.161	0.140	1	0.709	1.062	0.775	1.456
EMP[1]	-0.063	0.131	0.228	1	0.633	0.939	0.726	1.215
AUT[1]	-0.004	0.176	0.000	1	0.982	0.996	0.705	1.407
NVE[1]	0.038	0.144	0.070	1	0.791	1.039	0.783	1.378
MIN[1]	-1.579	1.094	2.083	1	0.149	0.206	0.024	1.759
WCL[1]	0.135	0.157	0.747	1	0.388	1.145	0.842	1.556
RTS[1]	-1.190	0.363	0.274	1	0.601	0.827	0.406	1.666
SAF[1]	0.056	0.741	0.006	1	0.940	1.058	0.248	4.519
SCR[1]	-0.442	0.478	0.855	1	0.355	0.643	0.252	1.641
CTN[1]	0.297	0.220	1.832	1	0.176	1.346	0.875	2.071
CLN[1]	-0.427	0.593	0.517	1	0.472	0.653	0.204	2.088
SPS1[1]	0.120	0.194	0.382	1	0.536	1.128	0.771	1.650
DIS[1]	-0.098	0.141	0.479	1	0.489	0.907	0.688	1.196
TIM[1]	-0.023	0.144	0.026	1	0.873	0.977	0.737	1.295
SEA[1]	- 0.064	0.167	0.146	1	0.702	0.938	0.676	1.302
WEA[1]	0.594	0.336	3.128	1	0.077	1.811	0.938	3.496
Constant	2.195	1.592	1.901	1	0.168	8.977		

Source: Field Survey, 2009 Number of Observations = 1183 Log Likelihood = 1506.672 Pseudo - R^2 = 0.009 LR X^2 = 13.677

From table 6.3, the logistic model gives:

$$D_{dtw} = Logit[P(Y=1)] =$$
$$2.195 - 0.212AGE - 0.024GEN - 0.080MAR + 0.060EDU - 0.063EMP -$$
$$004AUT + 0.038NVE - 1.579MIN + 0.135WLC - 190RTS + 0.056SAF -$$
$$0.442SCR + 0.297CTN - 0.427\ CLN + 0.120SPS - 0.098DIS - 0.23TIM -$$
$$0.064SEA + 0.594WEA$$

The logit response variables 'decision to walk' refers to the process of household heads and on-street persons readiness to walk that carries value (1) and readiness not to walk that carries (0).The reference point is readiness to walk, and this was discussed in relation to categorical covariates that carries the value (1) as shown in column one of table 6.3. In logistic model, the interpretation is based on whether the coefficient is larger than zero or not (that is $\boldsymbol{\beta < 0 \text{ or } \beta > 0}$) and the odd ratio ($\boldsymbol{e^{(\beta)}}$) of logistic regression is based whether ($\boldsymbol{e^{(\beta)}}$) is larger than (1) or not.

In testing for the significance of the logistics regression coefficients, Wald's Chi-square (X^2) was used, such that the null hypothesis ($H_o: \beta_1 = \beta_2 = \beta_3 = \cdots = \beta_k = 0\ ;\ \omega \neq 0$) shows that all the logistics regression coefficients except, the constant equal to zero. Equation 6.7 was used to obtain Wald's Chi-square. Using equation 6.7, the value of Wald's Chi-square is 13.677.

$$X^2 = [(-2\ln L_1) - (-2\ln L_0)] \qquad 6.7$$

Where:

$$L_0 = Initial\ iteration$$
$$L_1 = Final\ iteration$$
$$X^2 = [(-2\ln L_1) — 2\ln L_0) = 1520.349 - 1506.672$$
$$= 13.677$$

At one degree of freedom and 95% confidence level, the table value ($X^2 = 0.00039321, \text{p} \leq 0.05$) was low enough to reject the null hypothesis. From the analysis, 13.677 is greater than 0.00039321 and it can be concluded that, the entire

coefficients in the model are not equal zero ($H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \cdots \neq \beta_k \neq 0\ ;\ \omega \neq 0$). This means that not all the factors in the model do have similar influence on respondents' decision to walk. The geographical implications of the significance of the logistics regression coefficients and conclusion drawn were described below based on the results in table 6.3.

From table 6.3, the results of socio-economic variables of the respondents showed that the estimated odd ratio of household heads and on-street persons' readiness to walk are lower for age group above 35years old .This means that household heads and on-street persons within age group above 35 years old have negative effect on likelihood of readiness to walk. It therefore implies that household heads and on-street persons with age group (≤ 35years) are more likely to walk.

On gender basis, the result showed that the estimated odd ratio of household heads and on-street persons' readiness to walk is higher in female respondents than estimated odd ratio of readiness to walk of male respondents. This shows that sex of respondents have positive effects on readiness to walk. Although, the coefficient of logit regression coefficient is not significant, the odd ratio showed that a female respondent have 1.024 times more likely to walk than male respondents. The results of the logistic regression further affirmed the response of household heads and on-street persons' response whether they do walk or not. As shown in figure 5.2, of the male respondents sampled 49.6% do walk while 50.4% do not walk. Regarding female respondents sampled, 88.4% do walk while 11.6% do not walk.

Based on marital status, the result revealed that the estimated odd ratio of household heads and on-street persons' readiness to walk is lower in respondents that are single than estimated odd ratio of household heads and on-street persons' that are married. Single household heads and on-street persons' therefore have negative effects on the readiness to walk. The odd ratio showed that respondents that are single have 0. 923 times more likely to walk than respondents that are married. The result further revealed that married respondents are more likely walk than the single respondents.

In terms of education, household heads and on-street persons' with secondary and lower level of education have high estimated odd ratio of readiness to walk than

estimated odd of not ready to walk. This means that respondents with secondary and lower level of education have positive effect on readiness to walk. The odd ratio also revealed that, a respondent with secondary and lower level of education has 1.062 times more likely to walk than respondent whose level of education is above secondary education. The results of education qualification showed that respondents with secondary and lower level of education are more likely to walk than respondents with post-secondary education.

Regarding employment status, the result revealed that respondents estimated odd ratio of readiness to walk is lower for respondents who are employed by government than estimated odd of self-employed respondents. The result further revealed that the odd ratio of a government employed respondent readiness to walk is 0.939 times more likely to walk than self-employed respondent. This means that household heads and on-street persons' that are self-employed are more likely to walk than household heads and on-street persons' that are working with the government.

The result of auto ownership showed that the estimated odd ratio of household heads and on-street persons' readiness to walk is lower for household heads and on-street persons' that owned vehicle than estimated odd of household heads and on-street persons' that has no vehicle. This implies that auto ownership has negative effect on readiness to walk. The odd ratio revealed that a household head and on-street person that owns vehicle is 0.996 times more likely to walk than a household head and on-street person that has no vehicle. The result further revealed that respondents without vehicle are more likely to walk than respondents with vehicles. On the number of vehicles owned by household heads and on-street persons', the result revealed that, the estimated odd ratio of household heads and on-street persons' readiness to walk is high for respondents with one vehicle than the estimated odd of household heads and on-street persons' that has two or more vehicles. The odd ratio showed that a respondent with one vehicle has 1.039 times more likely to walk than a respondent with two or more vehicles.

The study further revealed that the estimated odd ratio of household head and on-street persons' readiness to walk is lower for household heads and on-street persons' whose monthly income is more than ₦7,500:00 than estimated odd of household

heads and on-street persons' that earns less or exactly ₦7,500:00 monthly. The result showed that the odd ratio of a household head and on-street person whose monthly income is more than ₦7, 500:00 is 0.206 times more likely to walk than a household head and on-street person that earn exactly ₦7, 500:00 or less. The implication is that household heads and on-street persons that earn ₦7, 500:00 or less monthly income are more likely to walk than household heads and on-street persons that earn more than ₦7, 500:00 as monthly income.

On work location, of household heads and on-street persons', the result revealed that the estimated odd ratio of household heads and on-street persons' readiness to walk is high for households and on-street persons' living within Ikeja than the estimated odd of households and on-street persons' that live outside Ikeja. The odd ratio showed that a respondent living within Ikeja has 1.145 times more likely to walk than a respondent living outside Ikeja. The result showed that work location has positive effect on readiness to walk .In summary, household heads and on-street persons' that live within Ikeja are more likely to walk to walk to their place of work than respondents whose work location is outside Ikeja.

Table 6.3 also provides explanation to preferred nature of pedestrian facility (walkways or sidewalks) in the logistic model. The results showed that the estimated odd ratio of household heads and on-street persons' readiness to walk is high for safety, continuity and the space on pedestrian walkways. Based on safety, estimated odd of household heads and on-street persons' who preferred walkways that are safe are higher than household heads and on-street persons that preferred walkways that are not safe. Regarding continuity of walkway, estimated odd of household heads and on-street persons' who preferred walkways that are continue is higher than the estimated odd of household heads and on-street persons' who preferred walkways that are not continued. Regarding the space on the walkways, estimated odd of household heads and on-street persons' who preferred spacious walkways are higher than estimated odd of household heads and on-street persons' who did not prefer spacious walkways. These imply that safety of walkways; continuity walkways and spacious walkways have positive effect on household head and on-street person's readiness to walk.

The odd ratio revealed that a household head and on-street person that preferred safety of walkways is 1.058 times a household head and on-street person who does not prefer safety of walkways. The odd ratio of a household and on-street person that preferred continuity of walkways is 1.34times more likely to walk than a household head and on-street person who does not prefer continuity of pedestrian walkways. Regarding the space on the walkways, the odd ratio showed that household head and on-street person that preferred spacious walkways is 1.128times more likely to walk than when pedestrian walkways are not spacious.

The results of the survey further revealed that the estimated odd ratio of household heads and on-street persons' readiness to walk is lower for road situation, security and cleanliness of the walkways. Based on road situation, estimated odd of household heads and on-street persons' who preferred walkways that are congested are lower than household heads and on-street persons that preferred walkways that are not congested. Regarding security, estimated odd of household heads and on-street persons' who preferred walkways that are secured is lower than the estimated odd of household heads and on-street persons' who preferred walkways that are not secured. On cleanliness, estimated odd of household heads and on-street persons' who preferred clean walkways are lower than estimated odd ratio of household heads and on-street persons' who did not prefer clean walkways. These imply congested walkways, secured walkways and clean walkways have negative effect on household head and on-street person's readiness to walk.

The odd ratio of road situation, security and cleanliness of pedestrian walkways revealed that a household head and on-street person that preferred congested walkways is 0.827 times more likely to walk than a household head and on-street person who does not prefer congested walkways. Also, the odd ratio a household and on-street person that preferred secured walkways is 0.643times more likely to walk than a household and on-street person who does not prefer congested pedestrian walkways. Regarding cleanliness of the walkways, the odd ratio showed that a household head and on-street person that preferred clean walkways is 0.492 times more likely to walk than a household head and on-street person who does not prefer clean pedestrian walkways

Table 6.3 further revealed that the estimated odd of respondents readiness to walk, has positive effect on weather while distance, time and season have negative effects. Based on weather, the estimated odd of respondents' readiness to walk when the weather is cool are higher than the estimated odd of respondents who are ready to walk when it is sunny. The odd ratio also showed that a household and on-street person who will walk when the weather is cool is 1.811 times a household head and on-street person who will walk when it is sunny.

On distance, the estimated odd of respondents on readiness to walk when the distance is equal or greater than 3.2 km is lower than the estimated odd of respondents readiness to walk a distance is less than 3.2km.The odd ratio of a respondent readiness to walk when distance is equal or greater than 3.2 km is 0.907 times respondent who will walk a distance less than 3.2km.Based on time, estimated odd of respondents readiness to walk when in the night is lower than the estimated odd of respondents readiness to walk when it is daylight. The odd ratio also showed that a respondent readiness to walk when it is night is 0.977 times a respondent who will walk when it is daylight. On season, the estimated odd of respondents' readiness to walk when it is rainy is lower than the estimated of respondents' readiness of to walk when it is dry season. The odd ratio further revealed that a respondent readiness to walk when it rains is 0.93 times a respondent who will walk when it is dry season. The hierarchy of importance of the factors that encourages or discourages respondents' decision to walk on walkways is presented in the next section.

6.3 PEDESTRIANS CHOICE VARIABLES OF PREFERRED WALKWAYS

The importance of logistic regression analysis in modelling scalable factors is well documented in the literature. However, the hierarchy of importance of preferred nature of pedestrian walkways variables, as presented in table 6.2, is quite different from the value of logistic regression coefficients. In order to ascertain the most significant of these variables (***safety, security, road situation, continuity, cleanliness and space***) when compared with respondents' response and logistic regression coefficients obtained in tables 6.2 and 6.3 respectively.

The study used Analytical Hierarchical Process (AHP) model to scale respondents' response of on these variables (*safety, security, road situation, continuity, cleanliness and space*) in order to arriving at the most significant variable that explains households and on-street persons choice of walkways or sidewalks. The results obtained using AHP is compared with results obtained based on percentage response of respondents and coefficients of logit model on the variables.

Analytic Hierarchy Process as described in chapter two of the study is a decision-making technique developed in the 1970s by mathematician Thomas L. Saaty. AHP is used in making decisions that are complex, unstructured, and contain multiple attributes. The decisions that are described by these criteria do not fit in a linear framework; because they contain both physical and psychological elements (Partovi, 1994; Palmer, 1999; Mian and Dai, 1999; Nataraj, 2005).

The choice of AHP is not limited to its application as decision making algorithm, but also to the fact that perceptions of households and on-street persons about *safety, security, road situation, continuity, cleanliness and space* of the walkways in the study area could be a function of both physical and psychological elements that may not fit in a linear framework and this informs it use in the study.

As a decision algorithm, (***safety, security, road situation, continuity, cleanliness and space***) of the walkways were tabulated to form a pair wise comparison matrix as presented in the questionnaire of the study. Households and on-street persons response to these variables in the questionnaire is based on a scale (1 to 9) as shown in table 6.4.

Table 6.4: The Pairwise Combination Scale of Analytical Hierarchical Process.

Intensity	***Definition***	***Explanation***
1	Equal importance	Two activities contribute equally to the object
3	Moderate importance	Slightly favours one over another
5	Essential or strong importance	Strongly favours one over another
7	Demonstrated importance	Dominance of the demonstrated in practice
9	Extreme importance	Evidence favouring one over another of highest possible order of affirmation
2,4,6,8	Intermediate Values	When compromise is needed

Source: Adapted from Nataraj S (2005)

Table 6.5: Pair wise Comparison Matrix Generated for Households and On-Street on Persons' on Preferred Nature of Pedestrian Facility in Ikeja.

	Safety	***Cleanliness***	***Security***	***Road Situation***	***Continuity***	***Spacious***
Safety	1.0000	9/1	7/1	5/1	3/1	1//1
Cleanliness	0.1111	1.0000	9/1	9/1	9/1	9/1
Security	0.1429	1.0000	1.0000	1/1	9/1	9/1
Road Situation	0.2000	0.1111	0.1111	1.0000	1/1	3/1
Continuity	0.3333	0.1111	0.1111	0.3333	1.0000	1/1
Spacious	0.5000	0.1111	0.1111	1.0000	0.3333	1.0000

Source: Field Survey, 2009.

Based on the scale of (1) to (9) table 6.5 present pair wise comparison matrix generated from the field survey. Using information in table 6.5, the weight or eigen values of these variables were generated in table 6.6 using Analytical Hierarchy Process calculation software (Japanese version developed) by CGI (see appendix VIII for input and output system of the software).

Table 6.6: Weighted Preferred Nature of Pedestrian Walkways in Ikeja.

Variables	***Eigen value***
Safety	0.4408
Cleanliness	0.2007
Security	0.2022
Road Situation	0.0418
Continuity	0.0488
Spacious	0.0658

Source: Generated using GCI Analytical Hierarchical Process Software

After obtaining the weight or eigen value of the variables in table 6.6, the next step in AHP is examination of consistency of the eigen value generated. In order to determine the consistency of the eigen value generated for the variables, Consistency Index (CI) formula as shown below was used.

Maximum weight generated from table 6.5 = $\lambda_{max} = 9.2625$
Consistency index is given as:

$$\frac{\lambda_{max} - n}{n - 1} = \frac{9.2625 - 6}{6 - 1} = \frac{3.2625}{5} = 0.6525$$

Where (n) = matrix size, Consistency Index (CI) = 0.6525. In order to accept the weight or the eigen vector generated in table 6.6, the consistency index (CI) must be less than random consistency index (RCI). From random consistency table, for (n=6), (RC = 1.24). From the analysis,

CI = 0.6525

RCI = 1.24

CI < RC, that is (0.6525 < 1.24), since the value of RC is greater than the value of CI, the value of eigen vector in table 8.6 is consistent. Hence, the weight or eigen values generated for the variables are accepted.

The result of the weight obtained for the variables represent the priority of the respondents in the choice of preferable nature of pedestrian walkways in their decision to walk. Most important variable that will inform households and on-street persons' decision to walk on walkways is ***safety***, and the least important variable is ***road traffic situation***.

Table 6.7 therefore, shows the ranking of the variables using percentage response of respondents in table 6.2, logit regression coefficients of the variables in table 6.3 and the weight or eigen vector generated in table 6.6 using pair wise comparison matrix.

Table 6.7: Summary of Ranking of the Results Generated for Households and On-Street Persons' Preferred Nature of Pedestrian Facility in Ikeja.

Variables	*% Response*		*Logit Reg. Coeff.*		*AHP Weight*	
	%	**Rank**	**β**	**Rank**	**Eigen vector**	**Rank**
Safety	99.3	1	0.056	3	0.4408	1
Cleanliness	98.7	2	-0.427	6	0.2007	3
Security	97.9	3	-0.442	5	0.2022	2
Road Situation	97.0	4	-0.190	4	0.0418	6
Continuity	91.7	5	0.297	1	0.0488	5
Spacious	88.3	6	0.120	2	0.0658	4

Source: Field Survey, 2009.

In table 6.7, safety of walkway was ranked 1st as the most significant variable among the variables in column two and six but ranked 3rd in the fourth column. Cleanliness of the walkway and security along the walkway ranks are similar in column two and six, when cleanliness of walkway was ranked 2nd after safety of walkway in column two, security along walkway was ranked 3rd.Similarly, when security along walkway was ranked 2nd after safety in column six, cleanliness of the walkway was ranked 3rd. In the fourth column, security along walkway was ranked 5th while cleanliness was ranked 6th.

Road traffic situation along walkway was ranked 4th in column two and column four but, ranked 6th in column six. Continuity of the walkway follow similar trend with road traffic situation. Continuity of the walkway was ranked 5th in column two and column six but, ranked 1st in column four. Space along the walkway was ranked 6th in column two, 2nd in column four and 4th in column six.

From the analysis, safety was ranked between 1st and 3rd, followed by security, cleanliness, continuity, spacious and road traffic situation in that order. From the analysis, it shows that safety and security along walkways is very important in household heads and on-streets persons' decision to walk.

The advocacy toward a liveable community, where walking and the use of public transport is an increasing option to improving pedestrian movement and safety, areas typically seen as being non-pedestrian-friendly now serves as transit routes. However, as vehicular volumes continue to increase, pedestrians' ability to walk or cross many roadways safely is often obstructed. And based on the significance of safety and security of walkways in people's decision to walk, the study examines pedestrian level of safety in roadside environment in the section that follows.

6.4 THE ENVIRONMENT FOR WALKING AND PEDESTRIAN LEVEL OF SAFETY

The environment for walking or walking environment entails:

(i) Provisions of sidewalks and walkways with buffer zones to separate pedestrians from the roadway;

(ii) Provisions of street furniture and marked crosswalk. walkways are kept clear of poles, sign posts, news-paper racks, and other obstacles that could block pedestrian paths and marked crosswalks indicate locations for pedestrians to cross and signify to motorists to yield to them;

(iii) Provisions of curb ramps and transit stop. Curb ramps (wheelchair ramps) provide access between the sidewalk and roadway for people using wheelchairs, strollers, walkers, hand carts, bicycles, and also for pedestrians with mobility problems who have trouble stepping up and down high curbs. Bus stops should be located at intervals that are convenient for passengers. The stops should be designed to provide safe and convenient access and should be comfortable places for people to wait;

(iv) Provisions of Roadway lighting. Good placement of lighting can enhance an environment as well as increase comfort and safety. In commercial areas with night time pedestrian activity, street lights and building lights can enhance the ambiance of the area and the visibility of pedestrians by motorists;

(v) Provisions of Pedestrian underpasses and overpasses Pedestrian overpasses and underpasses allow for the uninterrupted flow of pedestrian movement separate from the vehicle traffic.

The environment for walking is all about safety and comfort of pedestrians in roadside environment. The results of the Descriptive Analysis, Logistic Regression Analysis, and Analytical Hierarchical Process on preferred nature of walkways show that safety and security on the walkways are factors that are most significant in respondents' decision to walk. There is also a general consensus that pedestrians' sense of safety (level of safety) or comfort within a roadway corridor is based on a

complex variety of factors. These factors include personal safety, (i.e., the threat of crashes), personal security (i.e., the threat of assault), architectural interest, pathway or sidewalk shade, pedestrian-scale lighting and amenities, presence of other pedestrians, conditions at intersections, and so on (Gaventa, 1980; Hass-Klau et al, 1994; Gehl, 1999; Smith, 1999; Pedestrian's Association,2000; Tight et al, 2004; Ovstedal and Ryeng, 2006; Rahaman, 2007 ; Landis et al, 2001 ; Raji, 2010).

This section modelled pedestrian level of safety based on pedestrian threshold (Level of Service) along roadside environment in Ikeja. Developing a model of pedestrian level of safety in Ikeja involved real time observations of 56 road segments where pedestrian activities predominate. Six of the 56 road segments have walkways and field measurement along roadways or streets complemented the field observations. The section therefore, examines factors affecting pedestrian walking environment, develop and pedestrian level of safety model and discusses empirical findings of the model results

6.4.1 Factors Affecting Pedestrian Walking Environment

The perceived safety or comfort (with respect to the presence of motor vehicle traffic) has not, until now), been quantified as a stand-alone performance measure (Landis et al, 2001), and this measure has also not been subjected to extensive research. It has been observed that the factors or variables that are significant in influencing pedestrians' level of safety or comfort include:

1. Presence of sidewalk
2. Lateral separation from motor vehicle traffic
3. Barriers and buffers between pedestrians and motor vehicle traffic
4. Motor vehicle volume and composition
5. Effects of motor vehicle traffic speed, and
6. Driveway frequency and volume.

However, in a long list of independent variables thought to have been influencing pedestrians' level of safety within streets or roadways, the following factors are very essential in the explanation of pedestrians' level of safety, and they are:

1. *Lateral separation - elements between pedestrians and motor vehicle traffic*: These include (i) presence of sidewalks, (ii) width of sidewalk, (iii) buffers between sidewalk and motor vehicle travel lanes, (iv) presence of barriers within the buffer area, (v) presence of on-street parking, (vi) width of outside travel lane and presence and width of shoulder or bike lane
2. *Motor vehicle traffic volume*
3. *Effect of (motor vehicle) speed*
4. *Motor vehicle mix (i.e., percentage of trucks)*
5. *Driveway access frequency and volume.*

In the quest of modelling pedestrian level of safety in the study area, these factors or variables were use in the development of the model as presented in section 6.4.2.

6.4.2 Development of Pedestrian Level of Safety Model in the Study Area

Establishing pedestrian level of safety model in the study area involve obtaining the pedestrian level of service along fifty-six (56) road networks in the study area in Ikeja. Pedestrian level of service is a threshold for free flow of pedestrian movement on walkways and this serves as surrogate for determining pedestrian level of safety along roadside (James and Walton,2000;Henson,2000;Gallin,2001; Jasskiwicz, 2001).

Fruin (1971) in an attempt to measure level of comfort of pedestrians in an urban setting used physical count and time lapse photographic images of pedestrian movements in Manhattan sidewalks. In the study of Fruin (1971), Pedestrian Level of Service (LOS) as recommended for available space per pedestrian in table 6.8 has been a reference point for many studies in developed and developing countries. Some of these studies include Pushkarev and Zupan (1975a), Pushkarev, Boris and Zupan (1975b), Brilon, Polus, Joseph and Ariela (1983), Tanaboriboon et al (1986) and Guyano, High Way Capacity Manual (1994), Milazzo et al (1999) (see Table 6.9).

Table 6.8: Recommended Level of Service Threshold for Free Flow Movement on Pedestrian Walkways

Level of Service	***Flow rate (Ped/minute/metre)***	***Available Space per pedestrian (m^2/ped)***	***Recommended Use***
A	<23	>3.3	Large scale public plazas
B	23-33	2.3-3.3	Transportation terminals for routine low level flows
C	33-49	1.4-2.3	Transportation terminals serving high volumes
D	49-66	0.9-1.4	Highest tolerable flows for public spaces
E	66-82	0.5-0.9	Threshold of intolerable operation
F	Var-82	<0.5	Queue formation

Source: Pedestrian Planning and Design by Fruin (1971)

Table 6.9: Walkway Level of Service (LOS) Thresholds by Available Space per Pedestrian (m^2/Ped)

LOS	*FRUIN*	**HCM*	*Pushkarev and Zupan*	*Brilon (Germany)*	*Polus (Israel)*	*Tanaboriboon and Guyano(Thailand)*
A	>3.2	>12	>12	>10	n/a	>2.38
B	2.3-3.2	3.7-12	4-12	3.3-10	n/a	1.6-2.38
C	1.4-2.3	2.2-3.7	2-4	2-3.3	1.67	0.98-1.60
D	0.9-1.4	1.4-2.2	1.5-2	1.4-2	1.33-1.66	0.65-0.98
E	0.5-0.9	0.6-1.4	1.0-1.5	0.6-1.4	0.5-0.8	0.37-0.65
F	<0.5	<0.6	0.2-1	<0.6	n/a	<0.37

Source: Platoon Pedestrian Movement Analysis: A Case Study Utilizing the Market Street Station in Denver, Colorado by James and Walton (2000).

*HCM = Highway Capacity Manual

In this study, pedestrian level of safety was based on variables listed in section 6.4.1.These variables were derived through measurement and real time observations rather than pedestrian perceptions of level of service. The factors considered the most probable variables affecting pedestrians' level of safety are based on Pedestrian Level of Service (PLOS) and they were model in line with hypothesis IV that states that:

Most people walk in areas where their level of safety is higher, than in areas where their level of safety is lower and their trips safety is a function of lateral separation, traffic volume, vehicles' speed and drive way access.

The explanation of the explanatory variables is presented under the following subheadings. These include;

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6.4.2.1 Presence of a Sidewalk and Lateral Separation

Having a safe, separate place to walk alongside the roadway is fundamental in pedestrians' sense of safety and comfort in the roadway environment. This sense of safety or comfort is strongly influenced by the presence of a sidewalk. Furthermore, the value of a sidewalk varies according to its location and buffering (i.e., the lateral separation) relative to the motor vehicle traffic (Landis et al, 2001).Where there are sidewalks in Ikeja, for instance, the values of lateral separation varies and buffer zones serves as drainage and on-street parking.

In general, lateral separations as specified by Landis et al (2001) in figure 6.1a, figure 6.1b, figure 6.2a, figure 6.2b and 6.2c. Figure 6.1a and figure 6.1b showed the effect of lateral separation, which is the effect pedestrian distance from the moving traffic. Figure 6.2a, figure 6.2b and figure 6.2c showed typical barriers within the roadside buffer

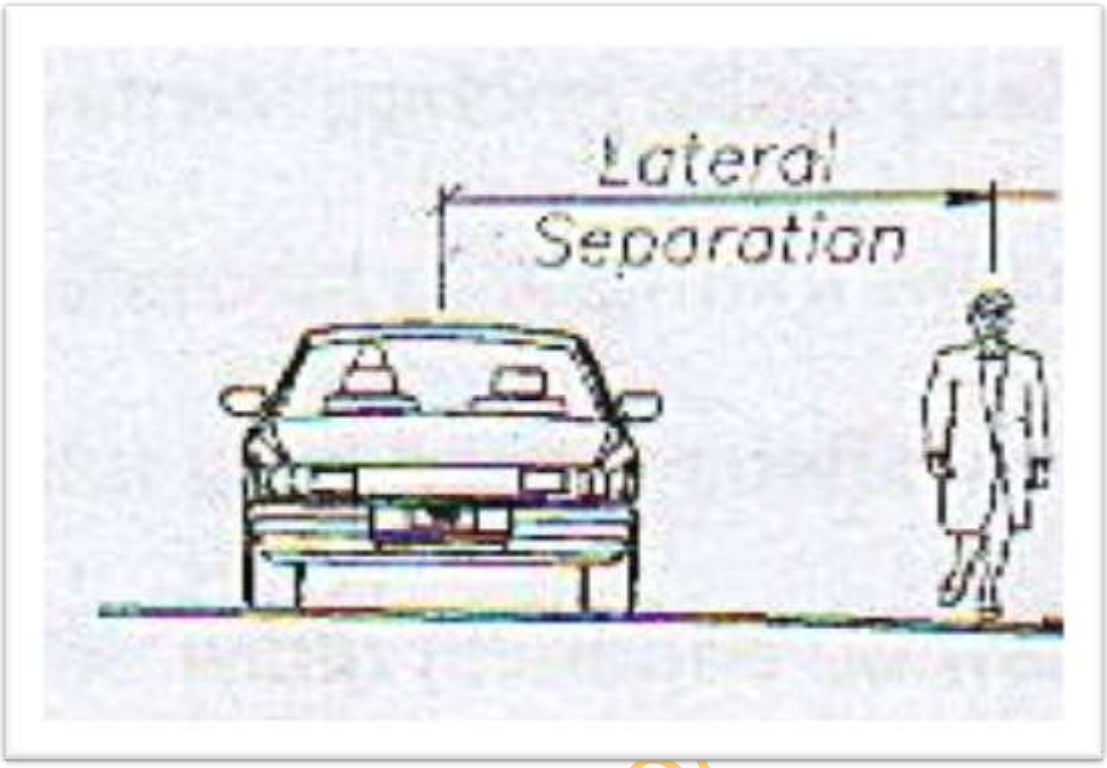

Figure 6.1a: Pedestrian Walking alongside Vehicle on the Outside Lane.

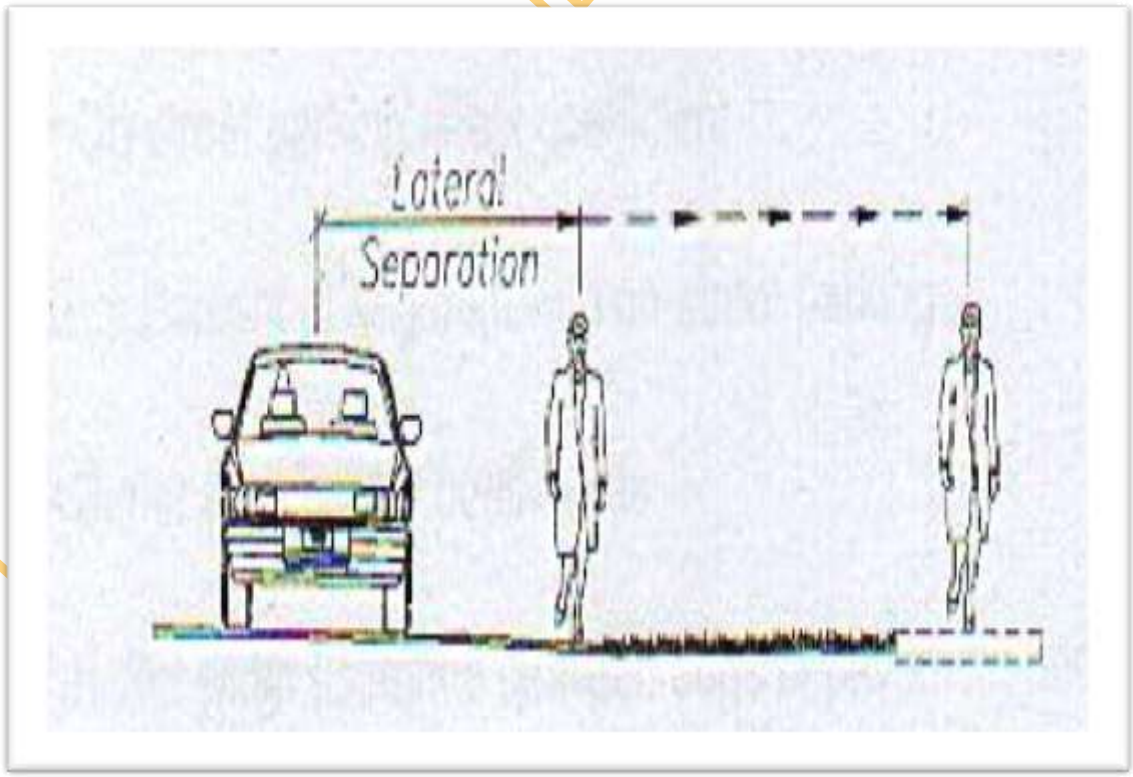

Figure 6.1b: Pedestrian Separated from Outer Lane by Buffer Zone.

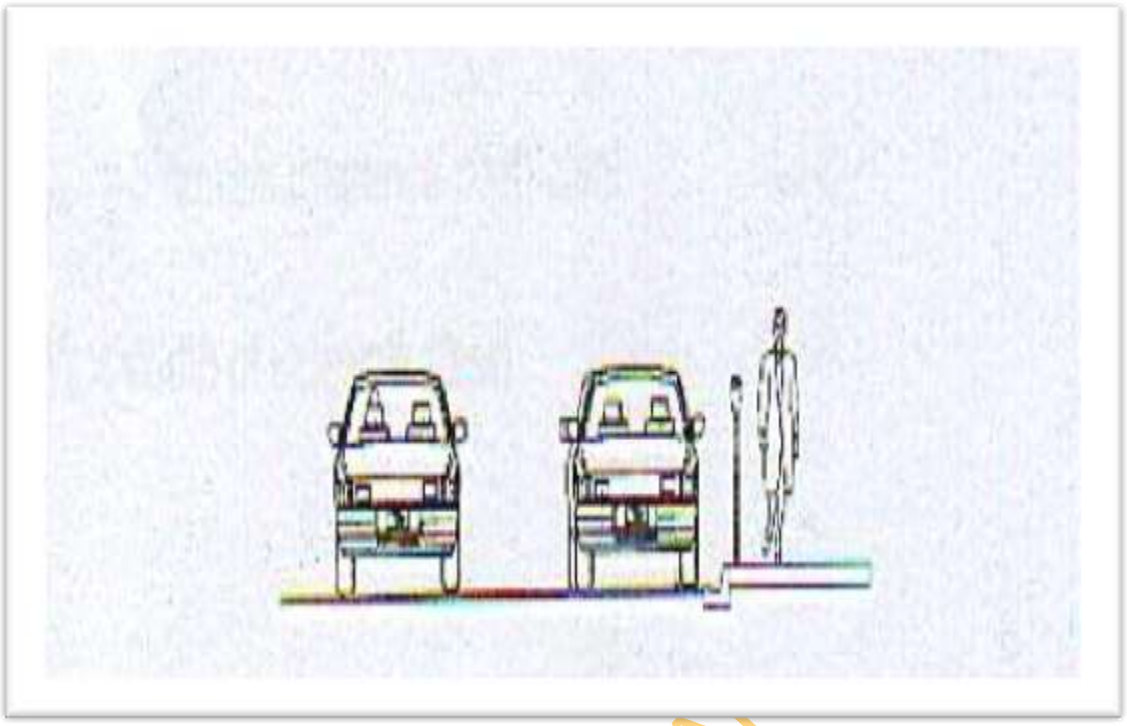

Figure 6.2a: On-street parking within Roadside Buffer Zone.

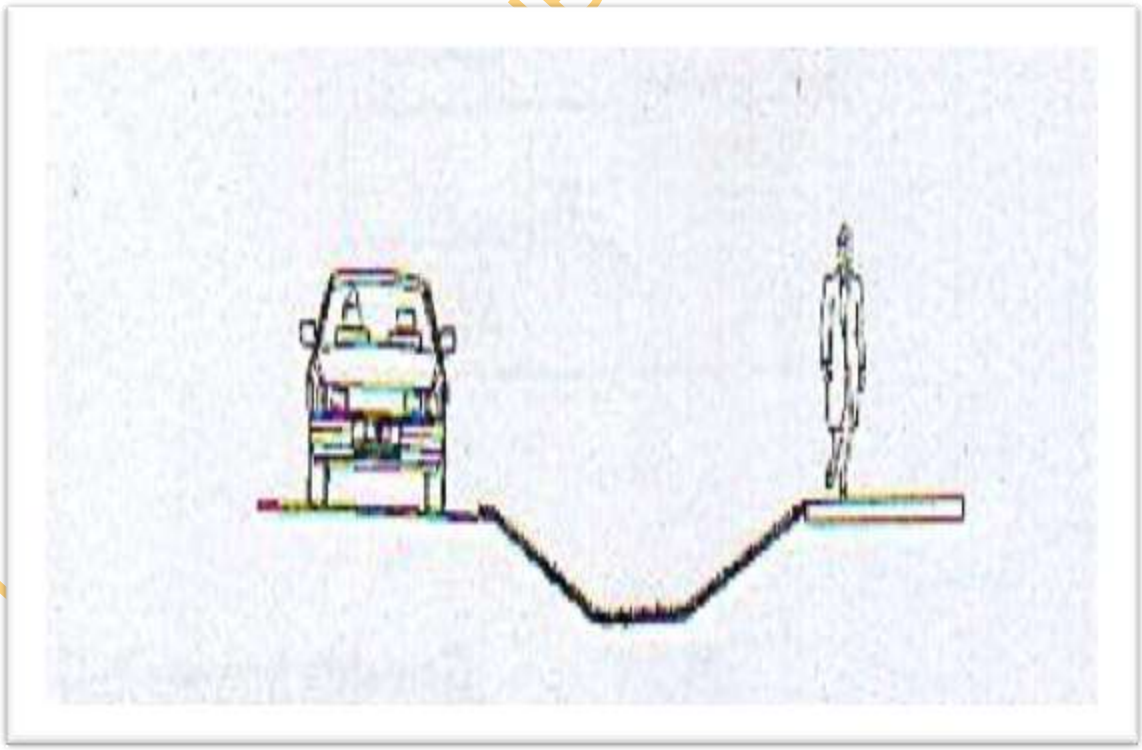

Figure 6.2b: Drainage or Swade within Roadside Buffer Zone.

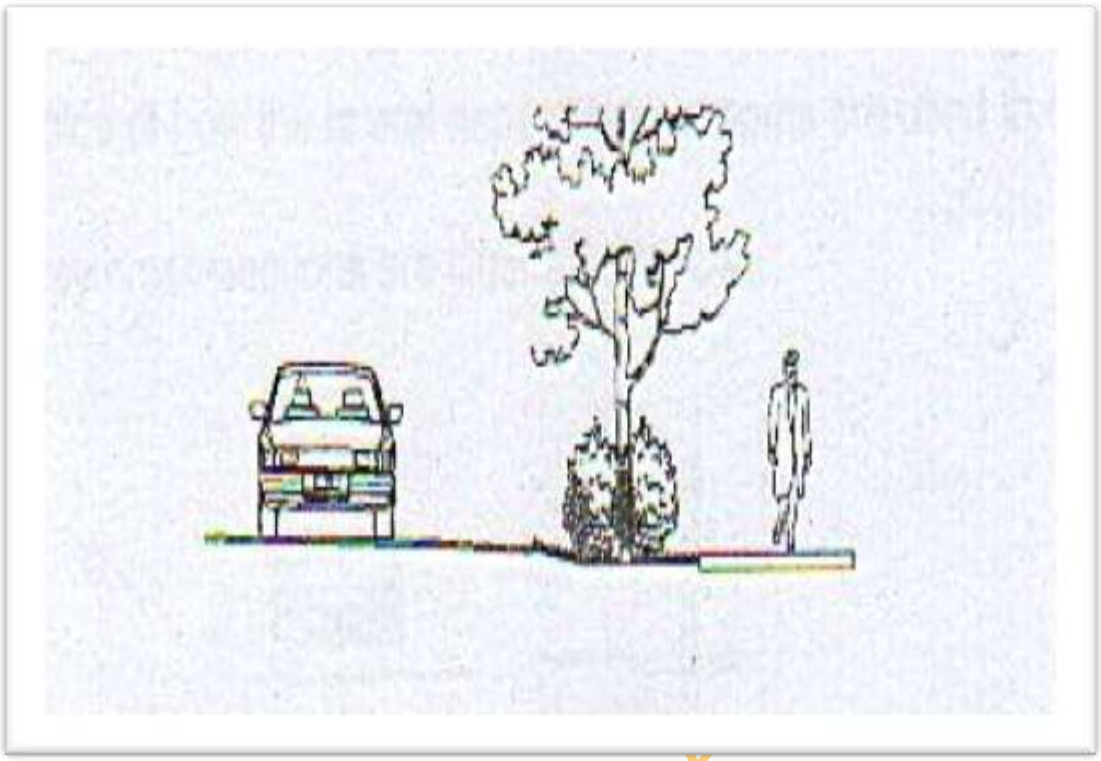

Figure 6.2c: Trees within Roadside Buffer Zone[2].

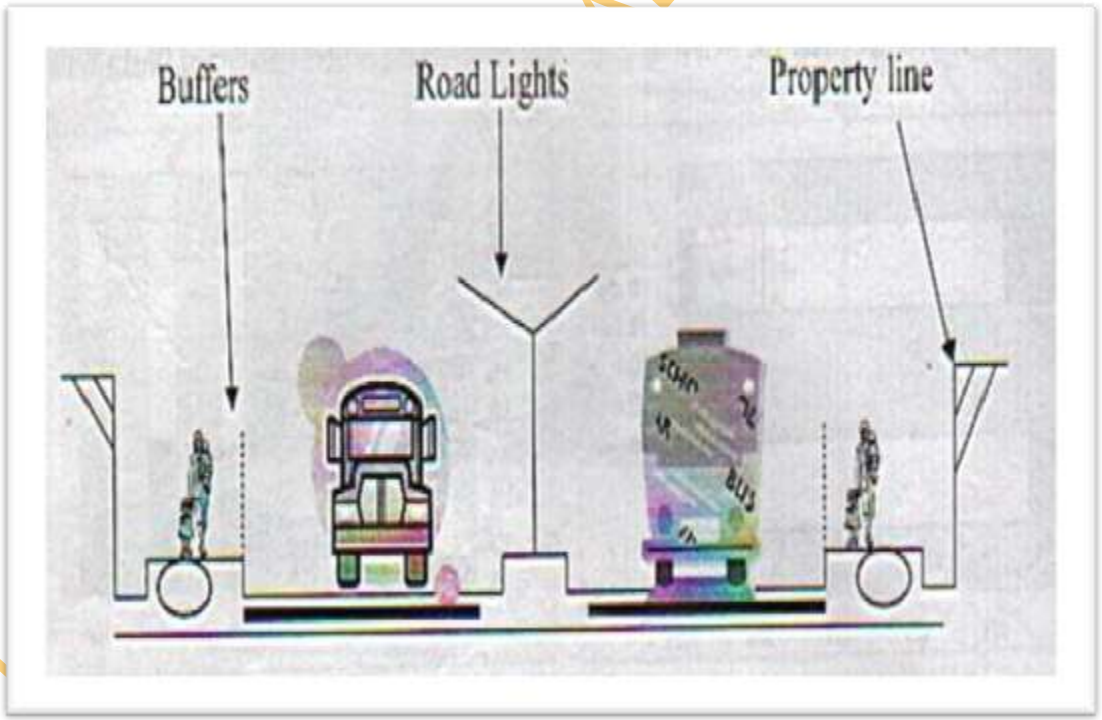

Figure 6.2d: An illustration of roadway a in Ikeja.

[2] **Figure 6.1a to figure 6.2c show the distance of pedestrian from moving vehicles. These figures also showed different buffer zones that are provided in order to protect pedestrians from moving vehicles.**

Plate 6.1 shows the situation of lateral separation (**LS**) in many of the road segments in Ikeja and Plate 6.2 shows a pictorial example of figure 6.2d in Ikeja roadways, but plate 6.2 lack buffer and walkways. Mathematical expression that explains elements of lateral separation, barriers, buffers, and presence of walkways as expressed by (Landis et al, 2001) and modified to reflect the situation in the study area is presented in equation 6.8:

$$LS = W_{OL} + W_{SBL} + f_{OPC}(\%OSP) + f_{BAC}(W_{BW}) + f_{SWC}(W_{WOS}) \quad 6.8$$

Where:

LS = Lateral separation

W_{OI} = Width of outside lane (metre)

W_{SBL} = Width of shoulder or bike lane (metre)

f_{OPC} = On-street parking effect coefficient

$\%OSP$ = Percentage of segment with on-street parking

f_{BAC} = Buffer area barrier coefficients

W_{BW} = Buffer width (distance between edge of pavement and sidewalk, feet)

f_{SWC} = Sidewalk presence coefficient

W_{WOS} = Width of sidewalk (feet)

Quantification of lateral separation elements in equation 6.8 is illustrated in figure 6.7.

Plate 6.1: Pictorial Presentation of figure 6.1a in many road segments in Ikeja

Plate 6.2: A roadway in Ikeja with a divide but Lack Buffer and Walkways

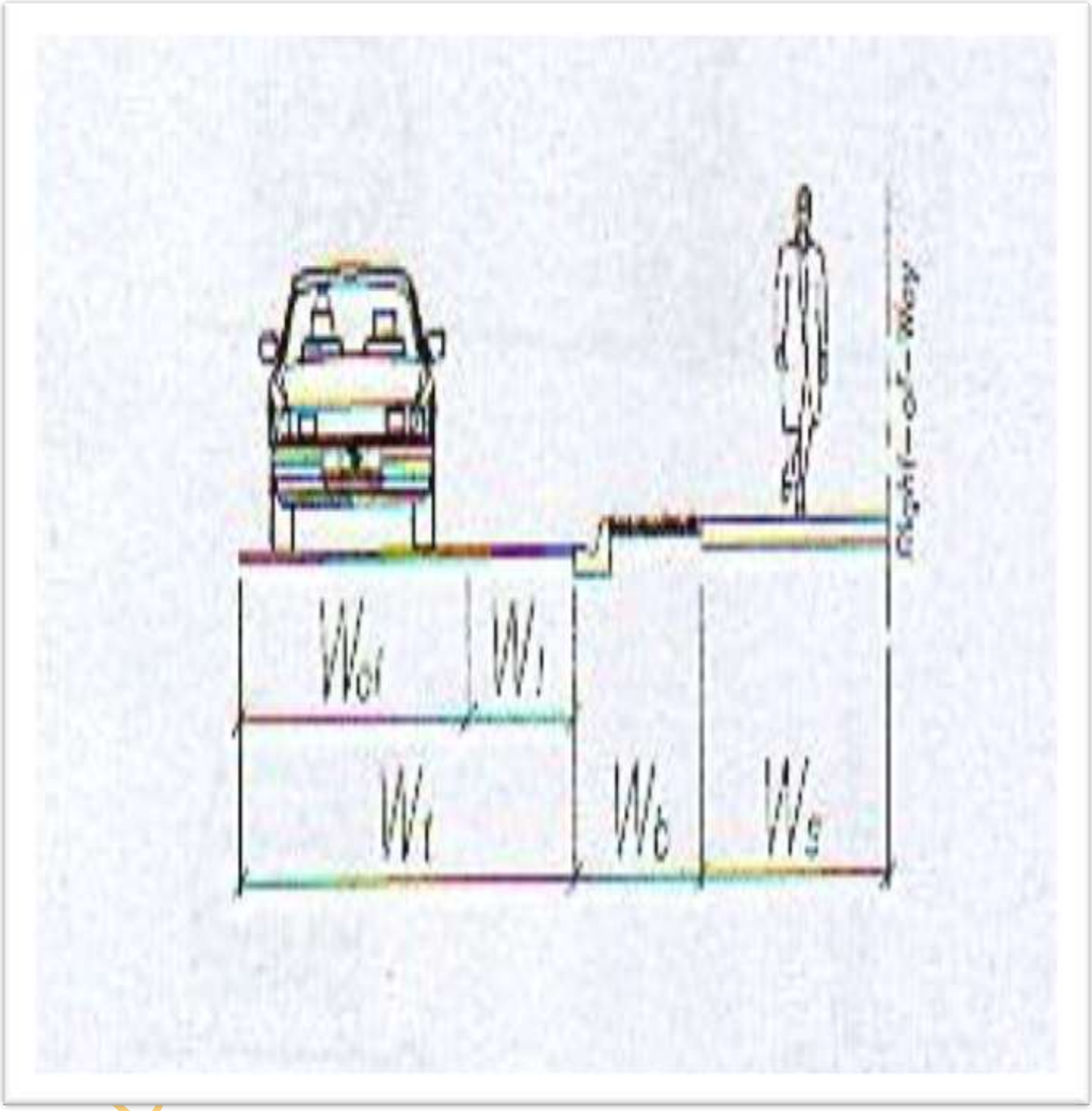

Figure 6.3: Quantification of Lateral Separation Elements

Source: Landis et al (2001)

Where, $W_{OI} = W_{ol}$, $W_{SBI} = W_l$ $W_{BW} = W_b$ and $W_{WOS} = W_s$, the explanations of which were given in page 168. From equation 6.8, when there is no on-street parking, the % OSP becomes zero. Then the lateral separation equation becomes:

$$LS = W_{OL} + W_{SBL} + f_{BAC}(W_{BW}) + f_{SWC}(W_{WOS}) \quad 6.9$$

In the case where there is on-street parking, its effect as a barrier would be quantified as in equation (6.9). But where there are no striped shoulders or landscape buffer, then the terms W_{SBL} and W_{BW} becomes zero. Then, the lateral separation equation is simplified to equation 6.10.

$$LS = W_{OL} + f_{OPC}(\%OSP) + f_{SWC}(W_{WOS}) \quad 6.10$$

In the case where there is on-street parking, but there is no bike lane, W_{SBI} equal zero then the lateral separation equation is simplified into equation 6.11.

$$LS = W_{OL} + f_{OPC}(\%OSP) + f_{BAC}(W_{BW}) + f_{SWC}(W_{WOS}) \quad 6.11$$

In the case where there is no sidewalk, no bike lane, no striped shoulder or buffer, then lateral separation equation becomes equation 6.12.

$$LS = W_{OL} + f_{OPC}(\%OSP) \quad 6.12$$

In the case where there is no sidewalk, no bike lane, no striped shoulder or buffer, and no on street parking then lateral separation equation then change to equation 6.13.

$$LS = W_{OL} \quad 6.13$$

In the 56 road segments in Ikeja, many of the road networks or streets are characterised with no sidewalk, no bike lane, no striped shoulder or buffer and with the operation of Lagos State Traffic Management (LASTMA) officers in Ikeja roadways, most of the roadways and streets are free of on-street parking.

In the road segments where there are sidewalks, equation 9.3 was used to compute the lateral separation. Where there are no sidewalks, no bike lane and no striped shoulder or buffer, equation 6.12 was used to obtain the values of the lateral separation. Furthermore, equation 6.13 was used where there are no on-street parking, no sidewalks, no bike lane and no striped shoulder or buffer. The equations used to compute lateral separation of the road segments in the study area are equations 6.10, 6.12 and 6.13 that is

$LS = W_{OL} + f_{OPC}(\%OSP) + f_{SWC}(W_{WOS})$, $LS = W_{OL} + f_{OPC}(\%OSP)$ and $LS = W_{OL}$.

6.4.2.2 Motor Vehicle Volume

The frequency of motor vehicles passing pedestrians is represented by the outside lane volume, and also found to be a factor or variable. As passing frequency of motor increases, pedestrians' feeling of safety may increase or decrease. So, the effect of traffic volume was calculated using the following: formula in equation 6.14:

$$TV = \frac{Vol_{15}}{L} \qquad 6.14$$

Where:

$TV =$ Traffic Volume

$Vol_{15} =$ Average traffic during a fifteen (15) minute period

$L =$ Total number of (through) lanes (for road or street)

Equation (6.14) assumes a 50/50 directional distribution. In cases where the directional distribution is other than 50/50, equation (6.15) should be used. The difference between the two equations (i.e. 6.14 and 6.15) is that while equation 6.15 uses a directional factor with "L_d" (total number of directional through lanes), equation 6.14 uses "L" (totals number of thru lanes).

$$TV = \frac{Vol_{15}}{L_d} \times D \qquad 6.15$$

Vol_{15} = Average traffic during a fifteen (15) minute period

L_d = Total number of directional (thru) lanes (for road or street)

D = Directional factor

In this study equation 6.14 that is $\left(\mathrm{TV} = \frac{\mathrm{Vol}_{15}}{\mathrm{L}}\right)$ was used to compute the values motor vehicle volume along each road segments selected in the study area (see Appendix VIII).

6.4.2.3 Effect of Speed

Speed of motor vehicle traffic was confirmed as a variable or factor influencing pedestrians' level of safety. As speed increases, pedestrian discomfort may increase or decrease. The speeds of moving vehicles along 56 road segments were recorded using speed radar gun.

6.4.2.4 Driveway Access Frequency and Volume

Along a roadway or street segment, uncontrolled vehicular accesses to adjoining properties (i.e., driveway cuts) have shown in many studies to have been influencing pedestrian level of safety. In this study, drive access frequency to adjoining properties was recorded through observations of passing motor vehicles along the road segments and the values are presented in appendix VIII.

Based on the measurement of the discussed variables, Pedestrian Level of Safety (PLOS) in Ikeja is model in the mathematical expressions in equation 6.16.

Pedestrian LOS =

C + b_1 f (lateral separation factors) + b_2 f (traffic volume) + b_3 f (speed, vehicle type) + b_4 f (driveway access frequency and volume) + $b_n f(x_n)$ + α 6.16

The result of field measurements and observations using the model in equation 6.16 is discussed in section 6.4.3 below.

6.4.3 Pedestrian Level of Safety Model Results

The results of the observations and measurements of 56 road segments in Ikeja using equation 9.8 is presented in table 6.10. Appendix IX provide values obtained for lateral separation, motor vehicle volume, speed of motor vehicles and drive way access frequency and volume during field observations.

Table 6.10: Relationship of Pedestrian Level of Safety along Road Segments in Ikeja.

Model Terms	***Coefficients***	***t-statistics***	***p>value***
Lateral Separation lin (LS)	0.596	5.139	.000
Motor Vehicle Volume lin $(\frac{Vol_{15}}{L})$	0.204	1.732	.000
lin(Speed of Motor Vehicle)	0.072	0.756	0.089
lin (Drive way access frequency and volume	- 0.067	- 0.745	0.453
Constant	-2.355	- 4.363	0.460
Model Adjusted (R^2)		0.581	
Model F-Ratio		20.089	

Source: Field Survey, 2009.

Table 6.10, shows that all the independent variables used in the model are statistically significant at 95% confidence level except "driveway access frequency and volume". The results of PLOS model of road segments in Ikeja area of Lagos agrees with the works of (Sarkar, 1993; 1996; Khisty, 1994; Dixon, 1996; Crider, 1998; Landis et al, 2001) on the statistical significance of lateral separation, motor vehicle volume and speed of motor vehicles. Thus, the model for Pedestrian Level of Service (PLOS) of road segments in Ikeja is given as:

$$PLOS = -2.355 + 0.596lin[W_{OL} + f_{OPC}(\%OSP) + f_{SWC}(W_{WOS})] + 0.204lin\left(Vol_{15}/_{L}\right) + 0.072\text{lin(SMV)}$$

From the model, lateral separation is significant. The result shows that lateral separation increase pedestrian level of safety or comfort. As lateral separation increases, pedestrians' level of safety increases. This means that level of safety is strongly influenced by the presence of a sidewalk. For instance, when a barrier such as on-street parking, a line of trees, or a roadside swale (see Figures 6.2, 6.3, 6.4, and 6.5) is near or on the buffer area between motor vehicle traffic and the pedestrian, pedestrians' feel protected, hence safety, is enhanced.

The frequency (volume) of motor vehicles passing pedestrians, represented by the outside lane in the results also found to be a significant variable. As volume of motor vehicles passing pedestrians along road segments in the study area increases the pedestrians' level of safety decreases. This often occurs when barriers at the buffer area are removed or there is no sidewalk and pedestrians shared width of outside lane ($\boldsymbol{W_{OL}}$) with motor vehicles as shown in plates 6.1 and 6.2. Pedestrians' level of safety tends to decrease because pedestrians are exposed to road traffic accident.

The results of the model also revealed that speed of motor vehicle traffic is significant in the model and this means that, as the speed of motor vehicle increases along roadside walking environment, pedestrian level of safety decreases. This implies that pedestrian level of safety increases with a lower speed of motor vehicle traffic along road environment in the study area.

Regarding vehicular access to adjoining properties (that is driveway cuts), respondents were of the opinion that their level of safety declines with escalation of vehicular access to adjoining properties along roadside walking environment. However, the regression results showed that at 95% confidence level, vehicular access to adjoining properties of the 56 road segments along the roadside walking environment was not significant in the model. This means that an increase or decrease in vehicular access to adjoining properties along pedestrian roadside walking environment has little or no effect on the level of safety of pedestrians.

The coefficient of determination of the model ($R^2 = 0.581$) revealed a goodness fit of the explanatory variables to the level of safety along the sampled road segments in Ikeja. However, the explanatory variables (lateral separation, motor vehicle volume, speed of vehicle and driveway access frequency and volume) contributed (58.1%) to the explanation of pedestrian level safety along roadside walking environment in Ikeja. Similarly, the F-Ratio ($F_{52}^{3} = 20.089$) of the model is also significant at 95% confident level. The results of the model show that the level of explanations ($R^2 = 0.581$) and variability and ($F_{52}^{3} = 20.089$) of pedestrian level of safety is high across road segments in Ikeja.

6.5 SUMMARY

The chapter examines the decision of household heads and on- street persons' readiness to walk. The study showed that the number of respondents that are ready to walk is greater than the number of respondents that are not ready to walk. From the chapter it was observed that female respondents are more willing to walk than the male respondents and this is because women engage is certain activities such as going to the market, taking children to and from school, and going for shopping that involve walking.

The study further showed that age group between 35 years and below is more likely to walk in Ikeja. From the study, it was equally discovered that the number of respondents that owned vehicles are more than the number of respondents without

vehicle, and as expected, respondents without vehicle are more likely to walk than respondents with vehicles. Also, among respondents with vehicles, respondent that has one vehicle are more likely to walk than respondent with two or more vehicles.

The study also revealed that respondents working within Ikeja are more likely to walk than respondents working outside Ikeja. The result of the study also showed that respondents that earn ₦ 7,500:00 and more monthly are not likely to walk than respondents that earn less. This means that an increase in monthly income of respondents may discourage them from walking.

On preferred nature of pedestrian walkways, respondents are more likely to walk if the walkway is safe, secured, clean, continue, spacious and not congested. On safety, the study affirmed the studies of (Hillman, Adams and Whitelegg 1990; DETR, 1997; Forward, 1998; Hamilton, 2000; Ackett, 2001; Living Streets, 2001; Dodd, Nicholas, Povey and Walker, 2004; Tight, Kelly, Hodgson and Page, 2004; Ovstedal and Ryeng, 2006) who observed that fears of about personal safety are one of the factors identified explicitly in empirical work as influencing both pedestrian route and mode choice. They further observed that some people do not walk because of fear of attack. They equally affirmed that the level of fear is greater in urban areas compare to rural areas and people avoid having to walk because of anxieties of personal safety and security. These scholars also observed that, parents and guardians have come to fear that their children will be attacked and abducted by strangers whilst in the street which has led to a restriction on children's freedom to play outside or walk.

On road traffic situation, the study affirmed the study of (Appleyard and Lintell, 1972; Hillman, Adams and Whitelegg 1990; Bly, Dix, and Stephenson, 1999; Bradshaw and Jones, 2000) who discovered that parents restricted their children's freedom to walk more because of their fears about road traffic than their fears about strangers assaulting their children. Road traffic type and volume is also given as a factor in choosing not to walk. They equally observed that emissions from traffic such as noise and air pollution also affect at the extremes the decision to walk. The survey further showed that respondents are likely to walk when the distance is less than 3.2km, weather being cool and not sunny, day time and during dry season. On distance, the study affirmed the study of (Forward, 1998; Hillman, 1999; Hodgson

and Tight, 1999; Bradshaw and Jones, 2000; Goodman, 2001; IHT, 2000; Stradling, 2000; Living Streets, 2001; Mackett, 2001) who observed that distance between services have grown and this increase journey time. The convenience of motor trip due to increasing distance often discouraged individuals to make a walking trip.

Based on season, the study also affirmed the study of (Forward, 1998; Hodgson, 2000; Tight et al, 2004).They observed that weather often comes up in the lists of factors that people find significant in the decision to walk. For short or long trips, dry weather had a positive impact on the decision to walk. It is not only the discomfort of walking in rainy weather that can deter people from walking but also the fact that one has to dress in the appropriate clothes for the weather. Regarding time, some studies relate it with season, distance or daytime. In this study it is a concept related to daytime and night, and it confirmed the study of (Virilo, 1986; Adams, 1995; Forward, 1998; McNaughten and Urry, 1998; Ackett, 2001; Living Streets, 2001; Hamilton, 2000; Burkit, 2000; Goodman, 2001; 2005).These scholars were of the opinion that because of personal security, people, women in particular organise journeys to avoid having to walk at night. They also observed that shift workers go to extra ordinary lengths to make sure that they are not walking or catching public transport at night. Hence, they argued that: lifecycle time; necessary time; (involve the complex scheduling of routine and domestic tasks); work time; and travel time are useful in understanding the motivation to walk.

The results of regression analysis of pedestrian level of safety along road segments in the chapter shows that distance of pedestrian from moving vehicle (lateral separation), speed of moving vehicles, and volume of vehicles are significant at 95% confidence level except drive way access frequency and volume. The result further showed that pedestrian level of safety increases as the distance between vehicle and pedestrians increases. The study further revealed that pedestrians level of safety or comfort decreases with increasing volume of motor vehicles and motor vehicle's speed. The results of pedestrian level of safety along road segments in the study area in Ikeja is in line with the studies of (Forward, 1998a; Forward 1998b; Forward, 2001; Roberts, 1989; Zuckerman, 1993; Lee, 1984; Cassidy 1997; Appleyard and Lintell 1972) who observed that heavy presence of traffic do affect pedestrian level of safety and social network; thereby discourage people not to walk. Gunnarson (1999) study also showed

that the outcome of an accident between a car and a pedestrian depends very much on the speed of the vehicles. Furthermore, he observed that the death rate quickly increases from 30 km/h to 70 km/h when basically nobody will survive.

The coefficient of determination of the model showed that about 58.1% of pedestrian level of safety and comfort along roadside walking environment is provided by lateral separation, motor vehicle volume, speed of motor vehicle and drive way access and volume. About 41.9% are unexplained variation, which showed that there are other factors such as quality of walkway, noise, air pollution - emission from moving vehicle and so on that might contribute to pedestrian level of safety along roadside walking environment. Nevertheless, the model was able to give an insight into factors or variables that influence people level of safety and comfort along roadside walking environment.

Pedestrian walkways or sidewalks are very significant in the design of road network. However, this aspect of our road is the most neglected. In any road network that involves human and vehicular movement, safety and security, comfort, quality of the footpath and other pedestrian facilities influence the decision to walk. Spacious walkways, continuity of walkways and decongested walkways affects pedestrian level of safety. In other to safe guard pedestrians, urban and transport planners need solid guidance on how to design roadside walking environments. Pedestrian *Level of safety model in Ikeja* thus provides a guide to urban and transport planners on (i) how far sidewalks should be placed from moving traffic; (ii) when, and what type of buffering or protective barriers are needed; (iii) how wide the sidewalk should be (iv) when and where to allow on-street parking or shoulder lane and (v) when and where to pedestrianized urban centre in order to discourage vehicular movement and encourage walking or pedestrian movement. At this juncture, the summary of findings, conceptual and theoretical contributions, implication of findings to planning, and further research needs of the study are presented in chapter seven.

CHAPTER SEVEN

CONCLUSION

This study examined the fundamental developments that explain pedestrian movement in Ikeja area of Lagos State, Nigeria; with a view to identifying, understanding and explaining the processes and patterns associated with pedestrian trips in urban areas. The study considered walking distances of household heads and on-street persons (pedestrians), volume of pedestrian trips generated by household heads and on-street persons, factors influencing household heads and on-street persons' decision to walk and pedestrian level of safety along roadways in Ikeja. This chapter summarises the findings, examines conceptual and theoretical contributions by linking findings implication to planning, and as well discusses further research needs of the study.

7.1 SUMMARY OF FINDINGS OF THE STUDY

The study showed that land use and economic activities are pull factors that enhanced pedestrian movement in the study area. Movement of people along the road network in Ikeja revealed that pedestrian activities are common, but there are no pedestrian facilities such as walkways, pedestrian shed and side road furniture along the road networks. Also, noticeable within the congested road, is competition between pedestrians and vehicles who try to claim right of way.

Another important finding in the study area is indiscriminate parking of vehicles along the road corridors or walkways meant for pedestrians. Pedestrians therefore jaywalk or spread on the road networks. The result of the study showed that there was an average flow of 56,663 pedestrians along the streets between 7am and 7pm of the survey and the pattern of flow varies significantly ($F_{187}^{16} = 56.76, p \leq 0.05$) across zones. The lowest average hourly pedestrian flow in the study area was recorded between 7am and 8am and the highest flow was recorded between 5pm and 6pm with flow rate of 1,788 and 6,313 pedestrians respectively. Between 7am and 8am, there is 54.5% increase in pedestrian flow. Between (9am and 10am) and (3pm and 4pm)

pedestrian flow in the study area decreases by 25.6% and increases by 46.5% between (3pm and 4pm) and (4pm and 5pm).The study also revealed that between (4pm and 5pm) and (5pm and 6pm) pedestrian flow increases by 18.2% and there is a reduction of 41.1% in the average number of pedestrians flow between (5pm and 6pm) and (6pm and 7pm). Though, the study showed a 51.9% increase in pedestrian flow between (7am and 8am) and (6m and 7m), the results showed a pedestrian flow pattern of an increase as early as 7am in the morning a decrease around 7pm in the night.

The result of the study shows that majority of both household heads (60.7%) and on-street persons (89.8%) do walk as pedestrian. The period between 5:30 am to 6:00 am, 94.6% of pedestrian trips originate from home and 86.7% of similar trips are home bound between 6:00 pm to 8:00 pm daily. The result of the study also revealed that nine categories {work (30.4%), recreation (6.7%), religious function (20.5%), business (9.2%), schooling (7.4%), shopping (17.4%), social function (3.3%), visiting friend (1.3%), exercising (3.6%)} of walk trip purposes were generated by household heads and on-street persons. On proportional basis, work (30.4%), accounted for the highest walk trip purpose and the least is friends' visiting (1.3%). Interestingly, religious function (20.5%) is next to work in order of magnitude. From the survey, it was also observed that female respondents have tendency (1.02 times) to walk more than their male respondents and this action may be attributed to the activities such as shopping, picking children from school, going to the market and other activities which women engaged in.

On walking distance, the mean walking distances taken by household heads to bus stations ($\bar{X}$=195m, δ=31.37) and land use activities ($\bar{X}$=1.53km, δ=3.77) is lower than on-street persons' walking distances to bus stations ($\bar{X}$=292m, δ=33.78) and land use activities ($\bar{X}$=2.47km, δ=5.76). The mean walking distances by household heads to bus stations and landuse activities was ($\bar{X}$=0.244km, δ=0.02) while that of pedestrians was ($\bar{X}$=2.km, δ=0.10) which is significant at (t=71.01, p=≤0.05). The ANOVA results $\{(F_{32}^{1} = 70.831, p_{value} \leq 0.05);\ (F_{32}^{1} = 16.288, p_{value} \leq 0.05);\ (F_{32}^{1} = 135.633, p_{value} \leq 0.05)\}$ on maximum walking distance of respondents to bus station, land use activities and bus station and land use activities respectively do not

support hypothesis one of the study that state that: the maximum distances people are ready to walk to bus stations, landuse activities and various functions and services do not vary across zones in the study area. The ANOVA results showed that the maximum distances people are ready to walk to bus stations, landuse activities and various functions and services vary across zones in the study area.

Predicting pedestrian trips generated by household heads and on-street persons, explanatory variables such as trip characteristics {work (β = 0.354, t = 10.125), religious function (β = 0.320, t = 8.415), business (β = 0.074, t = 2.627), shopping (β = 0.258, t = 7.138), friends visiting (β = 0.076, t = 1.843), exercise (β = 0.082, t = 2.432)}; and the number of economic activities household heads and on-street persons engaged in { industries (β = 0.452, t = 2.726), hotel and restaurant (β = 0.345, t = 1.103), shopping mall (β = 0.047, t = 1.577), fast-food points (β = 0.288, t = 3.816)} are the significant variables that explains pedestrian trips in the study area.

Based on decision to walk, the result from the study shows that respondents below 35years are more likely to walk than respondents whose age falls between 35years and above. It was equally observed that the number of respondents that owned vehicles are more than the number of respondents without vehicle, and as expected, respondents without vehicle are more likely to walk than respondents with vehicles. Among respondents with vehicles, respondents that have one vehicle are more likely to walk than respondents with two or more vehicles.

The study also revealed that respondents working within Ikeja are more likely to walk than respondents working outside Ikeja. The result also showed that respondents that earn ₦ 7,500:00 and more monthly are not likely to walk than respondents that earn less. This means that with increasing income of respondents, there is tendency of respondents not willing to walk. Another finding shows that people are likely to walk if the walkway is safe$(e^{\beta} = 1.058)$, secured$(e^{\beta} = 0.643)$, continue$(e^{\beta} = 1.346)$, clean$(e^{\beta} = 0.653)$, and spacious$(e^{\beta} = 1.128)$.The survey further showed that people are likely to walk when the distance is less than 3.2km $(e^{\beta} = 0.907)$, weather being cool and not sunny $(e^{\beta} = 1.811)$, during daylight $(e^{\beta} = 0.977)$, and in dry season $(e^{\beta} = 0.938)$.

The study also provides empirical study of pedestrian level of safety in 56 road segments where pedestrian movement predominate. Of the 56 road segments sampled, only 6 have walkways. People are left with no other choice than sharing the available space (roadways) with motor vehicle, and each of the road users claim the right of way. However, the consequence is vehicular and pedestrians conflicts, which either result to lose of life or injury on the part of the pedestrian.

Another major finding is that pedestrian level of safety variability ($F_3^{52} = 20.089, p_{value} \leq 0.05$) and explanation ($R^2$=0.581) is higher on roadside in the study area. Furthermore, pedestrian level of safety in the study area increases with increasing distance of sidewalks from moving vehicles (β_1 = 0.596, t_1 = 5.139), but decreases with increasing vehicles' volume (β_2 = 0.204, t_2 = 1.732), and vehicles speed (β_3 = 0.0.072, t_3 = 0.756) on roadside. However, at 95% confidence level drive way access frequency and volume (β_4 = - 0.067, t_4 = - 0.745) is not a significant variable in the prediction of pedestrian level of safety on road segment in the study area.

The coefficient of determination of the model showed that about 58.1% of pedestrian level of safety and comfort along roadside walking environment is provided by lateral separation, motor vehicle volume, speed of motor vehicle and drive way access and volume. About 41.9% are unexplained variation, which showed that there are other variables such as quality of walkway, noise, air pollution - emission from moving vehicle and so on that might contribute to pedestrian level of safety along roadside walking environment. Nevertheless, the model was able to give an insight into factors or variables that influence people level of safety and comfort along roadside walking environment in the study area.

A safe, secure and separate place to walk along roadways or streets is essential in rural, suburban and urban area of any country. Safe guarding pedestrians, road designers need solid guidance on how to design pedestrian environments, the study revealed that the *LOS model of Ikeja* is an understanding of roadway design of (i) how far sidewalks should be placed from moving traffic; (ii) when, and what type of buffering or protective barriers are needed; (iii) how wide the sidewalk should be (iv)

when and where to allow on-street parking or shoulder lane and so on so as to protect pedestrian and as well encourage walking.

7.2 CONCEPTUAL AND THEORETICAL CONTRIBUTIONS

This study looked at landuse and a number economic activities such as number of financial institutions; industries, fast food points, shopping malls, hotels and restaurants and so on, which are part of geographical phenomena represented by point pattern. The study used roads, streets as network which allowed common geometrical properties such as origins of pedestrian trips which is represented by nodes, routes or streets that pedestrians move is represented by links and various destinations of pedestrians is represented by nodes. Networks are structures designed to tie together nodes via routes, whether they are flows of people, goods, information, money, and so on. Pedestrian use different modes and transport facilities to achieve their trips from point of origin to their various points of destinations.

Graph theory enhances network analysis in urban geography. *Shimbel index*, a technique in graph theory was used in this study to assess the level of accessibility of the street network in zones understudy. Level of accessibility in relation to land use activities contribute significantly to the observed volume pedestrians found along road network of interest in the zones understudy.

Behavioural approach put greater emphasis on decision making processes that generate various kind of spatial pattern. The approach was introduced into urban geography through the study of movement patterns, especially those associated with intra-urban movement such as 'journey to work and journey to shop' (Herbert and Johnson, 1978). Models describing individual decision making process at various kinds of choice situation are now common and we built on such behavioural concepts as place utility, stress and information space. The second stand within the behavioural approach relates to the notion of individual cognition of urban environment. Urban dwellers possess cognitive and mental maps of their environment, and the maps are far from being identical with the actual physical structure of the city.

In the study the use of the model (Analytical Hierarchy Process), helps to capture both subjective and objective evaluation measures of pedestrian decision to walk on available pedestrian facilities. It also provides a useful mechanism for checking the consistency of the evaluation, measures and alternatives suggested by respondents and thus, reducing bias in their decision making. Analytical Hierarchical Process is significant to this study in that as a decision-support system (DSS), it helps using weight to explain significant factors affecting the decision of household heads and on street persons to walk on walkways and subsequently determine factors needed to model pedestrian level of safety in Ikeja.

Geographers are equally interested in describing and explaining spatial interaction or movement pattern within cities. These movement patterns might be temporary in nature, such as journey to work, shops, recreation and so on, or might be permanent such as residential mobility or the changing of resident within the city. Daily movement pattern consists of trips involving activities as work, shopping, recreation and so on. Attempt to forecast daily movement pattern involve the construction of inter-related models: trip generation, trip distribution, modal split and traffic assignment (Stopher and Meyburg, 1975; Cadwallader, 1985).

The study showed that issue of how movements take place involves travel choices of individuals. As earlier stated, movement issues are represented by "four step process". These four steps are supposed to represent the thought process of individual, because, individual makes four travel decisions as follows: (i) the decision that a trip is necessary to fulfil some need or purpose (generation), (ii) the decision where that need or purpose is best fulfilled (distribution), (iii) the decision of which means is best to get there (mode choice) and (iv) the decision of which route to take (trip assignment). These basic analogies of the traditional 4-stage transport model which are trip generation, trip distribution, modal split and traffic assignment.

Trip generation involves trip production and trip attractions for individual zones which are related primarily to the type of land use. The study has shown that human movements in urban centres are consequences of spatial imbalance created by urban land use types. Urban spatial structure therefore, emerged along two different lines of survey and the most relevant to this study, is classical theories which include

Concentric Zone Theory (Burgess, 1925); Sector Theory (Hoyt, 1939) and Multiple Nuclei (Harris and Ullman, 1945). These theories examine the expansion of city by explaining the processes of urban metabolism and mobility that revolves around a single centre to multiple centres. These urban metabolisms help to generate trips within and outside the city.

Theories of urban spatial structure provide basis for urban mobility in the city. They also provide explanation to location behaviour of households and group (Ayeni, 1979; Aluko, 2004). The relevance of these theories to pedestrian movements is their trip generating capability. City centres are focal point of socio-economic activities and because of their potential trip attractions, different land use types generate varying pedestrian traffic and trips within and outside residential, commercial, industrial, institutional and recreational zones.

Studies have shown that residential, manufacturing, public lands appear to generate about the same pedestrian trips per squares mile, but number of pedestrian trips associated with commercial land use are often considerably higher as observed in this study. As one would expect, the higher the land use density, the greater the trip attraction zones.

The subunits into which the study area was divided show the characteristics of sector model of axial growth along transport routes with few income groups tend to live in distinct area. Areas where such 'distinct area' can be found in the subunits are Allen Area (13), Alabi Area (15) and Kudeti Area (4). Subunits that show similar characteristics of multiple nuclei model include Otigba Area (1) , Governor Area (7), Awosika Area (2), Obanta Area (3), Akeem Balogun Area (5), Ajanaku Area (6), Kadiri Area (8), Olanrewaju Area (9), Secretariat Area (10), Kasumu Aleshinloye Area (11), Morrison Area (12), and Unity Area (14), Community Area (16) and Acme (17). In these subunits, a Central Business Districts (CBD) exists in each of the zones.

Furthermore, many traditional and indigenous centres reside in the core part of the city. For instance, core areas of the study area still retained the Yoruba traditional compound structure.Although, some of the residential buildings built by the Government are meant for low income people, but in reality residential districts in the

study area do not follow social class differentiation. In other words, the study area departs remarkably from the classical pre-industrial urban pattern of distinctive residential differentiation and social region typical of United State of American cities discussed earlier in chapter two. Commercial and business activities are concentrated in the Central Business District where jobs, office buildings and especially stores are located as observed in the classical models. However, observe business activities involving petty traders that are found along the streets of the Central Business District. Petty traders activities found along the streets of the Central Business District in the study area is in variance with one of the characteristics of multiple nuclei model that state that '*certain activities unable to generate enough income to pay for high rent in particular location are forced to locate at the site with low rents'*

Batty (2001) acknowledged that the internal structure of cities prior to industrial age was largely determined by economic exchange and social interaction based on walking. Even today, the configuration analysis of old cities and older part of modern cities requires some basic appreciation of the limits on scale posed by movement pattern that were largely conditioned by how far people could walk.

7.3 IMPLICATION OF FINDINGS TO PLANNING

Planning in any environment should be problem oriented. This is to say that for any planning process to be successful, it must address itself to providing immediate and long term solution to various problems of the city. It is in this regard that a strong methodology becomes a prerequisite for comprehensive planning (Ayeni, 1974).

Many pedestrian-related plans, programs, projects and policies in cities evolved over time, generally in response to very specific objectives and often singular divisional needs. Analysing the implication of the findings of this study for planning requires inventory of all existing policies, programs and projects in Lagos State and the country in general in order to integrate them and to identify gaps to be addressed by new initiatives.

In Lagos state where the study area is located for example; there is no transport policy that discusses the exclusive right of pedestrian in roadways. However, there are pedestrian overpasses constructed on highways in some part of the state. In Nigeria for example, the National Transport Policy, Federal Ministry of Transport main document of May 1993 only discussed other modes of transport without including walking as a mode of transport or discussed pedestrians in details. This showed that the rights of pedestrians are not incorporated in Nigerian transport policy and it is not a surprise why the results of the study showed the neglect of this mode of transport.

In the study, it was observed that there are no walkways in many road networks in the city understudy and where they are available in form of covered drainage, people have complained that vehicles are parked on the walkways and this usually constitute nuisance and impediment to their mobility. They believed that other road users (drivers, motorcyclists, tricyclists) demonstrate a lack of concern about them as potential users of the transport system.

The study also revealed that greater numbers of people do walk frequently and their walking distances to bus stops or transit points and landuse and places of economic activities lies between 0.244km and 2km. The study further revealed that factors related to safety, security, cleanliness, continuity, distance, time, weather, accessibility, aesthetic, speed of vehicles, heavy traffic do influence people's willingness to walk.

Recognizing these factors there is the need to modify land use patterns in order to make urban environments less car dependent and more oriented towards walking, cycling and public transport. These efforts include the new urbanism, compact city, smart growth, transit-oriented development and urban villages' movements, all of which promote some combination of concentrated development, interconnected streets, mixed land uses and proximity to public transport nodes. These approaches help to make walking a more viable travel option by decreasing distances between the origins and destinations of many trips (Southworth, 1997; Southworth and Ben-Joseph, 2003; Thompson-Fawcett and Bond, 2003). The integration of land use and transport planning is a key element in creating more sustainable cities.

Urban planning and land organization must be directed towards preserving and providing more foot space and proximity of work places and services should be improved. Public spaces must be made liveable with attractive and comfortable furniture, trees, devices for weather protection, benches, kiosks etc.

In short term planning, essential aspect of pedestrian program for sustainable development will be to organize landuse and design the city space so that walking is promoted such that:

(i) Walkways and pedestrian areas are continuously connected, comfortable, and free from hazards and risks, as well as free from air pollution.

(ii) Pedestrian areas are made interesting and attractive by varying the environment, places where people can meet on foot and enjoy the city atmosphere.

(iii) Safe and comfortable walkways should be offered to efficient, environment-friendly and affordable public transport service should be offered.

(iv) Street furniture should be available to disabled persons, e.g. seats for resting.

(v) Information should be given at key points in an easily understandable way.

(vi) Walkways and streets are maintained and well illuminated for safe and secure walking.

In the long run, formulating policies for sustainable development, environmental improvement, public health, urban and traffic renewal is significant. The goal is to balance the use of urban space and reduction of automobile dependency and encourage safe and comfortable walking environment.

Promotion of urban traffic planning; road construction and management and public transport services that can enhance pedestrian-friendly city. City design and towns landscaping must take into account the city's historical background. Architects must

form attractive and interesting walkways and public spaces that are full of variety of trees, arcades and provision and maintenance of adequate lighting in public areas. Indoor walkways should offer weather and climate protection and visible landmarks are necessary for effective orientation.

Urban planning and land use organization: Organization of a variety of functions, all over the city, by obtain proximity to work and service places Building arranged to avoid twist tunnels. Pedestrian zones are becoming more and more popular although some traders are still worried about loss of trade. However, the experiences from cities that have pedestrianized large areas of their city centres are generally been very positive (Zuckerman, 1993).

Traffic planning and transport management: Urban form adapted to efficient public transport system and traffic reduction is required. Increase speed management and number of car-free zones must be achieved. These zones need to be planned with great care of preventing them from becoming isolated islands in a sea of cars. Speed reduction walkable communities support public transit because most transit trips begin and end in a walking trip. The most vibrant, economically successful commercial streets depend on high levels of foot traffic. Cities which have dynamic, interesting walking environments attract millions of visitors every year. To compete globally, there is the need to invest in becoming a great walking city.

Information technology can be used to compel drivers to lower their speed to the pedestrian conditions. It could also detect pedestrians at signalized crossings or give pre-warnings. Police supervision directed to the enforcement of speed limits and control of other driver behaviour as well as protecting of people from criminal action along walkways is necessary.

Cities built for people rather than cars can be more aesthetically pleasing to the eye. There is the need to put aesthetics high on the agenda when planning a walkable environment because aesthetic environments enhance the experience of walking and time becomes less of an issue. Unfortunately the experience of walking for many people is taking themselves from the underground parking garage to the nearest shop

which is not particularly rewarding when it comes to aesthetic and will certainly not give a taste for more (Gunnarsson, 1995).

The result from the study showed that on-street persons walk more distances than the household respondents. This situation may be attributed to the fact that household respondents take pleasure in the comfort of their vehicles, which signifies that household respondents are likely to bring their vehicles as close as possible to activity centres. The implication is that where there are no parking facilities at these centres, as observed in the study, people may continue to park along the streets or walkways meant for pedestrians thereby not only creating traffic congestion along the streets but also expose pedestrians to danger. Where there is enforcement regarding on-street parking, this may result to underutilisation of such facilities.

Walking distances that are longer than acceptable limit, may not create avenue for an efficient utilization of public transport facilities and services. Where residential or commuter population or job density is great, short walking distances to public transport pick-up points or bus stops must be widely spaced because when bus stops are too close, to each other, the journey time lengthens. Long walking distances could only be acceptable if public transport bus stops are easily accessible, that is, if they are located at sites where passengers do not have to cross heavy traffic before getting to the bus stops. Longer walking distances could also be tolerated if the bus stops are made attractive by provision of such facilities as walkways, pedestrian crossings, sheltered seats, shopping facilities and so on.

In planning of housing estates or any other major urban expansion schemes, attention should be paid to maximum distance people are ready to walk. Based on the results of the study, average walking distance between 300m and 900m to public transport pick-up points may be considered for journey from home to bus stations and local facilities in the study area. Also, an average walkable maximum distance between 2.1km and 3km from home to various economic and landuse activities may be considered in and around the study area in Ikeja.

People use their cars for a variety of different purposes. Measures aiming to assist reduction in private car use will need to be carefully targeted at these purposes, providing viable alternatives to meeting those individual patterns of obligation. Urban and transport planners, architects and engineers must cooperate in order to achieve an attractive environment for pedestrians and all citizens, and they must strive to bring back proximity of work and service places. Attention must also be given to methods of reducing the increasing dependency on private cars. Multidisciplinary research will be necessary to increase knowledge of the behaviour of pedestrians and to promote walking as an important way to enjoy city life and keep healthy. Designing a pedestrian-friendly city will be great challenge in a program for developing sustainable cities. Walking freely and safely must be regarded as a human right.

7.4 FURTHER RESEARCH NEEDS

There is no doubt that urban travel and particularly pedestrian trips, is a function of complex socio-economic characteristics of urban centre and urban residents on one hand, and pedestrian trips with respect to the nature of roadside walking environment and pedestrian needs on the other hand.

The possibility of making generalisation on the basis of the results of this has some degree of limitations, since there is always room for improvements. Because of the difficulties in capturing all variables required for the explanation of pedestrian trips in this study. The conclusions reached for the study are based on data used.

Pedestrians can be divided into many types depending on age, physical and mental capacity, type of equipment used, occupation of hands, and group size. These characteristics influence whether one can walk freely and comfortably without strain and hindrance. Persons with disabilities have special problems that vary depending on the type of handicap, e.g. moving quickly, walking longer distances, using steps, reading traffic signs and other information, avoiding obstacles, and hearing approaching cars (Gunnarsson, 1995).

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Mentally disabled people have difficulty in orienting themselves, perceiving risks, and understanding signs and traffic information. Smaller children may also be handicapped to some extent, and Sandels (1968) has clearly demonstrated that most of the children up to an age of 8 to 9 years are unable to understand traffic rules, and they may not yet know the difference between right and left. Another group affected by traffic emissions is allergic and asthmatic persons, who get breathing problems and eye irritations.

In this study, pedestrians are not separated into different group. They are generalized on the definition of Association of Pedestrian Council (2001), as those who travel on foot and Risser (2003) as transport mode and only when it is done in public place where those who travel by foot interact with other people as road user. This study therefore, proposed that pedestrian trips based on categories of pedestrian as highlighted in table 7.1 is an area for further research.

Table 7.1: Classification of Pedestrian Types.

Classification	***Pedestrian Type***
Age	Toddlers School children, Teenagers Adults and Elderly
Capacity	Full capacity
Type of handicap	Handicapped (physically, mentally)
Equipment used	Crutch, cane or walker Wheelchair or rollator Roller-skates, skateboards
Occupation of hands	Hands free Guiding children, disabled persons Carrying toys, shopping or luggage Pushing a pram, shopping trolley Walking an animal.
Group size	Single A couple or a family Procession, parade

Source: Gunnarsson 1995

There are studies that argued that the form, that is the structure and the shape of the urban environment, can have impact on the decision to walk (Hass-Klau., Dowland, and Nold, 1994; Living Streets, 2001). The variables of urban form are not considered in the study and this is an avenue for inclusion of urban form variables into successive study of pedestrian trips.

The result of pedestrian preferred safety in Ikeja showed that variables (such as lateral separation, motor vehicle volume, speed of motor vehicle, and drive way access and volume) contributed 58.1% explanation to pedestrian level of safety along walking environment in the study area. Variance of 41.9% - unexplained variation showed that there are other variables that contribute to pedestrian preferred safety in the study area. Therefore, this study suggests that variables such as quality of walkway, noise, air pollution - emission from moving vehicle and others can be included into future research in the area of preferred pedestrian safety.

Behavioural change strategies have worked in many fields of study regarding traffic problem and the problems of reducing car use and advocating walking. A study of people's attitude and change in behaviour in the use of car for short distance trips instead of walking is another viable area for further research in pedestrian trips.

7.5 CONCLUSION

As the most basic form of mobility, walking has become increasingly marginalised in many cities as traffic congestion and automobile-oriented design have driven walkers from the streets (Frank, Andresen and Schmid, .2004; Giles-Corti and Donovan, 2003; Saelens, Sallis and Frank, 2003). This situation exacerbates reliance on the private motor vehicle for everyday activities.

Yet there is growing concern about the unsustainability of urban environments and a related acknowledgement of the need to reduce vehicle dependence and encourage active travel, which most obviously encompasses walking (Bean, Kearns and Collins, 2008). Various social problems are attributed to increased automobile dependency in cities, including social exclusion for those without access to a car, and a loss of

community and street life (Hine and Mitchell, 2003; Sheller, 2004; Sheller and Urry, 2000; Southworth, 2003; Bean, Kearns and Collins, 2008).

These problems are accompanied by public health concerns such as automobile accidents (Feyer and Langley, 2000; Tobias and Turley, 2005) and the disease burden associated with declining physical activity and increasing obesity (Mackett, Lucas, Paskins and Turbin, 2005). The increasing motor traffic in cities negatively affects the safety and environment for pedestrians. About 15-20% of persons killed in road traffic accidents in industrialized countries are pedestrians; this figure is 40-50% in developing countries.

Another problem of pedestrians is that they have to walk in the roadway due to lack of walkways and that more walking space has been given to motor vehicles through wider streets and more space for parking, even on sidewalks. They also have to walk in mud and water when maintenance is inadequate, and there is the danger of falling into holes and pits, as well as the difficulties of walking on slopes and steps

Information about the shortest route to popular destinations or points of interests is often lacking, pedestrians often have to make detours to avoid obstacles or parked cars and when they have to pass a motorway or a heavily loaded road. Heavy traffic on a street hinders and impedes social contacts. Although, Bean et al (2008) observed that the auto mobility literature emphasises the emergence of new sets of social activities and expectations in cities which are associated with growing dependence on the automobile. Yet, pedestrians have not disappeared from city streets and particular forms of sociality continue to be associated with the act of walking.

Problems of pedestrians must not be regarded as a serious traffic safety problem only, but also a question of well-being, health and security. Walking will play a greater role in the coming years both as a means of transport and as a way to experience city life. Efforts have to be made to design a safer and more comfortable environment for pedestrians by establishing more car-free areas and zones where speed, volume and type of vehicle are closely adapted to the conditions of pedestrians

The city has historically been devoted to pedestrians. Space for pedestrians needs not only to be defended but also extended and developed for the benefit of this very important mode. The rights of the pedestrians as adopted by the European Parliament (1988) are that:

(i) The pedestrian has the right to live in a healthy environment and freely enjoy the amenities offered by public areas under conditions that adequately safeguard his physical and psychological well-being.

(ii) The pedestrian has the right to live in urban or village centres tailored to the needs of human beings and not the needs of the motor car, and to have amenities within walking or cycling distance.

(iii) Children, the elderly and the disabled have the right to expect towns to be places of each social contact and not places that aggravate their inherent weakness.

(iv) The disabled have the right to specific measures to maximize their independent mobility, including adjustments in public areas, transport systems and public transport (guidelines, warning signs, acoustic signals, accessible buses, trams and trains).

(v) The pedestrian has the right to urban areas which are intended exclusively for his use, are as extensive as possible and are not mere "pedestrian precincts" but are in harmony with the overall organization of the town, and also the exclusive right to connecting short, logical and safe routes.

There was a limited distance over which household heads can walk to facilities making them drive close to such facilities thereby, creating congestion and parking problems. Walking is the most ancient and universal form of travel. It is the first kind of travel we learn and the one that is most accessible to all. Every journey begins and ends on foot. Therefore, educating and advocating should be used to promote walking as a healthy means of transport, and also as a way to avoid shorter trips by car. Increased investment on pedestrian facilities and pedestrianizing central business districts of urban centres will enhance pedestrians' mobility and safety. Pedestrian

traffic must be treated as an important component of road traffic rather than an incidental occurrence to vehicular traffic in urban transport planning.

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APPENDIX I

HOUSEHOLD TRIP DIARY IN IKEJA AREA OF LAGOS

Department of Geography
University of Ibadan, Ibadan

For Official Use Only
Enumerator: ……
House No: ……
Zone No: ……
Street Name: ……
Date: ……

Dear Sir/Ma,

DATA COLLECTION FOR DOCTORAL THESIS

This survey is for a Doctoral thesis. It has nothing to do with tax collection, property assessment or reassessment, increase in fuel pump price, transport or any other levy whatsoever.

The information provided here will be used only for academic purpose and strictly kept confidential.

HOUSEHOLD MOVEMENT RECORD IN AND AROUND IKEJA

1. Location of Respondent

Street: …… Area …… Zone: ……..

SECTION A: HOUSEHOLD COMPOSITION AND SOCIO-ECONOMIC CHARACTERISTICS

Note: This information is meant for the **household head**. A **household** is the number of people who live in a house including the head.

1. Age of Respondent

. (Less than 20) yr -- 0 (20 – 30) yrs – 1 (31 – 40) yrs – 2 (41 – 50) yrs – 3

(51 – 60) yrs – 4 (60 and above) yrs - 5

2. Sex of Respondent

Female – 0 Male – 1

3. Marital Status of Respondent

Single – 0 Married – 1 Divorced – 2 Widowed- 3

4. Level of Education of Respondent

Primary – 1 Secondary- 2 Post Secondary – 3

5. Work Status of Respondent

Not working – 0 Working - 1

6. Employment status of Respondent

Student – 0 Public sectors – 1 Private sector – 2

Self-employed – 3 Retired – 4 Unemployed – 5

7. Occupational Status of Respondent

Self employed – 1 Public sectors – 1 Private sector – 2

Student – 3 Retired – 4 Unemployed – 5

8. Occupation category of Respondent

Farming /agriculture – 1 Industrial/Manufacturing – 2 Commerce/Trading – 3

Administration – 4 Construction – 5 Teaching/Lecturing – 6 Schooling – 7

Others (specify) – 8…….

9. Religion Affiliation of Respondent

Muslim – 1 Christian – 2 Traditional – 3

10. Are you a native of Ikeja?

Yes - 1 No – 0

11. How long have you being staying in Ikeja.

1 – 5 years – 0 6 – 10 years -1 11 – 15 years -3 16 – 20 years – 4

Above 20 years -5

12a. Where is your work Location within Ikeja?

Central Business District – 1 Industrial Layout – 2 Commercial Layout – 3

Shopping Malls – 4 Secretariat – 5 Residential Layout – 6 Others - 7

12b. Where is your work location outside Ikeja?

Central Business District – 1 Industrial Layout – 2 Commercial Layout – 3

Shopping Malls – 4 Secretariat – 5 Residential Layout – 6 Others - 7

13. What is your monthly income?

Less than N7, 500 – 1 7,500 – 20,000 – 2 21,000 – 30,000 – 3

31,000 -- 40,000 – 4 41,000- 50,000 – 5 Above N50, 000 – 6

14. What is your estimated annual income in naira?

Less than N90, 000 – 1 N90,000 – 2 Greater than N90, 000 – 3

15. What is your estimated annual rent paid in Naira.

Less than N78, 000 – 1 N78, 000 – 2 Greater than N78, 000 – 3

16. Do you have a vehicle?

Yes - 1 No - 0

17a. If no to 16, indicate your household usual mode of inter-city travel.

Private owned car – 1 Official vehicle – 2 Public transport – 3

Motor cycle/bicycle - 4 Walking – 5 Others (specify)…… 6

17b. If no to 16, indicate your household usual mode of intra -city travel.

Private owned car – 1 Official vehicle – 2 Public transport – 3

Motor cycle/bicycle - 4 Walking – 5 Others (specify)……

18. If yes, how many vehicles are available for use by your household?

Less than two - 1 Two vehicles - 2 Three vehicles - 3 Four vehicles – 4

Five or more vehicles - 5

19. How many people live in your apartment?

One – 0 Two – 1 Three -2 Four – 3 Five -4 More than 5--- 5

20. How many of those living with you are adult?

One – 1 Two – 2 Three -3 Four – 4 Five -5 More than 5--- 6

21. How many of those living with you can drive?

One – 0 Two – 1 Three -2 Four – 3 Five -4 More than 5--- 5

22. How many of those living with you are adult driver?

One – 0 Two – 1 Three -2 Four – 3 Five -4 More than 5--- 5

23. How many drivers do you employ?

One – 0 Two – 1 Three -2 Four – 3 Five -4 More than 5--- 5

SECTIONB: ABOUT ORIGIN, DESTINATION AND PURPOSE OF TRIPS

In this section we are asking you to provide information about the journey made last week as pedestrian in and around Ikeja.

JOURNEY

25. Where did you start your daily journey? (Origin of trip)

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	**Origin of Trips as Routine**								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

26. Where was your daily destination? (Destination of trip)

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	Destination of Trips as Routine								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

27. What is the purpose of your daily trips?

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	Purpose of Trips as Routine								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

28. Do you make these daily trips weekly?

Yes –1 No --2

29. If yes to 28, how many times did you make these daily trips in a week?

Once in a week –1 2times in a week –2 3times in a week –3
4 times in a week 5 times in a week –5 More than five times in a week

30. What combination of modes of transport did you use for your daily trips from origin to destination?

Walk- Public Transport-Walk 1 Walk- Official Vehicle –Walk 2

Walk- Private Vehicle –Walk 3 Walk- Motor cycle –Walk 4

Motor cycle –Motor cycle- Walk 5 Walk- Walk –Walk 6

Private Vehicle- Private Vehicle-Walk 7 Official Vehicle- Official Vehicle-Walk 8

Walk- Public Transport-Train-Walk 9

31. Where did you start your daily trips as Pedestrian?

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	**Origin of Trips as Pedestrian**								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

32. What is the purpose of your daily trips as pedestrian?

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	**Purpose of Trips as Pedestrian**								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

33. Are their pedestrian facilities to use when embarking on trips as pedestrian?

Yes -1 No -2

34 . What type of pedestrian facilities is available for use along this street?

Sidewalk/Pavement -1 Street crossing -2 Zebra Crossing -3

Lighting signal -4 Pedestrian bridges -5 None - 4

35. What is the nature of side walk along this street (if any)?

+ There is no sidewalk
+ There are sidewalks, but they are not continuous
+ Sidewalks are broken, cracked making then unsafe and difficult to walk
+ There is not enough room for two people to walk side by side
+Sidewalks do not have ramps, curb cut, for wheel chairs, and strollers
+Car, Trucks are blocking the sidewalks
+ Others, please specify

Overall rating of sidewalks. (a) Excellent (b) Good (c) Fair (d) Poor

36. What is the nature of Street crossings along this street (if any)??

+Roads are too wide to cross safely
+Need traffic signal
+Traffic signal makes pedestrians wait too long before crossing
+Need pedestrian crossing signal/audible signal.
+There are zebra crossings
+Motorists do not stop at the zebra crossing making it unsafe for pedestrians

Overall rating of Street crossings. (a) Excellent (b) Good (c) Fair (d) Poor

37. What are the natures of available pedestrian facilities in and around Ikeja that may or discourage your usage or walkability?

Nature of Pedestrian Walkways/Available Pedestrian Facilities	**Characteristics**	
Traffic Situation	**Not Congested- -0**	**Congested – 1**
Safety	**Not Safe - 0**	**Safe – 1**
Security	**Not Secure - 0**	**Secure - 1**
Convenience	**Not Convenient - 0**	**Convenient - 1**
Continuity	**Not Continue - 0**	**Continue - 1**
Cleanliness	**Not Clean - 0**	**Clean - 1**
Cohesiveness	**Not Connected - 0**	**Connected - 1**
Spacious	**Not Spacious - 0**	**Spacious – 1**

Distance	**Trip length $\leq 3.2km$ - 0**	**Trip length $\succ 3.2km$ - 1**
OTHERS	**Characteristics**	
Time Of The Day	**Night/Darkness – 0**	**Daylight - 1**
Season	**Dry Season - 0**	**Rainy Season - 1**
Weather	**Not Sunny - 0**	**Sunny - 1**

38. What is your walking distance from to the bus stops or bus stations ?

(0 - 100) m -1 (100 - 200) m -2 (200 - 300) m -3

(300 - 400) m -4 (400 - 500) m -5 (Above 500) m -6

39. What is the distance you are likely to walk or trek to Land use and places of economic activities in your area?

(0 - 1) km -1 (1 - 2) km -2 (2 - 3) km -3

(3 - 4) km -4 (Above 4) km -5

40. Where do you usually end your daily journey as pedestrian?

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	**Destination of Trips as Pedestrian**								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

41. How do you see walking?

Necessity -1 Hobby -2 Exercise -3 Routine -4

Improve health -5 Alternative mode of transport -6

42. From a pair wise comparison matrix below, use a 1–9 scale, with: $a_{ij} = 1$ if the two factors are equal in importance; $a_{ij} = 3$ if O_i is weakly more important than O_j ; $a_{ij} = 5$ if O_i is strongly more important than O_j ; $a_{ij} = 7$ if O_i is very strongly more important than O_j ; $a_{ij} = 9$ if O_i is absolutely more important than O_j ; $a_{ij} = 1/3$ if O_j is weakly more important than O_i ; $a_{ij} = 1/5$ if O_j is very strongly more important than O_i ; $a_{ij} = 1/9$ if O_j is absolutely more important than O_i in your decision to walk. Where the number in the i_{th} row and j_{th} column gives the relative importance of Oi O_i as compared with O_j .

O_i / O_j	FACTORS					
	Traffic Situation	**Safety**	**Security**	**Continuity**	**Cleanliness**	**Spacious**
Traffic Situation						
Safety						
Security						
Continuity						
Cleanliness						
Spacious						

43. What other factors can you consider as important in discouraging you to walk?

1. ……..
2. ……..
3. ……..
4. ……..
5. ……
6. ……
7. ……
8. ……

44. Give any other information relating to Pedestrian activities along this street.

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45. Suggest measures to improving Pedestrian movement in this urban centre

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46. Suggest measures to improving transportation system in this urban centre.

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APPENDIX II

ON-STREET PERSONS' TRIP DIARY IN IKEJA AREA OF LAGOS HOUSEHOLD TRIP

Department of Geography
University of Ibadan, Ibadan

For Official Use Only
Enumerator: …….
House No: ……
Zone No: …….
Street Name: ……
Date: ……

Dear Sir/Ma,

DATA COLLECTION FOR DOCTORAL THESIS

This survey is for a Doctoral thesis. It has nothing to do with tax collection, property assessment or reassessment, increase in fuel pump price, transport or any other levy whatsoever.

The information provided here will be used only for academic purpose and strictly kept confidential.

NON-HOUSEHOLD MOVEMENT RECORD IN AND AROUND IKEJA

1. Location of Respondent

Street: …… Area …… Zone: ……..

SECTION A: HOUSEHOLD COMPOSITION AND SOCIO-ECONOMIC CHARACTERISTICS

Note: This information is meant for the **household head**. A **household** is the number of people who live in a house including the head.

1. Age of Respondent

. (Less than 20) yr -- 0 (20 – 30) yrs – 1 (31 – 40) yrs – 2 (41 – 50) yrs – 3

(51 – 60) yrs – 4 (60 and above) yrs - 5

2. Sex of Respondent

Female – 0 Male – 1

3. Marital Status of Respondent

Single – 0 Married – 1 Divorced – 2 Widowed- 3

4. Level of Education of Respondent

Primary – 1 Secondary- 2 Post Secondary – 3

5. Work Status of Respondent

Not working – 0 Working - 1

6. Employment status of Respondent

Student – 0 Public sectors – 1 Private sector – 2

Self-employed – 3 Retired – 4 Unemployed – 5

7. Occupational Status of Respondent

Self employed – 1 Public sectors – 1 Private sector – 2

Student – 3 Retired – 4 Unemployed – 5

8. Occupation category of Respondent

Farming /agriculture – 1 Industrial/Manufacturing – 2 Commerce/Trading – 3

Administration – 4 Construction – 5 Teaching/Lecturing – 6 Schooling – 7

Others (specify) – 8……

9. Religion Affiliation of Respondent

Muslim – 1 Christian – 2 Traditional – 3

10. Are you a native of Ikeja?

Yes - 1 No – 0

11. How long have you being staying in Ikeja.

1 – 5 years – 0 6 – 10 years -1 11 – 15 years -3 16 – 20 years – 4

Above 20 years -5

12a. Where is your work Location within Ikeja?

Central Business District – 1 Industrial Layout – 2 Commercial Layout – 3

Shopping Malls – 4 Secretariat – 5 Residential Layout – 6 Others - 7

12b. Where is your work location outside Ikeja?

Central Business District – 1 Industrial Layout – 2 Commercial Layout – 3

Shopping Malls – 4 Secretariat – 5 Residential Layout – 6 Others - 7

13. What is your monthly income?

Less than N7, 500 – 1 7,500 – 20,000 – 2 21,000 – 30,000 – 3

31,000 -- 40,000 – 4 41,000- 50,000 – 5 Above N50, 000 – 6

14. What is your estimated annual income in naira?

Less than N90, 000 – 1 N90,000 – 2 Greater than N90, 000 – 3

15. What is your estimated annual rent paid in Naira.

Less than N78, 000 – 1 N78, 000 – 2 Greater than N78, 000 – 3

16. Do you have a vehicle?

Yes - 1 No - 0

17a. If no to 16, indicate your household usual mode of inter-city travel.

Private owned car – 1 Official vehicle – 2 Public transport – 3

Motor cycle/bicycle - 4 Walking – 5 Others (specify)…… 6

17b. If no to 16, indicate your household usual mode of intra -city travel.

Private owned car – 1 Official vehicle – 2 Public transport – 3

Motor cycle/bicycle - 4 Walking – 5 Others (specify)……

18. If yes, how many vehicles are available for use by your household?

Less than two - 1 Two vehicles - 2 Three vehicles - 3 Four vehicles – 4

Five or more vehicles - 5

19. How many people live in your apartment?

One – 0 Two – 1 Three -2 Four – 3 Five -4 More than 5--- 5

20. How many of those living with you are adult?

One – 1 Two – 2 Three -3 Four – 4 Five -5 More than 5--- 6

21. How many of those living with you can drive?

One – 0 Two – 1 Three -2 Four – 3 Five -4 More than 5--- 5

22. How many of those living with you are adult driver?

One – 0 Two – 1 Three -2 Four – 3 Five -4 More than 5--- 5

23. How many drivers do you employ?

One – 0 Two – 1 Three -2 Four – 3 Five -4 More than 5--- 5

SECTIONB: ABOUT ORIGIN, DESTINATION AND PURPOSE OF TRIPS

In this section we are asking you to provide information about the journey made last week as pedestrian in and around Ikeja.

JOURNEY

25. Where did you start your daily journey? (Origin of trip)

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	**Origin of Trips as Routine**								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

26. Where was your daily destination? (Destination of trip)

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	Destination of Trips as Routine								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

27. What is the purpose of your daily trips?

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	Purpose of Trips as Routine								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

28. Do you make these daily trips weekly?

Yes –1 No --2

29. If yes to 28, how many times did you make these daily trips in a week?

Once in a week –1 2times in a week –2 3times in a week –3
4 times in a week 5 times in a week –5 More than five times in a week

30. What combination of modes of transport did you use for your daily trips from origin to destination?

Walk- Public Transport-Walk 1 Walk- Official Vehicle –Walk 2

Walk- Private Vehicle –Walk 3 Walk- Motor cycle –Walk 4

Motor cycle –Motor cycle- Walk 5 Walk- Walk –Walk 6

Private Vehicle- Private Vehicle-Walk 7 Official Vehicle- Official Vehicle-Walk 8

Walk- Public Transport-Train-Walk 9

32. Where did you start your daily trips as Pedestrian?

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	**Origin of Trips as Pedestrian**								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

32. What is the purpose of your daily trips as pedestrian?

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	**Purpose of Trips as Pedestrian**								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

33. Are their pedestrian facilities to use when embarking on trips as pedestrian?

Yes -1 No -2

34 . What type of pedestrian facilities is available for use along this street?

Sidewalk/Pavement -1 Street crossing -2 Zebra Crossing -3

Lighting signal -4 Pedestrian bridges -5 None - 4

35. What is the nature of side walk along this street (if any)?

+ There is no sidewalk
+ There are sidewalks, but they are not continuous
+ Sidewalks are broken, cracked making then unsafe and difficult to walk
+ There is not enough room for two people to walk side by side
+Sidewalks do not have ramps, curb cut, for wheel chairs, and strollers
+Car, Trucks are blocking the sidewalks
+ Others, please specify

Overall rating of sidewalks. (a) Excellent (b) Good (c) Fair (d) Poor

36. What is the nature of Street crossings along this street (if any)??

+Roads are too wide to cross safely
+Need traffic signal
+Traffic signal makes pedestrians wait too long before crossing
+Need pedestrian crossing signal/audible signal.
+There are zebra crossings
+Motorists do not stop at the zebra crossing making it unsafe for pedestrians

Overall rating of Street crossings. (a) Excellent (b) Good (c) Fair (d) Poor

37. What are the natures of available pedestrian facilities in and around Ikeja that may or discourage your usage or walkability?

Nature of Pedestrian Walkways/Available Pedestrian Facilities	**Characteristics**	
Traffic Situation	**Not Congested- -0**	**Congested – 1**
Safety	**Not Safe - 0**	**Safe – 1**
Security	**Not Secure - 0**	**Secure - 1**
Convenience	**Not Convenient - 0**	**Convenient - 1**
Continuity	**Not Continue - 0**	**Continue - 1**
Cleanliness	**Not Clean - 0**	**Clean - 1**
Cohesiveness	**Not Connected - 0**	**Connected - 1**
Spacious	**Not Spacious - 0**	**Spacious – 1**

Distance	**Trip length $\leq 3.2km$ - 0**	**Trip length $\succ 3.2km$ - 1**
OTHERS	**Characteristics**	
Time Of The Day	**Night/Darkness – 0**	**Daylight - 1**
Season	**Dry Season - 0**	**Rainy Season - 1**
Weather	**Not Sunny - 0**	**Sunny - 1**

38. What is your walking distance from to the bus stops or bus stations ?

(0 - 100) m -1 (100 - 200) m -2 (200 - 300) m -3

(300 - 400) m -4 (400 - 500) m -5 (Above 500) m -6

39. What is the distance you are likely to walk or trek to Land use and places of economic activities in your area?

(0 - 1) km -1 (1 - 2) km -2 (2 - 3) km -3

(3 - 4) km -4 (Above 4) km -5

40. Where do you usually end your daily journey as pedestrian?

Home –1 Work --2 Shop --3 Recreation -- 4 Mosques 5
Business--6 Exercising --7 School –8 Visiting Friends -9 Social function –10

Days of the Week	**Destination of Trips as Pedestrian**								
	Home	Work	Shopping	Recreation	Church/Mosque	Take Transit	Exercising	Save Money	Social Function
Monday									
Tuesday									
Wednesday									
Thursday									
Friday									
Saturday									
Sunday									
Monday									

41. How do you see walking?

Necessity -1 Hobby -2 Exercise -3 Routine -4

Improve health -5 Alternative mode of transport -6

42. From a pair wise comparison matrix below, use a 1–9 scale, with: $a_{ij} = 1$ if the two factors are equal in importance; $a_{ij} = 3$ if O_i is weakly more important than O_j ; $a_{ij} = 5$ if O_i is strongly more important than O_j ; $a_{ij} = 7$ if O_i is very strongly more important than O_j ; $a_{ij} = 9$ if O_i is absolutely more important than O_j ; $a_{ij} = 1/3$ if O_j is weakly more important than O_i ; $a_{ij} = 1/5$ if O_j is very strongly more important than O_i ; $a_{ij} = 1/9$ if O_j is absolutely more important than O_i in your decision to walk. Where the number in the i_{th} row and j_{th} column gives the relative importance of Oi O_i as compared with O_j .

O_i / O_j	FACTORS					
	Traffic Situation	**Safety**	**Security**	**Continuity**	**Cleanliness**	**Spacious**
Traffic Situation						
Safety						
Security						
Continuity						
Cleanliness						
Spacious						

43. What other factors can you consider as important in discouraging you to walk?

1. ……..
2. ……..
3. ……..
4. ……..
5. ……
6. ……
7. ……
8. ……

44. Give any other information relating to Pedestrian activities along this street.

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45. Suggest measures to improving Pedestrian movement in this urban centre

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46. Suggest measures to improving transportation system in this urban centre.

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APPENDIX III: Pedestrians Circulation on Road networks in the Study Area

Street Names	*OTIGBA AREA – ZONE 1*												Total
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Awolowo	1123	2010	2098	1870	2070	2311	1467	1234	2641	3123	3143	2113	**25203**
Otigba	621	1712	2412	2212	2012	1121	1231	2010	2113	1121	2114	1213	**19892**
Ola-Ayeni	644	1113	2212	2141	2111	2112	1300	2123	2021	3013	2121	1303	**22214**
Oba Kodesoh	1050	1214	1321	800	712	862	463	481	1213	2867	3112	2162	**16257**
Oba Akron	1003	1211	2131	2115	831	713	612	812	1216	2814	3200	2113	**18771**
Adepele	160	703	268	1231	712	813	1731	1041	1021	2131	2111	1312	**13234**
Oshitelu	168	812	1011	1312	781	681	1121	1021	1211	2142	2131	2113	**14504**
Somoye Osundairo	130	600	914	1234	1478	1634	1211	1121	2412	2164	2314	2144	**17356**
Francis Oremeji	423	1211	1321	1102	1010	1121	1020	1121	1131	1234	2012	1031	**13737**
Pebble	203	800	1246	1132	621	463	631	812	1031	917	1811	832	**10499**
Simbiat Abiola	903	1413	2112	1231	1121	1132	1061	937	2012	2112	2134	2034	**18202**
Mobolaji Bank Anthony	1861	2106	1862	1781	1113	1214	1136	2131	2014	2113	2010	2014	**21355**
Idowu Lane	40	86	83	68	71	73	66	81	34	46	39	28	**715**
Adegbola	103	161	102	86	121	132	156	137	148	192	304	413	**2055**
Oduyemi	50	30	40	30	42	36	27	81	86	52	74	86	**634**
Akinremi	146	171	182	131	102	134	103	124	86	41	43	103	**1366**
Araromi	86	50	45	41	43	40	41	45	43	25	66	54	**579**
Oyelola	40	48	67	41	26	21	15	43	51	46	100	63	**561**
Shodipo	23	46	42	53	61	36	25	45	41	42	52	25	**491**
Omobitayo	53	56	81	47	31	32	23	41	36	48	64	73	**585**
Olawaiye	23	36	35	41	48	53	60	43	48	51	54	61	**553**
Babatola	36	25	46	38	48	56	55	63	41	56	41	51	**556**
Nurudeen	55	45	61	54	41	34	46	47	51	43	46	56	**579**
Balogun	26	36	37	48	39	43	47	37	51	56	61	41	**522**
Independence	30	23	48	46	36	28	21	53	41	55	56	51	**488**
Ogunsefunmi	35	46	31	36	41	31	26	56	51	46	48	36	**483**
Abeokuta	24	43	46	53	41	43	56	51	40	58	63	100	**618**
Obasa	15	10	20	25	30	15	10	15	75	80	72	25	**392**
Bashiru	45	50	60	50	60	75	80	60	80	84	86	100	**830**
Planking	15	56	67	76	51	36	31	51	58	60	41	23	**565**

Olaide Tomori	21	54	68	61	48	56	54	54	54	53	46	21	**590**
Aro Omoeba	11	48	74	82	38	48	43	56	46	45	58	18	**567**
Adoni Ewa	12	56	81	47	54	34	36	41	57	58	43	25	**544**
Total	**9178**	**16081**	**20224**	**19315**	**15644**	**15233**	**14005**	**16068**	**21254**	**26988**	**29670**	**21837**	**225497**
Street Names	**AWOSIKA AREA – ZONE 2**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Oba Akran	2126	2347	1132	600	473	784	123	128	216	1321	3121	1204	**13575**
Ladipo Oluwole	1123	1875	50	60	78	600	800	60	167	2134	1341	89	**8377**
Gemco	200	600	712	70	45	50	55	45	56	81	678	63	**2655**
Sapara	1631	2921	100	500	781	856	786	600	160	2134	2040	314	**12823**
Awosika	25	56	86	50	45	60	78	89	160	45	56	50	**800**
Akinola	26	25	56	56	65	78	67	55	83	42	48	46	**647**
Ayodele Odiyan	15	35	44	30	85	60	45	25	43	45	34	45	**506**
Adeniyi	26	46	54	36	28	36	41	36	45	55	60	60	**523**
Total	**5172**	**7905**	**2234**	**1402**	**1600**	**2524**	**1995**	**1038**	**930**	**5857**	**7378**	**1871**	**39906**
Street Names	**OBANTA AREA – ZONE 3**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Ashogbon	20	45	68	69	33	86	28	31	45	83	92	24	**624**
Ali-Balogun	25	67	84	91	44	102	113	46	65	231	267	66	**1201**
Ogunlowo	15	35	26	48	36	21	25	26	37	38	29	32	**368**
Alhaji Kofowora	21	46	48	49	55	63	32	31	33	34	25	46	**483**
Modupe	28	45	33	21	26	38	21	23	35	18	36	28	**352**
Obafemi Awolowo	260	325	126	145	180	260	195	165	185	621	638	269	**3369**
Olu Akerele	23	45	65	36	39	42	46	36	58	54	65	86	**595**
Ojora	15	53	58	46	37	46	38	42	54	52	46	36	**523**
Olorunmbe	26	46	56	42	43	45	56	54	58	56	49	52	**583**
Eleruwa	35	40	45	43	54	53	46	62	48	49	56	61	**592**
Ajao	29	46	42	46	54	52	52	56	42	55	64	54	**592**

Seriki Aro	80	160	234	150	100	250	260	180	60	286	320	180	**2260**
Obe	35	45	56	58	49	56	44	42	46	48	54	58	**591**
Ajasa	28	35	46	25	48	36	42	43	44	48	56	52	**503**
Obanta	36	48	65	54	56	57	68	59	46	55	48	62	**654**
Adeojo	26	35	26	56	72	43	25	42	44	59	62	63	**553**
Eric Moore	38	36	37	48	46	43	34	25	26	48	29	36	**446**
Labande	27	28	43	46	47	54	56	54	65	55	46	54	**575**
Afariogun	80	800	600	250	260	180	140	127	1123	2124	1021	278	**6983**
Shanu	42	21	23	46	34	48	28	24	46	36	25	446	**819**
Total	**889**	**2001**	**1781**	**1369**	**1313**	**1575**	**1349**	**1168**	**2160**	**4050**	**3028**	**1983**	**22666**
Street Names	**KUDETI AREA – ZONE 4**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Adeniyi Jones	212	453	234	126	148	261	134	108	126	321	486	179	**2788**
Aromire	65	124	98	106	78	64	85	52	121	148	236	98	**1275**
Wemabod	27	20	24	18	26	28	31	18	21	31	46	42	**332**
Kudeti	32	25	38	26	34	22	35	31	21	36	43	36	**379**
Obafemi Awolowo	647	2132	1245	684	821	1812	623	721	821	1713	3214	2169	**16602**
Siyanbola	23	34	55	56	48	56	50	45	56	71	41	36	**571**
Adebowale	20	43	46	75	52	32	33	24	36	27	40	28	**456**
Orimolade	18	21	22	23	16	24	32	21	27	18	22	32	**276**
Ikare	26	18	12	21	23	32	16	23	26	32	16	24	**269**
Fafowori	28	24	18	21	16	18	22	10	12	22	28	18	**237**
Badagry	36	28	24	18	21	29	18	16	16	18	21	16	**261**
Ladipupo Oluwole	174	213	341	36	45	89	57	47	121	186	249	107	**1665**
Odanye	25	16	12	10	10	11	10	12	9	18	22	19	**174**
Aba Johnson	28	19	20	8	9	10	12	16	11	21	26	16	**196**
James Olaleye	15	18	12	6	4	8	9	18	14	18	16	14	**152**
Odegbami	19	10	9	14	12	10	13	14	16	18	21	11	**167**
Alh. Duro Dania	27	21	16	13	11	9	11	14	12	11	12	14	**171**
Molade Okoya	16	18	12	14	10	15	20	16	24	16	24	31	**216**
Orimolade	12	10	11	12	18	16	18	12	10	11	12	24	**166**
Ikare	10	12	15	12	13	14	16	15	16	18	21	13	**175**

Oyero	16	18	21	9	11	12	14	13	16	10	11	12	**163**
Alh. Bankole	18	24	35	21	12	14	16	18	16	12	36	23	**245**
Talabi	17	31	35	21	16	18	21	26	28	46	55	48	**362**
Akin Laguda	21	21	34	18	9	11	10	13	11	36	41	28	**253**
Total	**526**	**3353**	**2389**	**1368**	**1463**	**2615**	**1306**	**1303**	**1587**	**2858**	**4739**	**3038**	**27551**
Street Names	**AKEEM BALOGUN – ZONE 5**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Akeem Balogun	21	46	36	30	29	35	46	31	28	55	60	48	**465**
Abiodun Shobajo	26	41	24	41	46	49	50	32	26	60	48	36	**479**
Obafemi Awolowo	326	465	1121	1210	700	534	136	146	321	2136	2445	676	**10216**
Lateef Jakande	68	160	256	188	216	189	121	146	168	464	362	160	**2498**
Lagos –Ibadan	251	362	10	15	11	08	14	21	35	562	678	1132	**3099**
Total	**692**	**1074**	**1447**	**1484**	**1002**	**815**	**367**	**376**	**578**	**3277**	**3593**	**2052**	**16757**
Street Names	**AJANAKU AREA – ZONE 6**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Opebi-Oregun	66	126	102	60	101	68	46	55	214	361	378	136	**1713**
Opebi	86	236	210	87	126	62	63	58	264	382	321	268	**2163**
Irewole	18	35	36	24	38	16	12	11	24	46	53	38	**351**
Idowu	9	21	26	35	21	9	8	10	26	33	43	26	**267**
Church	12	46	36	27	19	12	11	13	14	36	46	33	**305**
Gafaru Balogun	21	36	39	20	21	14	10	16	21	31	36	28	**293**
Olayemi Abiola	22	41	23	18	12	11	10	18	16	21	28	19	**239**
Osho	11	21	24	33	26	11	10	18	16	21	26	30	**247**
Salvation	16	35	28	36	24	32	11	9	8	11	48	56	**314**
Methodist	21	35	46	21	26	24	18	21	26	55	48	38	**379**

Oyetola	22	21	34	26	21	16	21	18	21	25	46	23	**294**
Aderoju Adewunmi	18	20	11	18	14	12	13	18	21	26	31	16	**218**
Folusho Alade	21	22	18	16	21	10	12	16	14	21	28	22	**221**
Awose	16	12	16	18	23	12	16	11	16	31	26	24	**221**
Aberoreniyi	21	24	31	21	16	10	11	9	16	32	36	26	**253**
Igbasa	23	26	24	32	27	12	13	10	21	36	39	28	**291**
Dalago	21	48	56	38	46	53	21	36	34	65	54	38	**510**
Alfred Olaiga	8	56	34	26	43	26	36	19	16	35	58	52	**409**
Ajanaku	18	56	34	26	43	26	36	19	16	35	58	52	**419**
Obafemi Awolowo	126	326	451	214	184	106	156	124	241	478	514	186	**3106**
Thomas Olaiya	25	46	55	62	43	35	21	16	18	43	55	62	**481**
Total	**601**	**1289**	**1334**	**858**	**895**	**577**	**555**	**525**	**1063**	**1824**	**1972**	**1201**	**12694**
Street Names	**GOVERNOR AREA – ZONE 7**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Obafemi- Awolowo	631	2146	2139	821	624	321	361	289	432	931	3167	2121	**13983**
Governor	42	86	88	64	48	62	35	46	33	126	287	324	**1241**
Kafi	35	67	123	121	102	86	74	67	62	214	312	307	**1570**
House of assembly	148	1241	1246	607	732	726	623	321	164	2123	1674	146	**9751**
Total	**856**	**3540**	**3596**	**1613**	**1506**	**1195**	**1093**	**723**	**691**	**3394**	**5440**	**2898**	**26545**
Street Names	**KADIRI AREA – ZONE 8**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Kudirat Abiola	123	1021	861	433	124	86	45	36	48	867	1841	931	**6416**
Jogunosimi	35	48	54	48	34	26	18	21	16	86	124	108	**618**
Obafemi Awolowo	143	281	342	446	214	123	64	43	24	1121	2113	1411	**6325**
Bamgbose	26	46	32	28	32	26	28	35	46	58	54	21	**432**
Odewale	23	35	38	21	22	18	21	16	32	46	58	19	**349**
Kadiri 1	16	26	29	18	16	26	34	26	18	42	38	26	**315**
Kadiri 2	23	31	38	28	27	36	26	28	11	53	45	31	**377**

Makinde	21	22	35	26	18	27	19	16	21	46	32	19	**302**
Oshin	21	31	26	31	21	26	48	57	18	46	48	21	**394**
Oyeleke	18	26	32	17	18	21	18	12	16	24	36	18	**256**
Olaiya	15	18	16	14	19	26	12	11	09	26	37	16	**219**
Sunday Adigun	25	225	123	102	64	52	46	45	26	124	216	213	**1261**
Iyala	16	23	18	24	46	53	42	26	37	55	46	26	**412**
Kafi	35	67	123	121	102	86	74	67	62	214	312	307	**1570**
Total	**540**	**1900**	**1767**	**1357**	**757**	**632**	**495**	**439**	**384**	**2808**	**5000**	**3167**	**19246**
Street Names	**OLANREWAJU – ZONE 9**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Oyeleke	18	26	32	17	18	21	18	12	16	24	36	18	**256**
Kudirat Abiola	124	261	341	286	316	214	134	107	186	324	432	261	**2986**
Oregun	86	126	247	167	184	102	132	86	73	146	231	102	**1682**
Olayiwola	26	33	26	27	23	36	28	16	17	26	38	22	**318**
Liwa	24	26	32	24	36	16	24	12	10	32	43	24	**303**
Sanyaolu	22	32	36	26	34	18	16	23	24	28	36	21	**316**
Olanrewaju	18	21	41	32	34	21	36	24	16	42	56	43	**384**
Abayomi	16	32	26	34	36	28	38	42	21	36	42	39	**390**
Bamidele	14	26	31	29	36	27	43	31	16	44	26	38	**361**
Alh. Bakson	20	36	24	28	27	33	48	21	27	31	28	26	**349**
Fashade	25	26	36	33	35	46	39	27	38	21	48	36	**410**
Oregunwa	26	48	30	26	47	38	22	56	37	48	36	29	**443**
Ikosi	18	24	26	32	33	28	36	21	19	24	13	26	**300**
Mobolaji Johnson	15	36	24	21	20	16	17	18	21	36	21	18	**263**
Secretariat	35	42	55	62	30	21	14	26	54	36	46	62	**483**
Adeniji	20	26	32	27	38	23	26	31	18	19	55	36	**351**
Total	**507**	**821**	**1039**	**871**	**947**	**688**	**671**	**553**	**593**	**917**	**1187**	**801**	**9595**
Street Names	**MOBOLAJI JOHNSON – ZONE 10**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	

Oregun	86	126	247	167	184	102	132	86	73	146	231	102	**1682**
Billingsway	26	121	136	214	206	121	106	121	86	214	204	132	**1687**
Olanrewaju	18	21	41	32	34	21	36	24	16	42	56	43	**384**
De Iyamu	14	26	23	18	20	23	18	10	11	9	26	29	**227**
Kaf	35	67	123	121	102	86	74	67	62	214	312	307	**1570**
Ikosi	18	24	26	32	33	28	36	21	19	24	13	26	**300**
Mobolaji Johnson	15	36	24	21	20	16	17	18	21	36	21	18	**263**
Total	**212**	**421**	**620**	**605**	**599**	**397**	**419**	**347**	**288**	**685**	**863**	**657**	**6113**
Street Names	**KASUMU ALELSHINLOYE – ZONE 11**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Kasumu Aleshinloye	26	43	32	24	36	26	21	19	11	55	48	32	**373**
Obafemi Awolowo	86	123	79	89	74	68	55	48	73	194	187	164	**1240**
Acme	126	2123	624	563	1146	1612	106	178	214	1132	2416	178	**10418**
Vori	26	36	46	55	34	24	36	46	86	24	79	28	**520**
Acme Crescent	36	64	56	42	31	21	35	21	19	18	55	43	**441**
Ajobiewe	15	25	16	34	43	11	12	10	09	26	38	43	**282**
Fagba	10	12	15	10	09	12	14	10	11	11	36	43	**193**
Ajumobi Olorunojo	18	10	18	11	12	10	18	21	10	09	42	33	**212**
Kasumu Aleshinloye	18	23	16	24	28	27	16	11	16	9	26	35	**249**
MBH Power Ltd	26	13	14	9	8	11	12	10	8	21	16	18	**166**
Lateef Jakande	126	137	67	56	46	76	47	101	42	32	213	173	**1116**
Total	**513**	**2609**	**983**	**917**	**1467**	**1898**	**372**	**475**	**499**	**1531**	**3156**	**790**	**21057**
Street Names	**MORRISON – ZONE 12**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Obafemi Awolowo	143	281	342	446	214	123	64	43	24	1121	2113	1411	**6325**
Oregun	86	126	247	167	184	102	132	86	73	146	231	102	**1682**
Industrial Estate	48	213	247	365	124	123	136	66	78	268	432	276	**2376**

Morrison	29	42	36	24	48	37	19	16	26	11	52	46	**386**
Ogundana	18	23	12	26	34	21	12	11	12	09	26	20	**224**
Billy Odumala	25	36	47	56	32	24	26	18	19	21	46	57	**407**
Imayan	18	22	23	17	26	30	21	24	18	20	23	36	**278**
Olaniyi	28	24	18	21	16	19	20	11	12	20	29	20	**238**
Lawal	22	18	12	21	23	12	16	09	10	18	21	26	**208**
Sadatu	20	44	47	65	42	22	23	14	26	37	40	29	**409**
Olasumbo	21	21	34	19	11	21	20	23	21	46	51	38	**326**
Aly. Muri	19	34	45	31	12	24	16	18	16	22	46	33	**316**
Tairu Olugbami	11	13	16	13	14	15	17	16	17	19	22	14	**187**
Oremeta	17	19	13	15	11	16	21	17	25	17	25	32	**228**
Odunkan	27	26	14	23	32	18	24	28	34	30	20	20	**296**
Adebayo Banjo	23	34	56	47	38	56	40	35	46	61	31	26	**493**
Afolabi Awosanya	26	20	24	20	28	30	33	20	23	33	48	44	**349**
Irewole	36	28	26	20	23	32	20	18	20	23	20	18	**284**
Opebi	86	236	210	87	126	62	63	58	164	382	321	268	**2063**
Osho	21	21	36	20	11	13	12	15	13	38	43	30	**273**
Adenuga	14	16	21	16	17	19	18	19	21	25	18	20	**224**
Olayinka	20	21	22	20	20	21	22	19	28	32	29	18	**272**
Kosebinu	15	35	26	38	26	21	15	16	27	28	30	33	**310**
Felicia Koleoso	18	20	23	11	13	14	16	15	18	12	13	15	**188**
Total	**791**	**1373**	**1597**	**1588**	**1125**	**875**	**806**	**615**	**771**	**2439**	**3730**	**2632**	**18342**
Street Names	**ALLEN – ZONE 13**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Allen	128	1214	2136	324	365	429	123	106	246	1471	1234	268	**8044**
Obafemi Awolowo	647	2132	1245	684	812	1812	623	721	821	1712	3214	2164	**24587**
Afolabi Aina	78	124	261	361	161	214	86	77	126	326	385	272	**2471**
Orija	39	69	164	219	186	274	108	121	74	216	184	127	**1781**
Balogun	25	36	58	49	40	58	42	37	48	63	33	29	**518**
Adepeju	30	42	62	37	31	33	25	24	27	30	46	57	**444**
Abajobi	25	26	42	16	18	18	21	18	43	48	35		**345**
Alade avenue	28	24	18	24	20	22	23	16	18	23	26	38	**280**

Alade close	22	20	12	20	12	19	16	23	27	42	36	24	**273**
Fadeyi	26	21	25	21	29	32	22	35	22	25	35	50	**343**
Soji Adepegba	86	126	124	68	102	63	48	41	56	126	187	193	**1220**
Adeleke	36	28	26	20	23	32	20	23	33	26	43	35	**345**
Adeboye Solanke	66	89	76	43	58	33	27	21	33	61	83	96	**686**
Akinosiyemi	43	56	48	36	39	42	31	26	19	59	62	47	**508**
Ajayi	25	25	28	22	31	35	26	29	23	25	28	41	**338**
Hilton	18	44	47	26	23	24	32	26	28	46	51	35	**400**
Musa Ake	30	26	20	26	24	30	35	38	25	48	62	33	**397**
Ogunsiji	25	20	23	26	33	28	19	23	27	40	36	44	**344**
Olori Monisola	23	37	28	37	26	21	18	19	30	48	35	21	**343**
Olaribiro	24	22	25	16	19	23	20	23	17	35	33	35	**292**
Bolanle	19	35	26	38	26	21	15	16	27	28	30	29	**310**
Dipeolu	14	16	21	15	17	19	16	21	24	39	32	25	**259**
Adegbeyemi	22	21	36	20	13	15	18	16	21	18	36	43	**279**
Total	**1479**	**4253**	**4551**	**2167**	**2106**	**3297**	**1411**	**1503**	**1790**	**4550**	**5959**	**3741**	**44807**
Street Names	**LINITY AREA – ZONE 14**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Obafemi Awolowo	1213	2010	1870	2070	2311	1467	1234	2641	3123	3142	3143	2113	**26337**
Oriyomi	146	703	368	1113	836	874	649	136	1123	2143	2143	1102	**11336**
Kodesoh	1050	1241	1331	800	712	862	463	481	1213	2867	3112	2162	**16294**
Ilo	15	21	13	12	14	21	12	10	21	31	23	16	**209**
Olowu	146	513	486	236	321	141	123	421	623	1123	2131	324	**6588**
Adesina	21	36	22	43	46	51	20	15	18	35	46	53	**406**
Falola	15	10	22	25	30	16	10	25	27	38	42	36	**296**
Orishe	136	346	260	155	140	136	140	140	147	355	343	158	**2456**
Linity	148	181	112	96	131	142	166	147	158	202	314	423	**2220**
Ezekiel	45	52	64	50	61	76	82	55	84	80	86	96	**831**
Yinusa Adeni	20	31	34	40	46	50	55	43	45	56	41	52	**513**
Mojidi	23	37	38	40	48	50	55	40	42	50	43	46	**512**
Funmilola Okikiolu	55	46	67	54	53	41	43	57	58	62	46	58	**640**
Adeleye	24	43	46	56	42	32	36	56	48	40	48	49	**520**

Alh. Tokunbo	20	27	38	40	48	50	61	40	41	42	51	31	**489**
Toyin	184	142	124	206	247	213	104	124	111	312	247	219	**2233**
Amope	15	25	25	40	45	25	20	25	35	80	26	71	**432**
John Olugbon	20	30	35	31	38	43	50	33	38	41	44	51	**454**
Oluyide	16	12	21	20	31	28	10	12	23	15	26	28	**242**
Owodunni	26	43	48	34	36	25	21	40	33	58	63	56	**483**
Adenubi	15	12	21	26	31	18	10	14	25	46	38	48	**304**
Majekodunmi	25	43	22	16	19	10	09	08	24	36	48	32	**292**
Emina	10	25	15	16	18	10	21	09	15	12	23	28	**202**
Allen	128	1214	2136	324	365	429	123	106	246	1471	1234	268	**8044**
Oladipupo Kuku	36	44	55	43	31	48	36	32	21	31	28	43	**448**
Wemi Akinsola	28	36	42	37	22	42	29	28	16	33	21	55	**389**
Ladipupo Kasiumu	20	28	32	28	18	54	26	33	24	42	36	46	**387**
Ogun	33	46	50	41	43	46	23	24	19	48	29	58	**460**
Morenikeji	27	38	41	52	32	49	26	18	22	37	20	47	**409**
Bisi Ogabi	27	20	25	20	12	29	19	16	23	28	46	37	**302**
Oluwaleyimi	36	29	22	20	24	30	21	26	30	26	48	42	**354**
Bayode Oluwole	23	22	37	21	14	16	19	17	22	19	39	40	**289**
Atinuke Olabamiji	25	20	24	26	32	27	20	74	30	43	36	44	**401**
Akintoye Sogunle	28	24	20	23	18	21	10	18	28	39	56	21	**306**
Baloogun	26	18	14	21	21	17	12	11	17	44	28	47	**276**
Ipodo	346	1621	1781	1976	1362	1113	968	824	1034	1672	1891	578	**15166**
Total	**4171**	**8789**	**9361**	**7851**	**7298**	**6302**	**4726**	**5799**	**8607**	**14399**	**15639**	**8578**	**101520**

Street Names	**ALABI AREA – ZONE 15**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Kodesoh	1050	1214	1321	800	712	862	463	481	1213	2867	3112	2162	**16257**
Tonade	27	35	40	42	22	39	16	18	22	27	40	27	**355**
Ipodo	346	1621	1781	1976	1362	1113	968	824	1034	1672	1891	578	**15166**
Olowu	146	513	486	236	321	141	123	421	623	1123	2131	324	**6588**

Oladosu	23	30	40	31	23	34	18	22	31	43	28	37	**360**
Unity	148	181	112	96	131	142	166	147	158	202	213	423	**2119**
Ola Ayinde	64	162	134	87	106	172	87	134	178	192	127	148	**1591**
Alabi	54	68	82	45	55	36	33	21	102	100	148	116	**860**
Moshood Abiola	25	88	43	24	48	62	23	36	38	46	74	58	**565**
Mobolaji Bank Anthony	23	26	25	32	28	22	13	10	21	36	39	28	**303**
Ilori Moses	25	46	55	64	40	38	20	16	19	46	40	50	**459**
Christland	24	36	42	25	43	52	23	18	23	48	33	49	**416**
Adedeji	22	43	40	30	35	28	18	18	20	38	55	38	**385**
Adesina	20	36	42	25	33	29	21	19	21	20	46	40	**352**
Adebanjo	23	39	45	36	29	32	19	20	24	35	62	42	**406**
Adeyeri	25	42	52	28	31	28	20	22	35	20	35	56	**394**
Shogunle	15	25	38	30	28	33	22	18	29	19	39	58	**354**
Oredugba	18	28	44	29	32	43	21	19	35	20	44	56	**389**
Olaniyan	28	35	57	32	25	38	20	21	40	18	46	41	**401**
Opebi	86	236	210	87	126	62	63	53	264	382	321	268	**2158**
Opebi link	66	126	102	60	101	68	46	55	214	361	378	136	**1713**
Toyin	184	424	124	206	247	213	104	124	111	312	247	219	**2515**
Total	**2442**	**5054**	**4915**	**4021**	**3578**	**3287**	**2307**	**2517**	**4255**	**7627**	**9149**	**4954**	**54106**

Street Names	**COMMUNITY AREA ZONE 16**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Ajayi	125	255	102	86	36	121	36	48	76	88	245	106	**1324**
Allen lane	25	46	36	48	22	54	21	18	17	43	56	59	**445**
Allen Ave	128	1214	2136	324	365	429	123	106	246	1471	1234	268	**8044**
Community	25	36	26	24	20	31	20	21	43	54	42	26	**368**
Bola Ajibola	28	28	32	30	24	28	18	22	26	48	38	21	**343**
Ondo	32	43	28	36	28	36	16	31	54	42	34	20	**400**
Bamishile	30	50	24	38	31	42	21	21	46	39	30	21	**393**
Tiwalode	38	46	33	42	34	43	32	18	50	40	28	27	**431**
Adefolu	27	38	28	37	29	37	28	19	39	32	25	20	**359**
Agbarebo	33	28	24	21	11	30	21	12	41	25	14	18	**278**
Oyediran	26	32	28	33	14	35	19	21	38	27	22	15	**310**

Anuoluwapo	29	42	31	24	17	44	32	20	40	31	23	17	**350**
Regina Omolara	20	35	21	20	19	32	70	15	18	25	33	26	**334**
Tolawewo	21	46	37	47	21	56	15	21	16	32	48	37	**397**
Total	**587**	**1939**	**2586**	**810**	**671**	**1018**	**472**	**393**	**750**	**1997**	**1872**	**681**	**13776**
Street Names	**ACME AREA – ZONE 17**												**Total**
	7am – 8am	8am – 9am	9am-10am	10am-11am	11am-12pm	12pm-1pm	1pm-2pm	2pm-3pm	3pm-4pm	4pm-5pm	5pm-6pm	6pm - 7pm	
Ogba	246	456	231	121	127	148	76	54	38	213	543	217	**2470**
Ijaye	28	54	42	33	28	48	27	20	11	54	48	40	**433**
Damson	15	25	36	16	18	28	11	15	17	28	35	23	**267**
Alh. Umar Sanni	18	21	10	11	17	23	19	10	12	43	38	42	**264**
Pivot Co Ltd	15	22	11	15	21	43	11	21	10	32	26	27	**254**
Cocoa Industrial	15	45	36	28	43	54	18	10	12	37	48	54	**400**
Wemco	45	68	84	113	78	136	48	36	24	178	204	172	**1186**
Ladipupo Oluwole	175	213	341	36	45	89	61	47	121	186	249	107	**1670**
Israel Adebanjo	20	35	21	10	9	12	15	11	10	21	15	32	**211**
Vanni Close	15	55	48	35	21	65	18	11	28	43	56	43	**438**
Surulere Industrial	128	436	238	121	211	315	87	66	52	126	345	316	**2441**
Akin Lalcome	18	28	35	21	10	21	22	15	17	18	20	11	**236**
Olutoye	18	23	15	26	10	18	10	11	13	15	20	21	**200**
Talabi	21	32	26	38	28	32	18	15	15	25	35	43	**328**
Guinness	15	37	26	18	29	36	48	54	10	56	48	59	**436**
Lateef Jakande	145	356	132	102	131	143	82	46	54	86	264	207	**1748**
Meta box	128	346	215	102	87	178	38	43	52	214	306	186	**1895**
Akilo	43	58	43	35	46	68	43	40	32	84	235	578	**1305**
ACME	126	2133	624	563	1146	1612	106	178	214	1132	2416	178	**10428**
Total	**1234**	**4443**	**2214**	**1444**	**2105**	**3069**	**758**	**703**	**742**	**2591**	**4951**	**2356**	**26610**

Source: Field Survey, 2009.

APPENDIX IV: Household Heads and On-Street Persons Walking Distances to Bus Stations in the Study Area.

Zones	*0m- 100m*		*100m-200m*		*200m-300m*		*300m-400m*		*400m-500m*	
	Hshld	**Onsp**	**Hshld**	**Onsp**	**Hshld**	**Onsp**	**Hshld**	**Onsp**	**Hshld**	**Onsp**
Z_1	7	0	16	2	39	2	6	11	11	1
Z_2	10	2	8	0	22	2	5	5	4	2
Z_3	6	1	16	1	33	4	4	9	10	11
Z_4	19	3	21	2	28	2	8	11	9	2
Z_5	15	1	4	1	22	2	5	5	6	2
Z_6	32	1	14	1	8	2	2	6	2	4
Z_7	21	0	8	1	4	1	4	2	4	5
Z_8	26	1	6	1	3	1	2	4	3	3
Z_9	2	0	10	1	24	1	4	5	6	2
Z_{10}	4	1	10	0	9	1	3	2	3	2
Z_{11}	8	0	8	1	27	2	8	2	4	5

Z_{12}	15	1	30	1	12	1	8	3	6	9
Z_{13}	11	2	28	2	10	3	4	4	12	7
Z_{14}	19	1	27	1	6	2	6	5	8	9
Z_{15}	8	1	27	1	5	1	8	3	4	8
Z_{16}	16	1	25	1	9	1	6	2	5	8
Z_{17}	28	1	11	1	1	3	6	3	5	6

Source: Field Survey, 2009.

APPENDIX V: Households Heads and On-Street Persons Walking Distances to Landuse Activities in the Study Area.

Zones	*(0 – 1)km*		*(1 – 2)km*		*(2 – 3)km*		*(3 – 4)km*		*(4 – 5)km*	
	Hshld	**Onsp**	**Hshld**	**Onsp**	**Hshld**	**Onsp**	**Hshld**	**Onsp**	**Hshld**	**Onsp**
Z_1	25	7	20	2	7	6	6	11	3	4
Z_2	22	2	18	0	5	2	1	5	4	1
Z_3	36	1	26	1	6	4	4	6	10	1
Z_4	22	2	21	2	9	6	8	11	11	2
Z_5	30	1	9	3	3	2	2	5	6	2
Z_6	32	2	9	1	8	1	4	5	6	0
Z_7	20	1	8	3	4	1	4	5	4	1
Z_8	25	2	6	1	3	1	4	5	3	1
Z_9	23	9	13	1	2	2	1	5	6	2
Z_{10}	10	2	10	0	3	2	3	2	4	2
Z_{11}	15	1	14	0	0	2	0	5	5	2
Z_{12}	36	2	15	1	8	1	6	3	12	3

Z_{13}	26	1	11	3	10	4	4	2	7	4
Z_{14}	32	0	19	1	6	2	6	4	12	2
Z_{15}	33	0	8	0	5	2	8	2	4	2
Z_{16}	31	0	16	1	9	1	6	3	5	2
Z_{17}	28	1	18	1	8	3	6	8	10	4

Source: Field Survey, 2009.

APPENDIX VI: Regression Analysis Results of the Relationship between Household Heads and On-street Persons Pedestrian Trips Generated.

Variables	*Variables Acronym*	*Regression Coefficients*	*Standard Error*	*t-values*
Work	**WORK**	0.353	0.101	10.125
Religion	**RELI**	0.320	0.161	8.415
Business	**BNES**	0.074	0.165	2.627
Schooling	**SCHL**	-0.038	0.276	-0.758
Shopping	**SHOP**	0.258	0.146	7.138
Social Function	**SOFU**	-0.004	0.449	-0.221
Visiting Friend	**VIST**	0.076	2.324	1.843
Exercising	**EXER**	0.082	1.172	2.432
Industries	**NINDU**	0.061	0.166	2.726
Hotels and Restaurants	**NHRES**	0.034	0.313	1.103
Financial Institution	**NFINI**	-0.171	0.500	-3.223
Shopping Mall	**NSHPM**	0.047	1.836	1.577
Fast Food Points	**NFAST**	0.288	1.241	3.816
Accessibility	**ACCESS**	-0.010	0.081	-0.435
Constant		0.735	6.512	0.113
N		1,182		

Source: Field Survey, 2009

APPENDIX VII: Software Procedure of CGI Analytical Hierarchical Process (AHP)

Procedure	*Results*
Input	**Size of pairwise comparison matrix**
Input	**The values of pairwise comparison matrix**
Display	**Weight (Eigen vector), Eigen value, and Consistency Index**
Output	**Text file**

Source: takahagi@isc_senshu-u.ac.jp

APPENDIX VIII: Road segment number, level of service, pedestrian volume, lateral separation, motor vehicle volume, speed of motor vehicle and driveway access volume.

Road Segment Number	*Level Of Service*	*Pedestrian Volume*	*Lateral Separation (Feet)*	*Motor Vehicle Volume*	*Speed of Motor Vehicle (Km^{-1})*	*Driveway Access Volume*
1	4	25	28.245	34	45	2
2	4	30	28.245	41	56	1
3	1	65	12.705	7	35	0
4	1	48	12.705	8	46	2
5	2	30	26.69	10	10	1
6	2	26	26.69	18	12	0
7	1	56	13.913	6	10	0
8	1	48	13.913	8	10	0
9	1	27	12.443	10	25	0
10	1	69	12.443	5	26	1
11	1	44	8.138	7	10	1
12	1	48	5.915	6	30	2
13	1	39	10.08	8	35	3
14	1	26	16.555	14	28	0
15	1	44	12.548	7	36	0
16	1	56	17.29	8	34	3
17	1	35	11.9	12	38	2
18	1	28	13.615	11	18	0
19	1	36	14.998	13	36	4
20	1	54	8.138	6	38	2
21	1	48	5.915	9	40	1
22	1	36	10.08	8	42	0
23	1	34	16.555	10	30	0
24	1	29	12.548	18	35	0
25	1	35	17.29	14	10	0
26	1	26	11.9	11	20	0
27	1	27	13.615	10	30	3
28	1	32	14.988	12	20	2
29	2	23	22.19	18	31	4
30	2	27	12.233	11	10	0
31	2	31	22.19	10	26	0
32	2	57	14.998	6	15	1
33	1	23	12.233	14	10	2
34	1	43	13.913	8	30	0
35	1	14	10.08	15	26	0
36	1	22	5.915	7	10	3
37	1	15	10.08	10	30	1
38	1	36	13.913	8	24	1
39	4	18	53.305	56	45	0
40	2	11	35.63	34	41	1
41	2	26	25.655	28	32	0
42	2	21	35.613	41	35	1
43	2	16	25.655	18	31	0

44	4	36	53.305	42	56	1
45	1	21	14.998	10	10	2
46	1	38	11.9	9	16	3
47	1	29	12.233	10	30	2
48	1	32	13.913	18	20	2
49	1	23	5.915	10	12	0
50	1	26	10.08	24	15	0
51	1	16	12.705	24	35	0
52	1	8	12.443	31	31	1
53	1	21	12.548	26	26	2
54	1	11	11.9	11	40	3
55	1	9	12.705	18	45	4
56	1	18	12.443	30	28	2

Source: Field Survey, 2009.

APPENDIX IX: Logarithm of pedestrian volume, lateral separation, motor vehicle Volume, speed of motor vehicle and driveway access volume.

Road Segment Number	*Level Of Service*	*Pedestrian Volume*	*Lateral Separation*	*Motor Vehicle Volume*	*Speed of Motor Vehicle*	*Driveway Access Volume*
1	4	1.39794	1.450942	1.531479	1.653213	0.30103
2	4	1.477121	1.450942	1.612784	1.748188	0.00000
3	1	1.812913	1.103975	0.845098	1.544068	0.00000
4	1	1.681241	1.103975	0.90309	1.662758	0.30103
5	2	1.477121	1.426349	1.000000	1.000000	0.00000
6	2	1.414973	1.426349	1.255273	1.079181	0.00000
7	1	1.748188	1.143421	0.69897	1.000000	0.00000
8	1	1.681241	1.143421	0.90309	1.000000	0.00000
9	1	1.431364	1.094925	1.000000	1.39794	0.00000
10	1	1.838849	1.094925	0.69897	1.414973	0.00000
11	1	1.643453	0.910518	0.845098	1.000000	0.00000
12	1	1.681241	0.771955	0.778151	1.477121	0.30103
13	1	1.591065	1.003461	0.90309	1.544068	0.477121
14	1	1.414973	1.218929	1.146128	1.447158	0.00000
15	1	1.643453	1.098575	0.845098	1.556303	0.00000
16	1	1.748188	1.237795	0.90309	1.531479	0.477121
17	1	1.544068	1.075547	1.079181	1.579784	0.30103
18	1	1.447158	1.134018	1.041393	1.255273	0.00000
19	1	1.556303	1.176033	1.113943	1.556303	0.60206
20	1	1.732394	0.910518	0.778151	1.579784	0.30103
21	1	1.681241	0.771955	0.954243	1.60206	0.00000
22	1	1.556303	1.003461	0.90309	1.623249	0.00000
23	1	1.531479	1.218929	1.000000	1.477121	0.00000
24	1	1.462398	1.098575	1.255273	1.544068	0.00000
25	1	1.544068	1.237795	1.146128	1.000000	0.00000
26	1	1.414973	1.075547	1.041393	1.30103	0.00000
27	1	1.431364	1.134018	1.000000	1.477121	0.477121
28	1	1.50515	1.175744	1.079181	1.30103	0.30103

29	2	1.361728	1.346157	1.255273	1.491362	0.60206
30	2	1.431364	1.091069	1.041393	1.000000	0.00000
31	2	1.491362	1.346157	1.000000	1.414973	0.00000
32	2	1.755875	1.175744	0.778151	1.176091	0.00000
33	1	1.361728	1.091069	1.146128	1.000000	0.30103
34	1	1.633468	1.143421	0.90309	1.477121	0.00000
35	1	1.146128	1.003461	1.176091	1.414973	0.00000
36	1	1.342423	0.771955	0.845098	1.000000	0.477121
37	1	1.176091	1.003461	1.000000	1.477121	0.00000
38	1	1.556303	1.143421	0.90309	1.380211	0.00000
39	4	1.255273	1.726768	1.748188	1.653213	0.00000
40	2	1.041393	1.551816	1.531479	1.612784	0.00000
41	2	1.414973	1.409172	1.447158	1.50515	0.00000
42	2	1.322219	1.551596	1.612784	1.544068	0.00000
43	2	1.20412	1.409172	1.255273	1.491362	0.00000
44	4	1.556303	1.726768	1.623249	1.748188	0.00000
45	1	1.322219	1.175946	1	1	0.30103
46	1	1.579784	1.075547	0.954243	1.20412	0.477121
47	1	1.462398	1.087533	1	1.477121	0.30103
48	1	1.50515	1.143421	1.255273	1.30103	0.30103
49	1	1.361728	0.700271	1	1.079181	0.00000
50	1	1.414973	1.003461	1.380211	1.176091	0.00000
51	1	1.20412	1.103975	1.380211	1.544068	0.00000
52	1	0.90309	1.094925	1.491362	1.491362	0.00000
53	1	1.322219	1.098575	1.414973	1.414973	0.30103
54	1	1.041393	1.075547	1.041393	1.60206	0.477121
55	1	0.954243	1.103975	1.255273	1.653213	0.60206
56	1	1.255273	1.094925	1.477121	1.447158	0.30103

Source: Field Survey, 2009.