

**INTRA - MODAL COMPETITION IN URBAN
PARA- TRANSIT SYSTEMS:
CASE STUDY OF AKURE METROPOLIS**

BY

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(CVE/95/7050)



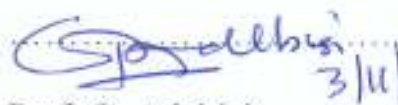
**A THESIS IN THE DEPARTMENT OF CIVIL ENGINEERING
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CERTIFICATION

This thesis entitled “Intra-modal Competition in Urban Para-Transit System: Case Study of Akure Metropolis” by Adebayo Oladipo Owolabi meets the regulation governing the award of the Degree of Doctor of Philosophy PhD in Civil Engineering of the Federal University of Technology, Akure and is approved for its contribution to knowledge and literary presentation.

 3/11/2004

Prof. O. Adebisi

Major supervisor



DEDICATION

This thesis is dedicated to God Almighty, the Author and Finisher (Perfector) of Engineering and Philosophy, and to the following people:

My wife who created a conducive home environment to make this research possible.

My sons; Bayode Emmanuel, John Korede and David Oladotun for putting melodies into my life through their love and behaviour.

My General Overseer, Evangelist Wale Adeleye whose encouragement and outstanding leadership qualities have positively influenced every aspect of my life.

To all who don't have anyone to help them but God.



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ABSTRACT

This study elucidates on intra-modal competition in urban Para transit system as it affects Akure metropolis. Against the background of the land use areas, transport systems and facilities, and operational characteristic of Para-transit mode, modal split trends were studied. Intra-city travel behavior survey was also conducted.

The study area was classified into nine zones (according to land use configuration) to facilitate collection of data and their summary. Data on Intra-city travel characteristics were collected through intensive home interview supported by road side interview, rider-ship surveys, general observations and other standard information gathering techniques. Home interviews were conducted using a comprehensive questionnaire covering socio-economic, travel behaviour and level of service features. A simple size of 1 in 10 dwelling units was used in accordance with the recommendation of Bureau of Public Roads.

Traffic survey was also conducted using manual counting for one week during morning, afternoon and evening peak periods to determine the characteristics of traffic volume on major roads within Akure metropolis. The overall transport environment of the study area was assessed through the inventory of existing transportation facilities. The analyses of data were done with the aid of computer software such as SPSS and MS-Excel.



Volumes of Inter-zonal trip exchanges were estimated and the distributions explained. Modal split trends among the Para-transit modes were used to calibrate standard modal split models (Behavioural Models). The analyses of the modal split trends via the Behavioural Models indicate clearly that both the taxi mode and the motorcycle mode have major inherent advantages especially over the bus mode. These in the author's view could be indices of availability of the modes. The analyses further indicate that long journeys and long waiting time favour the motorcycle mode. Long walking time favour the taxi mode over other modes while short waiting time favour the motorcycle mode. High travel cost favours the motorcycle mode over other modes while low travel cost favours the bus mode.

The results and observations of the transit operations within Akure metropolis show that the various modes compete rather than complement one another. This is obviously not to the advantage of the patrons. Besides the limitation due to service characteristics and factors due to inadequacies of operators, institutional issues and environmental factors also combine to accentuate the problems faced by public transport patrons in Akure metropolis.

Based on results obtained, an integrated Para-transit scheme for transit service in the study area was proposed and may be extended to similar cities in Nigeria.

CHAPTER ONE

INTRODUCTION

1.1 PREAMBLE

The history of man is invariably tied to the history of movement. Prior to the development of railroads and automobiles, nearly all cities were located at the waters edge where water transportation provided access abroad and along rivers to the hinterlands. Even today most major cities are port cities while development of rail and highways has also permitted large cities to be located away from water access.

Adams (1981), asserted that transportation is essential to social progress; in fact he said transportation itself is social progress because it has been, throughout history, the way in which not only goods and services but ideas as well are exchanged among people.

Ogunsanya, (1997), affirms that "Transportation becomes a critical factor in regional growth since it determines the extent to which an area can capitalize on its economic endowments and that although the process of spacial economic development of any country is a complex one involving several variables, transport stands out as a catalyst in the process of change in its development. It's role in agriculture, industry, commerce, health, education among others are recognizable".

However, one of the major urban problems confronting Nigeria is the transportation problem. The problem is multifaceted and tends to grow in magnitude on a daily basis. The demand for travel or interaction far outstrips

the facilities available to make interaction easy. Most roads are in a state of disrepair, the proportion of those who do not own cars to those who own them is very large while the public transport system is inefficient and not well developed.

In recent years, it has been proved that the solution to urban transport problems, especially intra-urban mobility, lies on a rational and comprehensive study and planning of the urban transport system. This is usually with a view to understanding and determining the pattern of spatial interaction within the city and making recommendations and suggestions on how the traffic problems could be ameliorated.

Generally, spatial interaction studies/analysis in the city involves an examination of some of the determinants of the propensity to generate trips at the household, firm or individual level and also the capacity of the various land uses to generate and attract trips (Ayeni, 1979). The household level of trip making is related to certain internal characteristics of the household. These characteristics include such variables as household income, the structure of the family unit, the size of the family unit, the number of employed persons in the family unit, car ownership, etc. This particular study is aimed at providing rational bases for urban transportation planning by studying the patterns of intra-modal competition within the para-transit mode of travel. Para-transit modes are privately operated assorted forms of public transport offering small scale services. Among these are shared taxi, buses, motorcycles, etc.

1.2 DESCRIPTION OF STUDY AREA

Akure metropolis, used as the study site, is the capital city of Ondo State, Nigeria.

Ondo state was one of the states created in 1976 and it shares boundaries with Ekiti and Kogi states in the north, Edo state in the east, Delta state and the Atlantic Ocean in the south, Osun state in the west and Ogun state in the south-west. (Fig.1& Fig. 2)

Akure is located in the northern part of Ondo state around latitude $7^{\circ}15'$ and longitude $5^{\circ}15'$ East (Fig. 3). It has an area of approximately 30.02 square kilometers. The Population of Akure was estimated at 239124 people according to the 1991 census. This consisted of 118,902 (49.75%) male and 120,162(50.25%) female. The population is assumed to be growing at a rate of 3.5 percent per annum (Okoko, 2002). This growth rate is tied to the administrative role of the city and its long-standing status as center of economic activities, which have attracted a large spectrum of immigrants into it. Majority of inhabitants of Akure are civil servants, self employed business men and women, traders and peasant farmers.

The climate of Akure has two distinct seasons, the rainy season between April and October, and the dry season between November and March. The temperature throughout the year ranges between 21°C and 29°C except when it is extreme. Humidity is relatively high ranging between 50 and 90 percent depending on the season, while the total annual rainfall ranges between 150mm and 200mm. Akure is located in the forest zone with abundant forest resources

like timber and she is endowed with a major river called "Ala" which passes through about 50 percent of the township length (Fig. 4).

1.2.1 LAND USE ACTIVITIES IN AKURE METROPOLIS

Akure residential land use can be grouped into four broad groups namely, core areas, planned neighbourhoods, Federal Government (low cost) housing estates, and Government Reservation Area (fig. 5a & 5b). The core areas include Oja Oba and its environ; planned neighborhoods include Oshinle quarters, Aiyedun quarters, etc; Federal Government low cost housing estate occupies the area presently referred to as Shagari Village; and Government reservation area include Alagbaka quarters and Ijapo estate. The buildings in the core areas are mostly bungalows or one storey with slopped corrugated metal roofs built very closely together and are used for commercial activities on the ground floor and for residential purpose on the upper floor.

Commercial activities in Akure are mostly concentrated along Oba Adesida road, Ondo road, Arakale Street and streets surrounding Deji's palace compound (Fig. 4).

Some successful small and medium scale industries can be found in Akure. These include sawmills, concrete and block making, welding, printing, furniture, machine tools workshops, feed mills, etc.

Educational centres and facilities include primary, secondary and vocational schools. The higher institutions, Federal College of Agriculture and

Federal University of Technology are fast expanding and are located at the outskirts of the town along old Owo and Ilesha roads (Fig. 5b).

Akure, being the state capital, accommodates the Federal secretariat and other offices in the state, Government House grounds and state secretariat as well as government offices. The Deji's (Oba's) palace is located within the commercial core-area and serves as a main attraction.

Health institutions in the metropolis include the State Specialist Hospital, Private Hospitals and clinics, Maternity and primary health centres and dispensaries.

1.2.2 TRANSPORTATION SYSTEM IN AKURE

Road transportation is the most predominant form of transport in Akure metropolis (and it accounts for about 98 percent of all travels in the town).

The city of Akure was not planned ab-initio and as a result of this, there is minimal functional relationship between the various land uses. This disaggregated location of land use coupled with the morphological linearity of the town, its poorly developed road network and inefficient traffic management techniques often create a chaotic traffic pattern which is always noticeable at Oba Adesida and Arakale roads (Fig. 4) during the morning and evening peak periods.

Almost all the roads in the study area are affected by flooding during the rainy season. This is due to lack of proper (inadequate) drains and culverts and where they do exist they are blocked by refuse dumps. All the major roads in

the metropolis are constructed with asphalt concrete. Generally most of the roads have little or no room for expansion especially in the core area where the houses reach the drains.

The problems of urban transportation in Akure metropolis range from gross inadequacies of public transport facilities relative to demand, lack of capital for new fleet acquisition, poor road infrastructure, road congestion due to over population of road by both human and vehicles as well as indiscipline exhibited by road users.

Like other urban settlements in Nigeria, the modes of transport on Akure roads include passenger cars, buses, motorcycles, etc. Due to reasons to be explained later, not all routes are plied by all the modes of transport available. Some routes are plied mainly by passenger cars, others by buses while others are plied mainly by motor cycles! Related to conventional classifications, Akure is served by assorted forms of public transport, which are largely of the Para-transit variety. Among these are shared taxi, buses, motorcycles, etc.

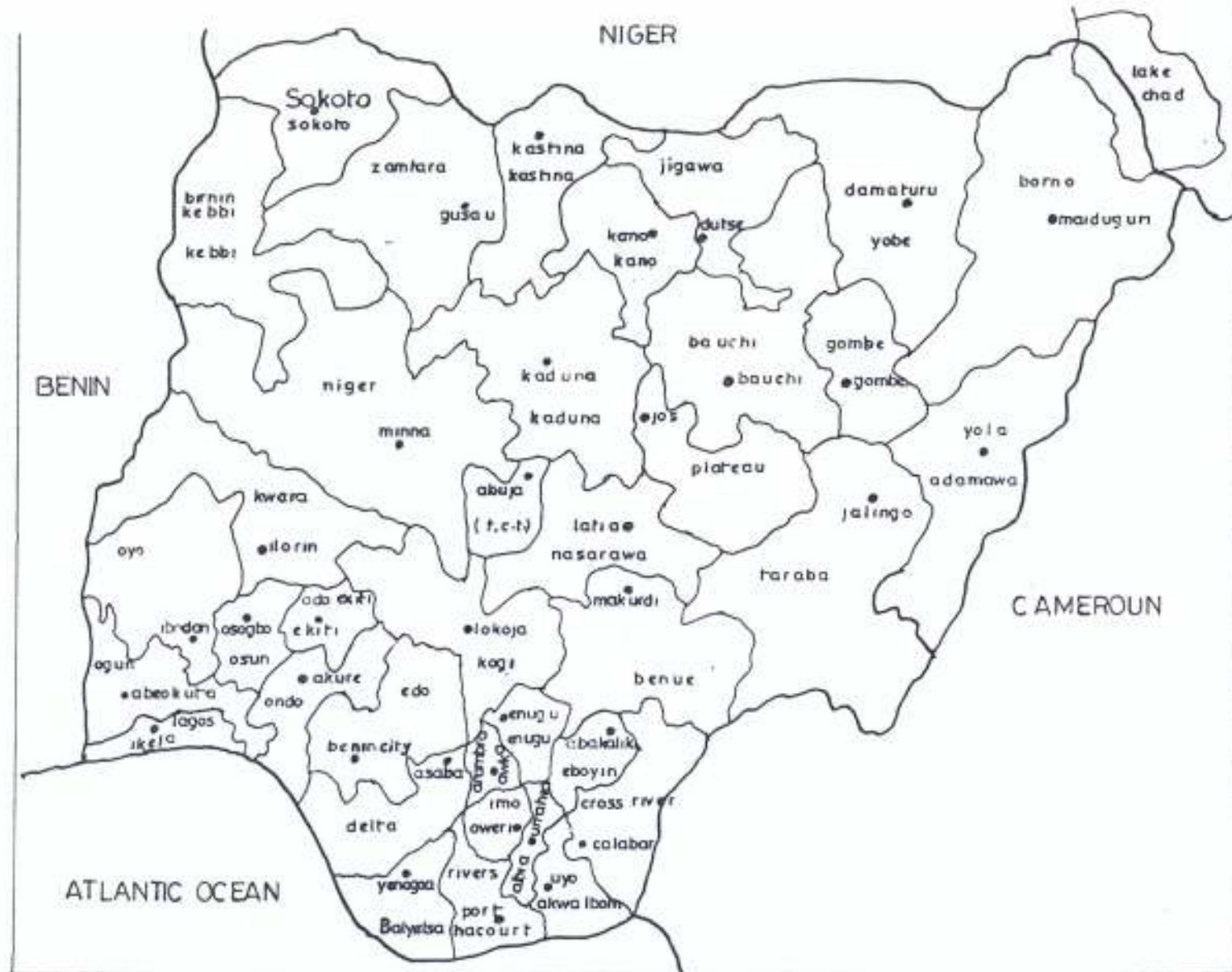


FIG. 1 — MAP OF NIGERIA SHOWING THE STATES AND FEDERAL CAPITAL TERRITORY

SOURCE — ONDO STATE MINISTRY OF NIGERIA



FIG.3.÷— MAP OF NIGERIA SHOWING ONDO STATE WITH THE LONGITUDES AND LATITUDES

SOURCE ÷— ONDO STATE MINISTRY OF WORKS, LAND AND SURVEY DEPT

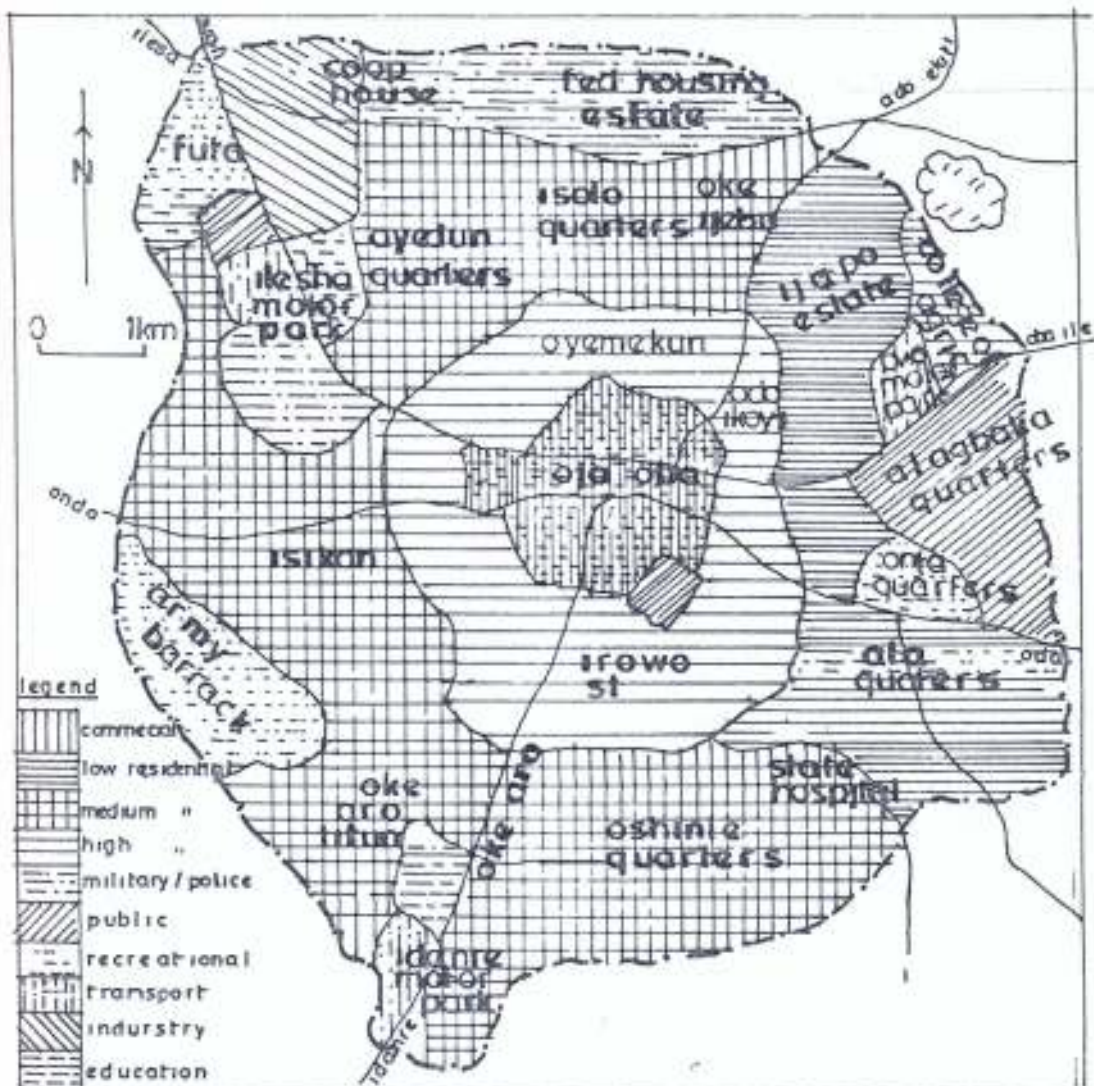
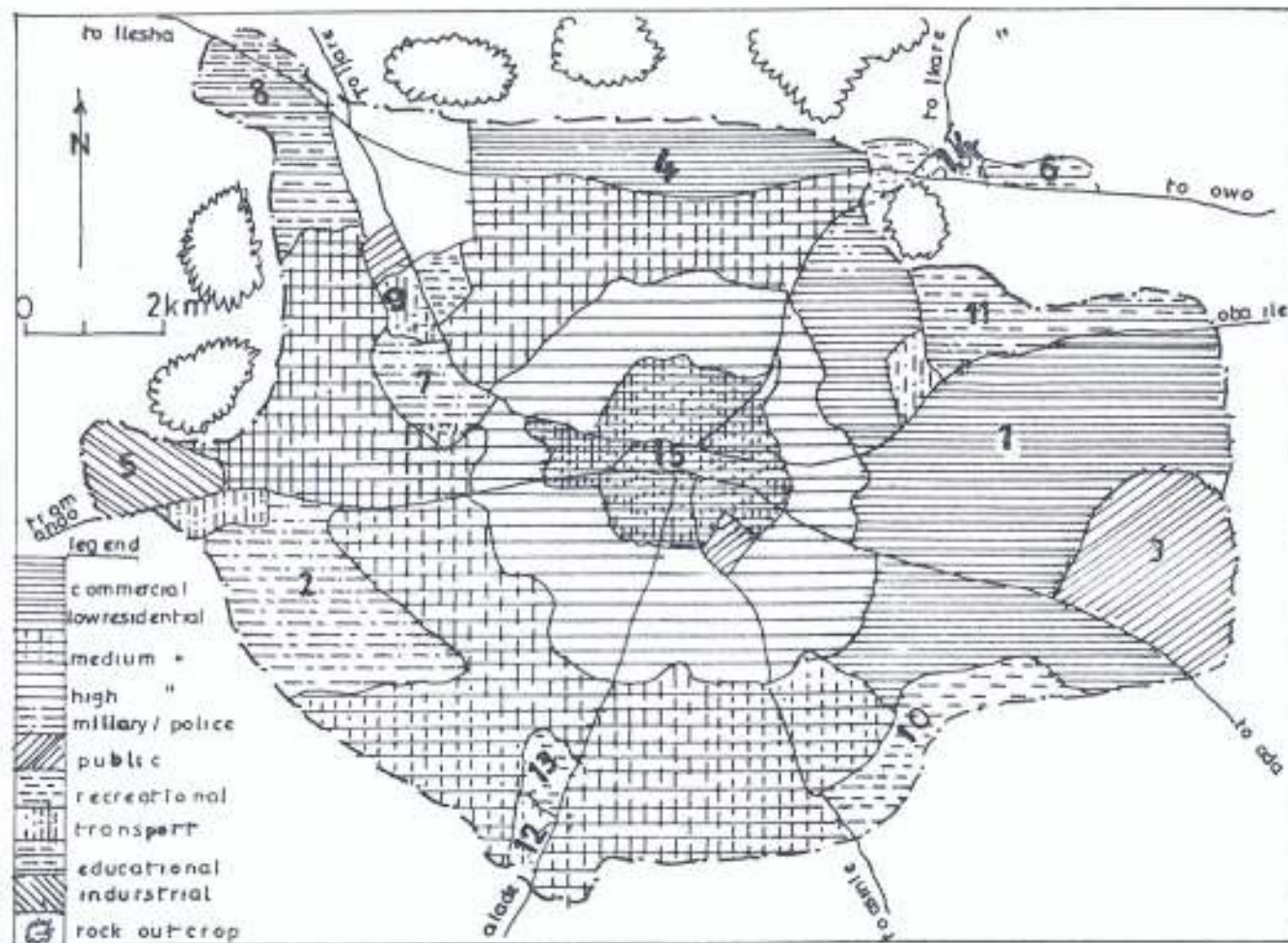


FIG. 5a:— LAND USE MAP OF AKURE, 1986

SOURCE :— ONDO STATE MINISTRY OF WORKS, LANDS AND SURVEY D



KEY

- 1.—OBA ILE HOUSING ESTATE
- 2.—NIGERIAN ARMY BASE
- 3.—FED. GOVT. SECRETARIATS
- 4.—SHAGARI HOUSING ESTATE
- 5.—AFRI COLA & SAWMILLS
- 6.—FUTA GUEST HOUSE
- 7.—MOTOR TRAFIC DEPT.
(former police headquarters)
- 8.—F. U. T. A.
- 9.—LAGOS, IBADAN, ILORIN, MOTOR PACK
- 10.—OWENA MOTELS
- 11.—FED. COLLEGE OF AGRIC.
- 12.—IDANRE MOTOR PARKS
- 13.—CONTINUOUS EDU. CENTRE
- 14.—IKARE, BENIN, ONITSHA, MOTOR PARK
- 15.—OJA OBA

FIG. 5b — MAJOR LAND USE MAP OF AKURE, 1996

SOURCE — ONDO STATE MINISTRY OF WORKS, LAND AND SURVEY DEPT.

1.3 AIMS, OBJECTIVES AND SCOPE OF STUDY

The major thrusts of this work are to first study the environment of the transportation system and characterize the network, its relationship with its environment generally but with specific focus on the intra-modal competition within the para-transit mode. Thus, The objectives of this study are to:

- a) Assess the relationship between land use and traffic generation in Akure metropolis.
- b) Assess the transportation systems and facilities in Akure metropolis.
- c) Characterize the traffic volume on the major roads within Akure metropolis in order to establish the predominant modes of transport and traffic desire lines.
- d) Determine the modal split among the major modes of travel, the intra-modal competition as well as the service quality of each para-transit mode.
- e) Propose a scheme for transit service in the study area which may be extended to similar urban settlements in Nigeria.

1.4 JUSTIFICATION FOR THE STUDY

Researchers have documented numerous problems, which confront the transport sector in Nigerian towns (Adeniji, 1986; Adesanya, 1986; Bolade, 1993; Fasakin, 1999; Okoko, 2002;). For example, Fasakin(2000) noted, that high population growth and urbanization have created a larger pool of citizens who are continuously deprived of adequate means of public transport.

Akure metropolis, which is the study site, is faced with diverse transportation problems. The roads, other transport facilities and means of public transport are in various states of inadequacies as explained in section 1.2.2.

These inadequacies are manifest in traffic congestion and large crowd of commuters waiting for means of public transport on the major roads especially during the morning, afternoon and evening peak periods.

It has been established that about 97% of the population in Akure depend on public transport. (Owolabi, 2000). This huge demand exerts a great strain on available facilities and because of institutional and funding constraints, conventional transit systems are not presently available. Hence some unconventional para-transit public transport modes like motorcycles and private vehicles not registered as taxis known as "Kabu-kabu" came in to act as supplements. Incidentally in majority of urban centers of Nigeria, these para-transit modes serve as the only public transport modes. Thus this study is of relevance to all urban centers of Nigeria.

In an attempt to deal with the various travel problems of those who do not own or have access to private mean of transport, planners and policy makers seem to have been concerned almost exclusively with conventional public transport modes though not much successes have been achieved in this regard. (Adeniji, 1983). The Nigerian experience has been that conventional public transport systems do not survive for long because of poor management. For most cities, Akure inclusive, there is no well-organized transit system and

public transport trips are undertaken with assorted types of para-transit vehicles. Hence, any study aimed at ameliorating problems faced by commuters in Akure must take into cognizance the dominance of the para-transit modes.

Previous studies on para-transit modes mainly considered their operational characteristics. Studies compiled by Cervero (2000), gives a global overview, while Fasakin (1999) considered only commercial motorcycles in Akure metropolis. So far, there has been no in depth study on the operations of para-transit modes as a whole in Akure metropolis. Therefore, this study is directed towards understanding the nature, magnitude, pattern and implication of Intra-modal competition within the para-transit mode, as a means of ameliorating problems faced by users of the mode in Akure metropolis. It will also serve as a scientific basis for understanding the situation in similar urban settlements in Nigeria as well as enhance general system improvement.

1.5 METHODOLOGY AND DATA COLLECTION STRATEGY

The study area was classified into nine zones (according to land use configuration) namely High Residential (HR), Medium Residential (MR), Low Residential (LR), Educational (ED), Commercial (CM), Industrial (ID), Military (ML), Public (PB) and Recreational/Transport zones (TR). This is to facilitate collection of data and their summary.

Data on intra-city travel characteristics were collected through intensive home interview supported by Roadside Interviews/ Rider-ship Surveys, general observations and other standard information gathering techniques.

Home interviews were conducted using a comprehensive three part questionnaire covering socio-economic, travel behaviour and level of service features. A sample size of 1 in 10 dwelling units was used in accordance with the recommendation of Bureau of Public Roads and O'Flaherty Traffic Survey was also conducted using manual counting for one week during morning, afternoon and evening peak periods to determine the characteristics of traffic volume on major roads within Akure metropolis. The roads monitored include Oyemekun/ Oba Adesida, Arakale, Ondo, Hospital and Oke – Aro. The overall transport environment of the study area was assessed through the inventory of existing transportation facilities. The analyses of data were done with the aid of computer software such as SPSS and Ms-Excel. Volume of inter-zonal trip exchanges were estimated and the distributions explained.

Modal split trends among the para-transit modes were used to calibrate standard modal split models (Behavioral Models) on the basis of results obtained, an integrated para-transit scheme for transit service in the study area was proposed and appropriate recommendations were made towards generalizing the results for similar cities in Nigeria on a scientific basis.

CHAPTER TWO

LITERATURE REVIEW

2.1 GENERAL

In 1961, the Stanford Research Institute declared in a report titled "The Economic Co-ordination of Transport Development in Nigeria" that the economic history of Nigeria is largely the story of the opening of its vast area by various forms of transportation. This assertion, which is as true today as it was at the time it was made sums up the importance of the transport sector to the political, social and economic spheres of national life. The transport sector, being a basic service sector to all other sectors of the economy, has become the yardstick for measuring a country's level of development. (Akinrinade, 1989).

Research has shown that the factor most closely related to a city's growth is its transportation network with other cities (Palen, 1987). Within the metropolis, transportation is also critical to growth. The automobile provides mobility to the average urban dweller and allows – and even encourages – rapid settlement in previously inaccessible areas on the periphery of the central city.

With the coming of the automobile, the maximum distance workers could live from their place of employment and commute within an hour increased from 19 kilometers to perhaps 40 kilometers or so (Palen 1987).

Rapid urbanization has substantially increased the demand for urban services throughout the developing world and, in most countries, the supply of

services has not kept pace with increasing demand of transportation and other services.

Urban transport in most third world countries has been found out to be inadequate (Rondinelli and Cheema 1988). The needs of the residential, commercial and industrial sectors are not met.

Some cities do not even have a public transport system; such that privately operated cars, buses and motorcycles are the main means of travel. Considering the increasing rate of urban growth, the future requirements for urban services will also continue to increase. In small cities, the mixture of diverse land uses provides people with easy access to nearly all activities. Most people depend on public transportation services for longer trips and cabs, motorcycles, buses and bicycles for medium length trips.

According to Rondinelli and Cheema (1988), when cities grow from upwards of 250,000 and larger in population, the transport problems become more complicated, since population densities increase, the cities physically expand and the volume of movement and average trip lengths increase substantially and more efficient public transportation systems and a variety of transport modes would need to be adopted.

For all intents and purposes, a large and increasing demand for public transport exists in Nigerian cities. This huge demand exerts a great strain on available transport facilities and these being unable to cope, some unconventional para-transit transport modes like motorcycles and private

vehicles came in to act as supplements. In a majority of cases, only these para-transit modes serve as public transport modes.

Economic factors more than anything else has helped in the evolution of motorcycle as a means of public transportation as highlighted by Ogunsanya and Galatima (1993) who concluded that the adverse economic situation of the country has forced the operators into this business more than the interest of meeting the demands created by the inadequate transport facilities. On the other hand, the users are constrained to use this mode in the absence of alternatives.

Adesina (1994) noted that motorcycles ("okada") first came in trickles to Lagos metropolis and were almost insignificant but then like a swarm of locust, they came in full force and now, like an army of occupation, they have over run Lagos. The same is also true about other cities in Nigeria.

The impact of the operations of motorcycles in the urban centres were examined by Oni (1993). In a survey he conducted in some cities he discovered that the massive use of motorcycles as a public transport mode has adversely affected the entire urban traffic by creating serious traffic problems in the form of planning and policy implementation and they are very prone to serious accidents and other associated hazards.

Hathway (1985) posited that the kind of transport, which people use, is both that which they can afford and that which meets their immediate needs. Improved methods must, of course, fulfill the same requirements. He also argued that the best way of meeting these individual needs is to have access to a means of transport of suitable size, capability and cost. An individually

owned means of transport ensures control and immediate availability as and when it is needed and transport costs are not indicated by others. When transport has to be hired most needs will be met by a service, which is flexible, locally oriented and economically efficient for the carriage of small loads.

In areas where conventional motor vehicles are available they are widely used. Their suitability is dependent on the existence of a system of suitable roads but since few people own motor vehicles, the operation of commercial vehicles for hire on those routes has increased. Motor vehicles are normally made available by private operators or co-operatives or public sector transport services. Public sector transport services are often cheaper for the consumer, but use large vehicles which are not fast and tend to be operated only on a limited number of more important routes. Besides, the Nigerian experience has been that public sector transport systems do not survive for long because of mismanagement.

In an attempt to deal with the various travel problems of those who do not own or have access to private means of transport, planners and policy makers appear to have been concerned almost exclusively with conventional public modes, that is motorcars and buses though not much success has been achieved in this regard (Adeniji 1983). Hence the need to look at para-transit modes.

2.2 MODES OF URBAN PUBLIC TRANSPORTATION IN NIGERIA

Modes of urban public transportation in Nigeria include municipal buses, mini buses, taxis, motorcycles and privately owned cars known as "Kabu-kabu".

2.2.1 MUNICIPAL BUSES

This mode of transportation, unlike their counterparts in developed countries, does not have the monopoly of public transport provision in the cities where they operate in Nigeria. They have to compete with other modes for passengers and, so far, they have rather limited coverage where they exist.

In a survey of municipal bus operations in the country, (Adeniji, 1983) it was found out that perennial shortage of vehicles spare parts is a serious problem. This, coupled with the lack of regular and proper maintenance of vehicles, bad road conditions, absence of effective traffic control methods and poor driving habits in most Nigerian cities, lead to incessant vehicles breakdown and the ultimate shortening of the life span of the buses. In effect, they have virtually disappeared from the scene in nearly all cities in Nigeria.

The most popular of these buses in Lagos used to be the "Molue". The "molue" which is a bus built locally on the chassis of a truck has a passenger capacity, on the average of about 50 people-standing and sitting.

However, Akure metropolis does not enjoy this mode of transport.

2.2.2 MINI BUSES

Mini buses and taxis are, to a large extent, the prime movers of passengers in the urban centers of Nigeria. A survey of newly registered vehicles shows that there has been an upward trend in the number of mini buses in the last two decades (Adeniji 1983).

In most urban centres, these mini buses operate only along economic routes, which are largely fixed. The vehicles have capacities ranging from 10 to 22 persons.

2.2.3 TAXIS

Taxis, like mini buses operating in urban centers, are mostly owner-driver operated. Potential riders wait along the main streets of urban centres to board taxis or go to loading points where they exist. In most cases, users share their rides with other passengers while the operations are largely on fixed-routes.

Because of the down turn in the economy, taxis now carry about six passengers, two in the front with the driver and four at the back.

2.2.4 MOTORCYCLES

To a certain extent, motorcycles are now becoming a major mode of public transportation in Nigerian cities. A survey shows that about 30% of motor vehicles on Nigerian roads in urban areas are motorcycles (Adebisi, 1990). The passenger carrying capacity is one but at times up to two passengers

are carried. Presently they constitute the major travel mode along the interiors and uneconomic routes. In Akure Township, they are fast becoming a major force in the public transportation system.

The origin of motorcycles dates back to the early 70's and their operations were first noticed in the riverine areas of Rivers, Delta and Edo states due to the abundance of creeks and rivers in these areas. It was primarily used as a form of inter-rural and urban-rural transport. Also, in the early 70's there were smaller numbers of operators or unregistered motorcycles in Zaria and Kaduna.

Due to the introduction of Structural Adjustment Programme (SAP) in 1986, which brought about a lot of stringent economic measures such as the withdrawal of the subsidy on petroleum products and the adjustment of the Naira to international convertible currency, the use of motorcycles as intra-urban means of transportation became prevalent (Ogunsanya 1997).

2.3 URBAN PARA – TRANSIT SYSTEMS: A GLOBAL OVERVIEW.

The existence of Para-transit mode is not peculiar to Nigeria or the study site alone.

Plying the streets of Bangkok Sao Paulo, and other cities in developing world are fleets of small, low - performance vehicles driven by private operators that serve low – income neighborhoods.

In some places, environmental – friendly pedal – powered modes, like the pedicabs of Manila, provide lifts between markets and squatters whose

narrow alleys and walkways are impenetrable by motor vehicles. In other places, like Kingston, Jamaica, station wagons and mini-vans fiercely compete head-to-head with public buses, providing curb-to-curb delivery for a premium fare.

In increasing number of cities and towns around the world, dozens of young men on mopeds and motorcycles congregate at major intersections, offering feeder connections between mainline bus routes and nearby neighbourhoods for a reasonable fare.

These privately operated, small scale services are varying referred to as "informal transport", "para transit", "low-cost transport", "intermediate technologies" and "third-world transport". For the purpose of this study the term "para-transit" is adopted.

A simple definition of informal transport is illicit para-transit. To the naked eye, the sector consists of mini buses, micro buses, station wagons, motorcycles and tri-wheelers modes often lumped together under moniker "para transit" scaled down versions of collective ride transport that capture the full spectrum of service-price options that lies between conventional buses and single passenger taxis (Cervero, 1997).

The emergence of para transit services largely results from the fact that formal public transport services (where they exist) are rarely up to the task of satisfying escalating demands for travel. Most public (formal) transport operators exist as protected monopolies, and accordingly lack the incentive to



contain costs, operate efficiently, innovate or respond to shifting market demands.

2.3.1 ROLES AND BENEFITS OF PARA-TRANSIT SERVICES

Roles and benefits of Para-transit services include provision of mobility and employment, complementarity, efficient low cost services and market responsiveness.

These benefits are discussed below:

Provision Of Mobility and Employment

Para-transit services provide much needed and much valued mobility especially for the poor. Ninety-nine percent (99%) of households in the poorest countries of Africa do not own or have access to a private automobile (Cervero, 2000). Thus, they are entirely dependent on public transport for reaching jobs, markets, medical clinics, and other destinations.

World -wide, Para-transit services provide desperately needed employment for hundreds of thousands of unskilled young men, many who have just arrived from the countryside in hopes of improving their lives. Para-transit service is often a gateway to urban employment.

Complementarity

Para-transit services are often leaned upon by formal operators to provide feeder connections between neighbourhoods and trunk routes.

Efficient Low Cost Services

Para-transit service is resourceful and cost effective. Hard work and no frill service keep costs low. The drive to maximize earnings and frequent passenger turn over produces high patronage counts.

Market Responsiveness

Para-transit operators can easily alter schedules, routes and operating practices in response to shifting market conditions. Their inherent flexibility and sensitiveness to changing markets stand in sharp contrast to the rigidities and unresponsiveness of protected monopolies.

2.3.2 ISSUES AND CONCERNS

In spite of its roles and benefits, pressure to regulate and even eliminate the para-transit sector comes from many quarters. A central concern is that the sector is responsible for significant negative externalities, like traffic congestion, disorderly operations and unfair practices, accidents, air pollution and environmental problems. These concerns are discussed below:

Traffic Congestion.

Un-restricted market leads to excessive supplies of service providers, and in the quest to survive in the market place cut-throat competition, traffic slows to a crawl not only because there are too many vehicles but also because drivers cut each other off, stop in middle lanes to load customers and weave erratically across lanes.

Disorderly Operations and Unfair Practices

Fierce competition for customers invites chaotic and collectively damaging driving behaviour. Para-transit operators frequently head –run on formal, scheduled services, getting in front and arriving first at busy pick up points. And if demand tapers off, drivers might elect to halt services altogether.

Accidents and Public Safety

Due to hyper competition, Para-transit operators are notorious for driving aggressively and recklessly. Many are guilty of cutting off cars to pick up fares, blocking lanes to load and unload passengers, overloading, operating unsafe vehicles, ignoring red lights, and excessive cruising and hawking for customers. The widespread use of poorly maintained vehicles running on under-inflated, bald tires only increases the risk of accidents. And mixed traffic operations of highly vulnerable modes like motor cycle-taxis and pedicabs (many of which lie in the blind, spots of car-motorist) invite serious injuries and fatalities.

Air Pollution and Environmental Problems

Para – transit modes - Mini buses, motorized pedicabs, and for hire station wagons etc. are gross-emitters of air and noise pollution for a number of reasons: diesel propulsion; absence of catalytic converters; reliance on old, decrepit vehicles with under tuned engines; frequent acceleration and

deceleration in congested traffic; and the prevalence of low- stroke engines. For example Delhi's vast population of two-wheel motorcycles (1.8 million) and two – stroke engine-powered auto – rickshaws (78,000) emit more hydrocarbons and carbon monoxide per kilometer than even fully loaded buses (Badami, 1998). Dhaka auto rickshaws emit 30 times more pollutants than a normal car (Karim et al, 1998)

Cream - Skimming

Unbridled competition is also blamed for “skimming the cream” i.e. the tendency to operate only along lucrative routes leaving high – cost, unprofitable services to the formal sector. In some parts of the world, para-transit operators have lured such large numbers of customers from public buses that formal services are in serious jeopardy of collapsing. In Buenos Aires, massive losses in patronage have forced dramatic cuts in bus services along some corridors, undermining the ability to co-ordinate timetables and fare systems due to the loss in critical mass. From 1992 to 1999, franchise bus operators lost 25 percent of their patronage (representing 3 million trips per day) to private for- hire cars (called remises) and illegal Colectivo – vans (Barbero, 2000).

2.3.3 PARA – TRANSIT MARKET

Table. 1 summarizes some of the core traits of para-transit (informal transport) services relative to formal ones. Flexibility is a trademark of para-

transit services. Spatially (e.g. variable routing), temporally (e.g. variable schedules), and monetarily (e.g. variable prices). It is because of the unconventional, variable nature of para transit services that generalizations are difficult to draw. What can be said, however, is that flexibility and running a "lean " one -man business allows para-transit operators to be remarkably demand - responsive, quick to realign services to satisfy new and emerging markets.

Table 1: Contrasting Dimensions of Formal Versus Informal (Para-transit) sectors.

DIMENSION	FORMAL	INFORMAL (PARA-TRANSIT)
SUPPLY		
Service structure	Fixed Route, standardized	Variable route, Adaptive
Delivery	Line – Haul, Trunk-line	Distribution, feeder
Scheduling	Fixed time table	Market Driven, Adaptive
Reliability	Reasonably Dependable	Inconsistent
Vehicle type	Large	Small to medium
Ownership	Public and private	Private
Market perspective	Monopolist	Entrepreneurial
Labor	semi-skilled	Semi –to-non-skilled
Organization	Bureaucracy	Route Associations
DEMAND & PRICE		
Market focus	Mixed	Niche
Main Trip purposes	Work, school	Mode Access
Trip Distances	Medium to long	Short to medium
Customer Relations	Impersonal	Interpersonal
Socio – Demographics	Low to moderate income	Low income
Fare structures	Fixed, uniform	Variable, and differentiated

SOURCE:- (CERVERO, 2000)

2.3.4 THE SUPPLY SIDE: VEHICLES AND SERVICE

Para-transit modes span across most classes of mass transportation although in general the sector is made up of comparatively small passenger - carrying vehicles. **Table: 2** summaries five classes of rubber - tire, mixed - traffic vehicles, with the largest and fastest vehicles occupying the lowest class (Class I) and the smallest, slowest ones belonging to the highest class (Class V)

Classes are partly distinguished on the basis of whether vehicles are motorized (classes I through IV) or non - motorized (class V). Another distinction involves the relatedness of passengers. The larger vehicle classes (I and II) represent "collective" carriers i.e., they serve collections of unrelated individuals usually 12 or more, along fixed or semi fixed routes. Providing "shared - ride" services among either related parties or small sets of unrelated passengers (in the range of 4 to 11) heading in the same general direction are the class III micro buses, station-wagons, pick- ups, and jam-packed sedans. Class IV (motorized tri-wheel and motorcycle) and class V (non - motorized pedal - and horse - powered) carriers handle door - to- door trips for individuals or related parties of up to 3 persons (and occasionally one or two more, if small children).

In sum, lower class vehicles - I through III generally ply fixed routes and only make minor detours off of fixed paths. Accordingly, they represent "route-based" and "bus - like" services. Higher class (IV and V) services tend to be more demand - responsive, providing door-to-door services (though some

class III service operate similarly). Accordingly they tend to be more "taxi – like. Of course, some para transit modes do not neatly fit into any one category, and are hybrids. In practice, for instance, many minibuses tend to follow fixed routes but will make a detour at a passenger's request for an additional fare.

Table.2 Summary of Classes of Para transit Vehicles that Operate Informally.

S/No	CLASS	Service Routes	Features Schedules	Passenger capacity	Service Niche	Service Coverage
I	conventional bus	Fixed	Fixed	25-60	Line Haul	Region/Sub Region
II	mini bus/Jitney	Fixed	semi fixed	12-24	mixed	Sub-region
III	microbus/pickup	Fixed	semi fixed	4-11	Distribution	Sub-region
IV	3-wheel/motorcycle	Variable	Variable	1-4	feeder	Neighborhood
V	pedicab/Horses cart	Variable	Variable	1-6	feeder	Neighborhood

SOURCE: (CERVERO, 2000)

2.3.5 OPERATIONS

From an operational stand point, Para transit services are generally divided into those that function mainly as feeders over short distances and those that provide long or haul, main line connections. Taxi – like, small vehicles dominate the former while route based, 12- 24 seaters characterize the

latter. Even within classes however, functional roles vary. Commercial vans tend to be specialized operating mainly as peak – period commuter service. In Bangkok, for instance, vans log most of their kilometers on freeways as express services between residential suburbs and city terminuses. Their travel patterns *are few- to- one*. In contrast, mini buses tend to be all-day, non – express carriers that serve multiple origins and destinations along a corridor.

One general rule is that the smaller the vehicle, the more limited the geographic coverage. In Metro Manila for example, around 65 percent of bus trips are over 7.5 kilometers in length while an equal share of Jeepney (minibus) trips are under 5 kilometers in length (Japan International cooperation Agency, 1986). These are also sharp contrasts in rates of passenger through puts. In Jarkarta, the average number of passengers per kilometer of service is 1.5 for human – powered becaks, 4 for three – wheel bajajs, and 7 for bemo micro – vans. On a daily basis, passenger loads in Bangkok vary from 44 on hired motorcycles, 60 on silors (small Daihatsu or Suzuki pickups) 520 on mini buses, and 1300 on conventional buses (Japan International Cooperation Agency, 1990)

2.3.6 OPERATORS

The Para transit sector absorbs a considerable share of the labor surplus that beleaguers many large cities of the developing world. In many instances, the supply of the unskilled men in their twenties who are willing to drive vehicles for meager earnings far outstrips both demand and the availability of

equipment. Over supply breeds over competition, and all the negative externalities that go with it.

Most unskilled labor in the developing world is physically demanding, and the informal transport (Para transit) sector is no exception. Few jobs are as difficult and physically taxing as pedaling a three- wheeler. World wide, most pedicab drivers work 70 to 80 hours per week , rarely with a day off , in a highly competitive and stressful environment. While their work is less strenuous drivers of motorized vehicles also put in long days , working 10 to 12 hours , six to seven days a week, to make ends meet . One thing that appears to be the universal is the understandable desire among the para transit operators to one-day move to a better job. Interviews the world over whether in Bandung- Indonesia, Kingston-Jamaica, Phnom Penh- Cambodia, or Yola- Nigeria show this to be the case. (CERVERO, 2000) Drivers often say they toil in this line of work in hopes that their children will not have to be para-transit operators and are usually, though not always, among the most underprivileged members of societies. Most are unskilled and minimally educated virtually all are men with wives and kids.

2.3.7 THE DEMAND SIDE

A core market feature of entrepreneurial, para transit system is service-price differentiation. In general, the sector is dichotomized as follows: Large-vehicle services, like vans and minibuses, tend to focus on long-haul commuter markets, serving semi-skilled and professional -class workers. Services often

parallel formal bus routes, providing higher quality connectivity (e.g. guaranteed seat, faster speeds) for a high fare. In contrast, micro-vehicle services, like motorcycle-taxis and pedicabs function more as complementary, feeder connectors, catering to lower income marginally skilled individuals, many of whom work in the informal economy themselves. There are some exceptions to this generalization, notably in India where cycle-rickshaws are patronized predominantly by middle class because of high fares per kilometer.

User Profiles

Those who patronize para transit services tend to have similar socio-economic backgrounds as operators (especially when the formal transport service is efficient) though there is greater variation in customers make-up

Gender consideration

Perhaps the major difference between para transit operators and users is that while the former are virtually always men, the latter tends to be more of women. Women frequently patronize non-motorized modes because of their traditional domestic roles of shopping and maintaining the household. Pedicab use is skewed towards women making short trips to market and retail centers. Women often prefer pedicab to motor bike-taxi and micro buses not only because they can carry more groceries and goods on board but also because they are perceived as being safer.

A 1997 study found that 35 percent of Dhaka's female commuters relied on cycle rickshaws to get to work, with another 6 percent using them in combination with buses and scooters(Paul-Mjunder and shefali, 1997)

A quarter of women heading for school and colleges also relied on rickshaws. This affinity towards rickshaws stems , in part from the Islamic practice of purdah , or the social exclusion of women sharing crowded buses with mainly the male riders. (Peters,1998)

In Africa where few pedicab services exist, women often turn to motor-bike, taxis and mini-buses instead.

Socio-economic Standing

The few survey results available suggest that those who patronize pedicabs, motorized three-wheelers and other modes that are relatively slow and perceived as being harzadous, are generally of low income with few mobility options.

Faster modes , like motorcycle, taxis and commercial vans, often serve educated , professional class people . In Bangkok and Manila, significant shares of mini-buses, commercial van and jitney patrons are professionals, Many with trained skills and middle class earnings. About half of Bangkok's express van riders are high school or college students from middle income households (Plan Pro Corporation and Bangkok Metropolitan Administration, 1998)

Age profiles

Surveys from several countries reveal some general age pattern among patrons of Para transit modes. Motorcycle, taxi generally draw from a younger crowd . Pedicab users tend to be considerably older . Surveys revealed the average age of cycle-riders in Phnom Penh of 39 years (Etherington and Simon, 1996).

In many Asian cities , those in their 70s and 80s regularly catch pedicabs ,cycle-rickshaws and becaks . Larger informal carriers like vans and minibuses tends to carry a wider age mix of passengers, many being college -age and in their thirties. The elderly do not patronize long-haul carriers very often. A survey of Brazil's clandestine van rider found fewer than 1 percent in Rio De Janeiro and Sao Paulo were over fifty years of age (Balassiano and Braga, 1999)

User satisfaction

Consumer attitudes are among the best barometers of how well para-transit services perform. On the whole patronage of Para transit services is influenced by the following modes attributes : availability , affordability (fare), reliability , swiftness and flexibility, level of comfort and safety.

Surveys in India found many people opted for cycle rickshaws because compared to their alternative, public transport , they are more affordable and reliable. User surveys reviewed by Cervero (2000), reveal that para-transit services are often prized for their swiftness and flexibility . Surveys of van

customers in Brazil reveal the main reasons Vans are preferred to conventional buses are speed advantages (44percent of respondents)and “level of comfort “(25 percent of respondents) (Balassiano and Braga, 1999)

Para transit services nevertheless get bad marks mainly in terms of safety. Motorcycles and micro buses operated at breakneck speeds received the poorest marks among customers . Two-thirds of surveyed motorbike riders in Nigeria felt that the services were unsafe (Ogunsanya and Galtima , 1993). Where rules and regulations are lax or un-enforced, para transit services get criticized for being undependable.

2.3.8 ORGANIZATION AND REGULATIONS

The common view of the para-transit sector as anarchistic and chaotic is largely misplaced.

In reality, all forms of para-transit services exercise some degree of self-policing and self restraint. These responsibilities fall principally on the shoulders of routes associations or unions.

Institutionally, route associations fill the regulatory void left by weak governance and public oversight. Notwithstanding the in road made by route associations all countries with para transit services, maintain some levels of regulatory control over market entry , indemnification, pricing , service practices and fitness. What is more variable, however is the level of commitment to monitoring and enforcing rules and regulations.

Again, in many areas with thriving para- transit services , this responsibility rests with route associations. Government's role, however should not be solely a disciplinary one. There is also a need for active promotion. The two most effective potential ways this can be accomplished are through public assistance in aiding operators finance vehicle purchases (when additional numbers can be justified) and in constructing supportive infrastructure, like off-street terminals.

2.4 SPATIAL INTERACTION SYSTEM

For planning and engineering purposes, what is of direct relevance is the response of the trip making population to the transport system as it exists. This response is reflected in the demand for travel. It is the demand for travel within the transport system that facilities should be planned and engineered to accommodate.

In the analyses and forecasts of urban travel demand, it has become fashionable to adopt either one of zonally based techniques or the behavioural modeling.

Originally, direct demand models with a demand function of the form

$$q = f(P, t) \quad (\text{where } q = \text{quantity of movement})$$

$$P = \text{price}$$

$$t = \text{travel time})$$

which was used extensively for inter city travel. As time went on, the flaws in the model were discovered namely:

- the implication that those who travel do so more because they can afford it rather than because they want to take advantage of the opportunities at the trip ends.
- besides, it was recognized that the direct demand models conceal many of the important structural dimensions of trip makers' behaviour. For instance, the interdependencies between land use and travel characteristics is not duly accounted for. (Burton, 1985).

Later on, the derived nature of travel demands was realized, hence the sequential modeling techniques evolved. Thus, trips classified into two, namely

- Non choice/business trips i.e. those affected by available opportunities at the trip ends and
- Choice/recreational trips.

The non choice/business trips are modeled using the sequential techniques discussed in subsequent sections, while the choice/recreational trips are modeled using the direct demand models. For the sequential techniques, demand analyses are undertaken in for sequential steps involving:

- Trip Generation
- Trip Distribution
- Modal Split
- Traffic Assignment

2.4.1 TRIP GENERATION

Trip generation analyses trips originating or terminating in specific parts of the urban area. This is generally facilitated by use of mathematical models examples of which are discussed below:

Trip-end generation models are concerned with the estimation of the number of trips into and out of various traffic zones. They are derived from the principle that land use generates trips, and that, for example, both the numbers and types of 'from home' trips are influenced by (a) socio-economic variables such as car ownership or availability, household income and size, occupational status, household composition (e.g. number of workers per household) (b) location variables such as population or residential density, rate able value and distance of household from the town centre, and (c) public transport accessibility variables. (This last variable is of particular importance if the modal split is to be included as part of the trip generation model; in the following discussion the modal split will be treated separately from the generation stage.)

As may be gathered from the above, the number of variables considered to exert a causal effect on trip generation can be very many. The purpose of the trip-end modeling process is to identify those, which are meaningful determinants of trip-making behaviour, and express their effects in a mathematical way so that they can be used with confidence as a predictive tool. In general, the traffic analyst has the choice of three main methods of developing trip-end models, namely:

1. Expansion Factor method.
2. Regression Analysis method.
3. Category Analysis method.

The Expansion Factor method is mentioned here primarily to emphasize that its use is now generally out-dated in relation to trip generation in fast-changing complex urban areas. Methods of this nature, which simply place reliance upon past growth rates as a means of predicting future trips, should be confined to short-term forecasting in rural areas.

The Multiple Regression Analysis method is probably that which has been used in the majority of transport demand studies in the past. The extensive use of the 'best fit' least square method, which involves developing a linear equation of the form

$$Y = b_0 + b_1X_1 + b_2X_2 + \dots + b_kX_k \quad \text{-----} \quad (1)$$

is primarily due to the increasing accessibility of sophisticated computer programs which, automatically and speedily, can carry out the extensive calculations required by the process. The following example from Cardiff illustrates the applicability of the method:

$$Y_w = 0.097 X_1 - 351 X_2 + 0.773 X_3 + 0.504 X_4 - 43.6 \quad \text{-----} \quad (2)$$

where Y_w = zonal work trips by all modes

X_1 = population of zone

X_2 = number of households in zone

X_3 = number of employed residents in zone

X_4 = number of cars owned in zone

and $-43.6 = \text{constant}$

Similar equations for other types of trips were also developed so that when the various Y-values were combined $\sum Y$ gave the total number of trips associated with each zone for the year of the study. On the assumption that the relationships expressed by the various Y-equations remain stable, the future numbers of zonal trips were estimated by substituting appropriate future estimates of the independent variables.

It may be noted that the use of regression equations derived on a zonal basis has been rigorously criticized on the grounds that the models may not be stable and transferable from one area to another. Instead, it is recommended that regression equations should more properly be derived initially on a household rather than on a zonal basis; that household regression models provide a more meaningful description of the factors underlying trip-making behaviour, and yet can be easily expanded to provide zonal trip and estimates as required. Because such models are behaviorally based, their results are transferable to places with similar level of development.

In an attempt to free the traffic analyst from many of the assumptions and problems inherent in the use of multiple regression techniques, another trip-end modeling method – Category Analysis – has been developed which considers the household as the fundamental analysis unit, but assumes in this instance that the number of trips from a household is a stable function of three main parameters: household income, car ownership or availability, and family structure. In all, the following 108 different categories of household have been

defined, and each associated with a trip rate. (Table 3).The 108 different categories were obtained by variously combining the elements in each column of the table.

Table 3: HOUSE CLASSIFICATIONS ASSUMED FOR CATEGORY ANALYSES OF TRIP GENERATION

Income classes, £/annum (as reported in 1967)	Ownership, cars/household	Family structure, persons/household
≤ 500	0	0 workers + 1 non-employed adult
501 – 1000	1	0 workers + ≥ 2 non-employed adults
1001 – 1500	2+	1 worker + ≤ 1 non-employed adult
1501 – 2000		1 worker + ≥ 2 non-employed adults
2001 – 2500		≥ 2 workers + ≤ 1 non-employed adult
>2500		≥ 2 workers + ≥ 2 non-employed adults

Source : (O' Flaherty, 1974)

Category analysis has some appeal as a method of predicting trip generation and/or attraction. One obvious reason for this is that it is intuitively appealing to categorize households in a given zone, both now and in the future, and associate each with an expected trip-making behaviour. More important is the fact that its usage cuts down very considerably on the amount of current home interview data which need be gathered and analyzed, since the household information required for any given urban area can be obtained directly from National Census data, while trip rates are available from previous studies (and only require sample checks in the area being considered).

2.4.2 TRIP DISTRIBUTION

Trip distribution is the process wherein generated and attracted trips distribute (i.e. find destinations) from each zone to any other zone. Three main models have so far evolved for distributing these trips. These are:

1. Growth Factor methods.
2. Gravity methods.
3. Opportunity methods.

All of the models assume that travel between any two zones is a function of both the attractiveness of the activities in the destination zones, and the resistance to travel (expressed in travel distance, time, or cost) between the generating and destination zones.

2.4.2.1 Growth Factor Methods.

Four different types of growth factor model have been developed. These are the Uniform Factor, Average Factor, Fratar, and Detroit methods.

The Uniform Factor method involves the determination of a single growth factor for the entire survey area; all existing interzonal trips are then multiplied by this factor in order to get the future interzonal flows. The expansion factor used is the estimated ratio of the total number of future trip ends to the existing total.

The Average Factor method is derived from the fact rates of development in zones are normally different from the rate for the urban area as a whole. Thus, in this version of growth factor the average growth expected at

each pair of origin and destination zones is used. As might be expected, this method, as described, will not give total future flows originating and terminating in a given zone which agree with the figures derived from the trip generation model. To overcome this problem an iterative process, based on revised interzonal growth factors, must be used until an acceptable balance is achieved.

The Fratar method of successive approximations is perhaps the most widely known version of the whole lot. More complicated than the Average Factor method, it gives more rational answers, albeit at the expense of a considerable amount of computer time. A variation of the Fratar method which requires considerably less computer time is known as the Detroit method. This latter model is easiest described mathematically, viz:

$$T_{ij} = t_{ij} \frac{F_i F_j}{F} \quad \text{-----} \quad (3)$$

where T_{ij} = future trips from zone i to zone j

$F_i = \frac{T_i}{t_i}$ = future total trips originating at zone i
 existing total trips originating at zone i

$F_j = \frac{T_j}{t_j}$ = future total trips originating at zone j
 existing total trips originating at zone j

$F = \frac{T}{t}$ = future total trips in the entire survey area
 existing total trips in the entire survey area

and t_{ij} = existing trips from zone i to zone j = $t_i \left(\frac{t_j}{t} \right)$

Although relatively easy to understand, the Growth Factor methods are now rarely used except for short time updating of data. Major weaknesses of all

the methods are that they completely underestimate growths in existing zones which are at or near zero, (even though land use may change significantly as, for example, in a growing town), while they assume that the resistance to travel between zones remains a constant into the future (even though, for example, a new motorway might be opened).

2.4.2.2 Gravity Model

The Gravity model, as an approach to trip distribution, is actually an adapted tool, having been developed in other fields, notably the telephone industry and, to a lesser extent, sociology. Its utilization is based on the premise that all trips starting from a point are pulled by various traffic generators or land uses, and that the degree of pull from each 'magnet' varies directly with the attraction of the generator and inversely with the friction (i.e. distance or travel time) over which the attraction is generated.

The general form of the gravity model used today is:

$$T_{ij} = \frac{G_i A_j F_{ij} K_{ij}}{\sum_{j=1}^n A_j F_{ij} K_{ij}} \quad \text{-----} \quad (4)$$

where T_{ij} = future number of trips from zone i to zone j

G_i = total number of trips generated in zone i

A_j = total number of trips attracted to zone j

F_{ij} = empirically derived travel friction factor, calculated on an area-wide basis

K_j = empirically derived zone-to-zone compatibility factor which takes account of other socio-economic influences not included in the model (not usually necessary in towns with less than 100,000 population).

Existing-year data are used to calibrate the model, i.e. to determine appropriate values for the F- and K-factors

The Gravity model is by far the most widely used trip distribution process. As well as recognizing the gravitational 'pull' of different land uses, and changes in travel time, it can also take account the influences of differing trip purposes and responses to policy changes. What used to be its main disadvantage, the relative complexity of the iterative calibration process, is now largely overcome as a result of the development of well-established standard routines.

2.4.2.3 Opportunity Model

A major criticism often leveled at the Gravity model is that it does not take direct account of individual behaviour patterns. An opportunity model, which is derived on the basis of probability theory, assumes that as trips which are generated in zone i move away from that zone, they incur increasing opportunities for their purposes to be satisfied at any zone j , and therefore there is an increasing probability that they will not proceed beyond zone j . Two forms of opportunity model have been well developed; the Intervening Opportunity model and the Competing Opportunity model. The difference

between them relates to the manner in which the probability function utilized in the distribution equation is calculated, viz. the Intervening model requires trips to remain as short as possible and they only become longer if suitable destinations cannot be found closer to zone i , whereas the Competing model assumes that the probability of a trip from zone i stopping in zone j is independent upon the ratio of the trip destination opportunities within a given time boundary.

The basic Intervening model is expressed as

$$T_{ij} = G_i [e^{-LD} - e^{-L(D+D_j)}] \quad \text{-----} \quad (5)$$

where T_{ij} = future number of trips from zone i to zone j

G_i = total number of trips generated in zone i

D = total number of destination opportunities closer in time to zone i
than are those in zone j

D_j = number of destination opportunities in zone j

L = probability that any given destination opportunity will be selected

The opportunity model approach has been rigorously tested in three studies in the United States, and it has been shown that, in general, the intervening opportunity model can give results of a reliability equal to that of the gravity model.

2.5 MODAL SPLIT

The general purpose of the modal split analysis is to mathematically model for the proportion of total trips that use or is expected to use each of the

various modes of travel available. So far, two basic analysis approaches have been developed, viz. Trip-end and Trip-interchange models. The main difference between these two is that trip-end models are normally applied before the trip distribution phase of the study, and often as part of the trip generation process, whereas trip-interchange models allocate person-trips to different transport modes after the trip distribution process.

Trip-end models assume that the principal factors which affect modal split are the socio-economic characteristics of the traveler, e.g. income and car availability, family size and composition, etc. Regression or category analysis procedures are then used to predict the number of trip by the various modes, in a manner similar to that described for trip generation studies. Thus, for example, in the study previously described, the 108 household classifications were increased to 108 x 6 by assigning each zone a low, medium or high accessibility index which reflected its ease of access to bus or rail facilities, viz.

$$I_{bus} = \frac{\sum_i (N_{ij})^{1/2}}{(0.39A_j)^{1/2}} \text{ and } I_{rail} = \frac{\sum_i (N'_{ij})^{1/2}}{0.39A_j} \quad (6)$$

where N_{ij} = off-peak frequency of buses on route i and passing through zone j

N'_{ij} = Number of trains during the off-peak period stopping at station i in zone j

and A_j = area of zone j , km².

In effect, trip-end modal split models assume that users are captive to the mode used.

Trip-interchange models assume that the levels of service provided by the transport systems are also major factors affecting modal split and that mode users rationally choose modes. Proxies for level of service, which have been used in various studies, include relative travel times, excess travel times, and travel costs.

A typical travel time ratio is

$$R_{TT} = \frac{t_1 + t_2 + t_3 + t_4 + t_5}{t_6 + t_7 + t_8} \quad \text{-----} \quad (7)$$

where t_1 is the access time (i.e. spent walking to, say, the bus stop at the trip origin); t_2 = waiting time at bus stop; t_3 = time on bus; t_4 = time spent changing from one bus to another; t_5 = egress time (i.e. spent walking from bus stop to destination); t_6 = time spent driving car; t_7 = time spent parking car at destination; t_8 = time spent walking from parked car to destination.

A typical excess travel time ratio is

$$R_{ETT} = \frac{t_1 + t_2 + t_4 + t_5}{t_3 + t_8} \quad \text{-----} \quad (8)$$

where t_1, t_2, t_4, t_5, t_7 and t_8 are as defined above.

A representative travel cost ratio R_{TC} , is given by

$$R_{TC} = \frac{n_f}{c_1 + c_2} \quad \text{-----} \quad (9)$$

where n = average car occupancy; f = fare by public transport; c_1 = cost of fuel (petrol and oil) for car trip; and c_2 = parking cost. (Note that road tax, insurance, or maintenance costs are not included in the R_{TC} formulation as

they are not taken into account by a motorist when deciding about the mode for a particular trip.)

Whichever of the above ratios (for other combinations) is selected in a particular study, the end result is the preparation of a series of multiple regression equations or diversion curves which incorporate the relevant variables and are used to predict the number of public transport trips between each pair of zones. Perhaps, the most complex modal split model so far developed involves progressing through a series of diversion curves incorporating relative travel times, relative travel costs, relative excess travel times, income of the traveler, and trip purpose, in order to determine the modal split. Another important procedure has extended regression techniques to separate groups of trip-makers into different mode users by utilizing probability techniques based on a combination of variables which related to both the journey characteristics and characteristic of the trip maker. The main advantage of the 'pure' trip-end type of model is its simplicity; its weakness is its insensitivity to the effect on the future modal split of, for example, improving specific inter-zonal travel corridors. In contrast, the trip-interchange model is much more sensitive to adjustments in the inter-zonal network, but at the cost of losing sensitivity to the effects of the trip generation characteristics. It is for these reasons that recent models have tended to try and incorporate both sets of variables in their formulations.

Another major criticism of present-day modal split models is that they are based on current levels of service, and these have a built-in bias in favor of

the private car. Thus, future estimates of public transport usage could err significantly on the low side should, for example, the bus service be significantly improved by the provision of reserved track ways in combination with a stringent parking or road pricing policy.

2.5.1 TRAFFIC ASSIGNMENT

The next stage in the travel demand analysis process is the assignment of the various modal trips to the different highway (or rail) routes within the survey area. A typical urban network assignment process might first involve an initial assignment by means of an All-or-Nothing procedure (i.e. whereby the total trips between any two zones are assigned to the path, or 'tree' with the minimum travel resistance – usually specified in terms of travel time), or by a proportional diversion procedure and then use one of a number of iterative Capacity Restraint procedures to re-distribute the traffic volumes until the situation is reached where the travel speed assumed in the calculation for each link of the network is relatively unaffected by the assignment process.

The general approach is easiest illustrated by considering the iterative procedure utilized in the Detroit Area Traffic Study. In this study, traffic was first assigned to the various links of the proposed network using the all-or-nothing approach; the speed assumed for initial assignment purposes was the free (or unrestrained) flow speed. Obviously, traffic on a network will not always operate under free flow conditions, and the speed on each link is affected by the flow; hence, each link's travel time was modified as follows:

$$T_A = T_0 e^{(v/c-1)} \quad \text{-----} \quad (10)$$

where T_A = adjusted travel time.

T_0 = original assigned travel time (a function of the desired operating speed, or the travel time on a link)

v = assigned volume

and c = computed capacity

The second iteration was accomplished using the new travel times to determine a new series of minimum paths or trees. The volumes so determined were then added to the results of the previous iteration, and the average link load determined. Successive iterations recalculated the T_A -value based on the model using the average link volume for the v -value until a balanced network was obtained.

Realism in traffic assignment has been an ideal long sought after by highway and traffic engineers. As with other aspects of the transport planning process, this ideal became more practical with the advent of digital computers of sufficient size to manipulate the large arrays of data required by all assignment techniques. The Detroit Transportation Study in 1958, noted above, is generally considered to be the first technique to depart from the traditional procedure of using only diversion curves. Since then a number of different techniques have been developed, each of which has some particular advantage over others. Even so, the results or answers from a traffic assignment program still require considerable examination and judgment before being applied.

In real life, a motorist selects his journey route for a variety of reasons e.g. time, distance, monetary cost, convenience, comfort and safety. In theory, there exists in each situation an optimum route which offers the driver the best combination. Whilst much progress has been made, it cannot yet be stated with surety that the procedures available at this time are able to fully interpret the complexities of human behaviour and the dynamic ever-changing events that take place in an urban area.

2.6 MODAL CHOICE MODELS

Apart from O'Flaherty (1974), several other authors have proposed and elucidated on Modal Choice Models. Among them are Meyer and Straszheim (1971), and John Black (1981). According to Meyer and Straszheim (1971), urban modal choice models represent attempts to develop relationships that determine what share of total traffic will use each mode, with most attention usually devoted to the split between transit and private automobile. While all urban transportation studies include modal split models, there are important differences in their level of sophistication, and in the variables included. Modal split models developed in recent years can be classified as either trip-end or trip interchange models.

Trip-end models were originally developed for, and still have their most widespread use in, highway-oriented origin and destination studies.

By contrast, trip-interchange models initially were developed for, and still have their most widespread use in, transit feasibility studies. In the earliest

and simplest trip-end and modal split models, some proportion of trips origination in each zone was subtracted from total trip generation before assigning the trips to the highway network. This transit-use proportion was often specified as a function of car ownership, net residential density, income, or a combination of these variables. A typical modal split of this kind may be expressed by the following pair of equations:

$$T_i^B = \alpha_0 + \alpha_1 A_i + \alpha_2 D_i \quad \text{-----} \quad (11a)$$

$$\text{where } T_i^B = T_i^B(T_u) \quad \text{-----} \quad (11b)$$

T_i^B = the population of trips originating in i by mode B.

A_i = automobile ownership in i

D_i = net residential density in i

Obviously, such formulations are adequate for small places and for urban areas without major transit systems, but for large, dense metropolitan areas having extensive transit systems, more elaborate models are needed. The most common extensions of these trip end models have been trip stratification by purpose and estimation of separate relationships for trips made to and from the central business district and those made to and from the remaining zones. Examples of trip purposes accorded special attention in modal split models are school trips and work trips. Transit is generally competitive with other travel modes for regular trips to and from work, but most school children are captives of transit because they are unable to drive.

It is generally argued that mode users in developing countries like Nigeria are captive. Thus, modal split analysis arrived at separating personal

auto trips from public transport trips is essentially one question of sorting out the trip makers on the basis of their socio-economic characteristics. For most cities, there are no well organized transit system and public transport trips are undertaken with an assorted types of para-transit vehicles. The way and manner these trips distribute among the various para-transit vehicles is of interest to policy formulation and general system improvement. It is this aspect of modal split analysis that this research is focused on.

In a similar vein Black (1981), explains that mode-choice modeling attempts to estimate the total amount of patronage on the different transport modes and to indicate the spatial pattern of this demand. He further discusses that though modal split is the allocation of the total survey traffic to the separate modes, it is often a term used in the more limited sense to mean the bi-partition of traffic into public and private transport modes. In his opinion, the information available for building mode choice models is the observed modal split, characteristics of traveling population and operational characteristics of the competing urban transport modes.

Black explains the applications of four types of mode-choice model as follows:

Type I modal-split models are formulated as special cases of either the linear regression model or the category analysis model of traffic generation. The dependent variable in the multiple linear regression model is specified as the amount of traffic produced by an origin zone by each transport mode.

$$\hat{Q}_{pi(m)} = \alpha + \beta_1 L_{o1i} + \beta_2 L_{o2i} + \dots + \beta_z L_{ozi} \quad \text{-----} \quad (13)$$

or as the amount of traffic attracted to a destination zone arriving on each transport mode:

$$\hat{Q}_{aj(m)} = \alpha + \beta_1 L_{a1j} + \beta_2 L_{a2j} + \beta_3 L_{a3j} \quad \text{-----} \quad (14)$$

where $\hat{Q}_{ai(m)}$ = estimate of the amount of traffic produced by zone i per unit time by transport mode m;

$\hat{Q}_{aj(m)}$ = estimate of the amount of traffic attracted to zone j per unit time by transport mode m;

$L_{a1i}, L_{a2i}, \dots, L_{a3i}; L_{d1j}, L_{d2j}, \dots, L_{d3j}$ = explanatory (independent) land use variables for origin zone i and destination zone j respectively;

α = regression constant and

$\beta_1, \dots, \beta_3$ = partial regression coefficients.

The explanatory variables and the parameters will be different (a) for productions and attractions, and (b) for each transport mode. In the case of two modes, the equation would usually be estimated for one mode, and the other obtained by subtraction from the total. In the case of more than one, the 'last' mode would be obtained in this way. For category analysis, households are cross-classified by car ownership, size and income in the usual way, but the mean traffic production by each transport mode is calculated for each cross-classification cell from the home interview survey. Zonal traffic production for each mode is estimated by (a) multiplying the mode-specific trip rate for each cross-classification by the number of households in each cross-classification

that are located in the zone, and (b) summing the mode-specific traffic for all household categories in the zone.

Type II modal split models were among the first to be developed in the USA because the transport studies of the 1950s and 1960s were concerned primarily with highway planning, and the earlier in the process that transit trips could be estimated and removed from further consideration, the more efficient would be the resulting highway travel forecasting process (Stopher and Meyburg, 1975). There are numerous examples of type II models in the literature (Fertal *et al*, 1970; Stopher and Meyburg, 1975), but the principle is straight forward: graphical diversion curves. The percentage of zonal traffic using one transport mode, say public transport, is plotted against a selected land-use variable, such as zonal car ownership. A best-fit line or curve is drawn through the data points, and this represents the empirical diversion curve.

Type III modal split models exploit the gravity model with an exponential function of transport impedance to estimate the amount of inter-zonal trips on each transport mode (Wilson, 1969). The modal-split formulation, derived from entropy-maximizing methods, (Wilson, 1970), in the case of two transport modes ($m = 1$ and $m = 2$) is

$$\hat{Q}_{ij(1)} / \sum_{m=1}^2 \hat{Q}_{ij(m)} = \frac{1}{1 + \exp[-\beta(T_{ij(2)} - T_{ij(1)})]} \quad (15)$$

where $\hat{Q}_{ij(1)}$ = estimate of the number of trips from zone i to zone j by transport mode 1

$\hat{Q}_{ij(m)}$ = estimate of the number of trips from zone i to zone j by transport

mode m

$T_{ij(1)}$ = transport impedance from zone i to zone j by transport mode 1

$T_{ij(2)}$ = transport impedance from zone i to zone j by transport mode 2;

and

β = gravity model calibration parameter.

The term $(T_{ij(2)} - T_{ij(1)})$ could be expanded into a "generalized cost".

The type IV multiple linear regression model specifies as its dependent variable the proportion of traffic from zone i to zone j by one transport mode. The explanatory variables are zonal land use variables associated with either the origin or destination zone, and transport characteristics between the two zones. The model is:

$$\hat{Q}_{ij(m)} / \sum_{n=1} \hat{Q}_{ij(n)} = \alpha + \beta_1 L_{oi} + \beta_2 L_{oj} + \beta_3 T_{ij} \quad \text{-----} \quad (16)$$

where the dependent variable is an estimate of the proportion of total inter-zonal traffic using transport mode m, and where

L_{oi} = land use variable for origin zone i

L_{oj} = land use variable for destination zone j

α = regression constant; and

$\beta_1, \dots, \beta_3$ = partial regression coefficients.

The model specification may include two (or more) land-use variables both for the origin and destination zones, and two (or more) transport variables.

2.7 BEHAVIOURAL MODELLING OF TRAVEL DECISIONS

An alternative approach, which emerged during the 1970s and is still being refined (Hensher and Stopher, 1979), is the analysis of individual travel behaviour. A behavioural model 'represents the decisions that consumers make when confronted with alternative choices' (Domencich and McFadden, 1975). Travel-related choices include whether to make a journey or not, time of day of travel, destination, transport mode and route.

An important distinction is that behavioural models focus on individual travel, whereas the models discussed previously represent 'bundles of individual trips' aggregated into zones. Several advantages follow from this micro-scale analysis (Hensher, 1977c). Conceptually, the analysis is more realistic because behavioural patterns of individuals are investigated instead of statistically derived zonal correlation. Behavioral models are calibrated on individual data, thereby making a more efficient use of the survey. Behavioural models avoid the 'ecological fallacies of inference' from grouped data (Kassoff and Deutschman, 1969).

2.7.1 BEHAVIOURAL MODELS

A behavioural model is based on a representation of individual choice when faced with alternatives. Common experience suggests that in choice situations a person weighs up the advantages and disadvantages of one course of action against the advantages and disadvantages of the alternatives. The

comparison is made on an assessment of the attributes of each alternative, such as price or quality. A logical decision is to select the alternative which gives the 'greatest enjoyment', 'the most satisfaction', 'the highest utility', or whatever phrase best describes the derived emotion. However, the decision is normally "biased" by the tastes of the individual which is largely a consequence of his "status".

Expressing the same thing in notational terms, assume there are two alternatives a, and b, which have a number (n) of relevant attributes (X). The attributes for each alternative are specified in the following two vectors:

$$[X_{1(a)}, X_{2(a)}, X_{3(a)} \dots X_{n(a)}]$$

$$[X_{1(b)}, X_{2(b)}, X_{3(b)} \dots X_{n(b)}]$$

An individual's revealed preference function is a function of the derived satisfaction from alternative a, and is stated theoretically as:

$$U_i = f_i (X_{1(a)}, X_{2(a)}, X_{3(a)} \dots X_{n(a)}) \text{ -----} \quad (17)$$

Where

U_i = revealed preference function for individual i; and

F_i = a function specific to individual i.

A similar function may be stated for alternative b. Alternative a is chosen if.

$$f_i (X_{1(a)}, X_{2(a)} \dots X_{n(a)}) > f_i (X_{1(b)}, X_{2(b)} \dots X_{n(b)}) \text{ -----} \quad (18)$$

Extending this argument to a multi-choice situation, the alternative with the highest preference function is selected.

The principle of individual choice is extended to formulate a generalized model for the population as a whole. Within the framework of economic

rationality and utility maximization, tastes vary over the population. This is handled in the model by assuming that each individual preference function has two parts: the first is common to a definable subgroup within the population (for example, a socio-economic group); the second is unique to each individual. Because this second part cannot be observed, the analyst can attach only a probability to any individual choice.

There are alternative functional forms for the choice probabilities for two alternatives (Domencich and McFadden, 1975), but a suitable expression, selected partly because of computational convenience, is the binary logit probability model:

$$P_{i(a)} = \frac{\exp\{f(X_{1(a)} \dots X_{n(a)})\}}{\exp\{f(X_{1(a)} \dots X_{n(a)})\} + \exp\{f(X_{1(b)} \dots X_{n(b)})\}} \quad (19)$$

Where

$P_{i(a)}$ = probability of individual choosing alternative a;

$f(X_{1(a)} \dots X_{n(a)})$ = preference function for alternative a;

$f(X_{1(b)} \dots X_{n(b)})$ = preference function for alternative b; and

$X_1 \dots X_n$ = relevant attributes.

The probability of choosing the alternative b is equal to $1 - P_{i(a)}$. Equation is derived mathematically, as shown by Stopher and Meyburg (1975) from the assumption that the distribution of the random, second part of the individual preference function is a Weibull distribution. The Weibull frequency

distribution, which has the same general bell-shape as a normal distribution except that it is skewed (Domencich and McFadden, 1975), is chosen because it has some convenience mathematical properties.

One of these properties is to reduce the mathematical complexity of deriving a formulae, equivalent to equation, for the case of choice amongst more than two alternatives. The probability of an individual choosing alternative a from a set, N , which contain up to n alternatives, is the multinomial logit probability model:

$$P_{i(a)} = \frac{\exp f(X_{1(a)} \dots X_{n(a)})}{\sum_{N=a} \exp f(X_{1(N)} \dots X_{n(N)})} \quad (20)$$

Where

$f(X_{1(N)} \dots X_{n(N)})$ = preference function for the general case of alternative N .

The application of the above theory of individual choice behaviour to the analysis of urban travel demand is relevant because each traveler is confronted with choices, including to make a journey or not, the time of day, the destination, the transport mode, and the route. Theoretically, choice of land-use activities and transport are made simultaneously from all possible activity-transport combinations, but this is impossible to model satisfactorily. Instead, the choices are separated (Brand, 1974) and sequential models are constructed.

Formulating a model of behavioural travel demand involves the identification of the relevant attributes, which influence the individual's decision-making process. Identification and measurement of these attributes influencing individual travel behaviour are straightforward to identify because the variables used in aggregate models are relevant also at the individual scale of analysis. The individual's preference function is comprised of the attributes of land-use activity-transport characteristics and individual socio-economic characteristics, and equation becomes:

$$U_i = f_i (L_i, T_i, S_i) \text{ -----(21)}$$

Where

U_i = revealed preference function for individual i for land-use activity-transport alternative;

L_i = land-use activity attributes confronting individual i

T_i = transport attributes confronting individual i ; and

S_i = socio-economic characteristics of individual i .

The use of bold variables indicates that each of L_i , T_i and S_i may be a list of variables.

The form of the preference function is assumed to be a linear combination of the relevant attributes of each alternative. Thus, if there is one variable in each group, the equation is

$$f_i (L_i, T_i, S_i) = \alpha + \beta_1 L_i + \beta_2 T_i + \beta_3 S_i \text{ -----(22)}$$

Where

$\alpha, \beta_1, \dots, \beta_3$ = calibration parameters.

More generally, if there is more than one variable, a vector notation is appropriate:

$$f_i (L_i, T_i, S_i) = \alpha + \beta_1 L_i + \beta_2 T_i + \beta_3 S_i \text{ ----- (23)}$$

The right-hand side of equation (24) is substituted into either the binary logit probability model (22) or the multinomial logit probability model (23). Calibration is described in the next section, and involves both the identification of the exact variables that enter the preference function and the estimation of the unknown parameters.

An example of the results obtained by calibrating a binary logit probability model of transport mode choice for work travel based on commuters in Sydney who have a choice between car and train is in Hensher (1972). The relevant attributes of the two transport alternatives were found to be door-to-door travel time, waiting time, walking time and transport cost. Because this is a binary choice the variables in equation (24) can be expressed as differences. The preference function calibrated is a version of equation (25) with three transport variables and no land-use or socio-economic variables. For clarity, the individual subscript i associated with the variables has been omitted from the right-hand side of the equation.

$$F_i (T_a - T_b) = 0.254 - 0.010 (I_a - I_b) - 0.028 (W_a - W_b) \\ - 0.015 (R_a - R_b) - 0.027 (C_a - C_b) \text{ ----- (24)}$$

where a = car travel

b = train travel

$F_i (T_a - T_b)$ = preference function for individual i ;

$I_a - I_b$ = in-vehicle travel time by car minus in vehicle travel time by train in minutes;

$W_a - W_b$ = waiting time by car (if any) minus the total waiting time by train in minutes.

$R_a - R_b$ = walking time involved in using the car minus the walking time and transfer time associated with the train, in minutes; and

$C_a - C_b$ = door-to-door cost by car minus the door-to-door travel cost by train in cents.

The negative coefficients indicate that when travel times become longer, or costs become higher by train (the differences between car and train will be negative and increasing) the preference function for car choice has an increasing positive value.

The above expression can be substituted into the binary logit probability model (equation (21)), but because differences in transport attributes are specified, equation (21) is now written as:

$$P_{i(a)} = \frac{\exp\{f_i(T_{(a)} - T_{(b)})\}}{1 + \exp\{f_i(T_{(b)} - T_{(b)})\}} \quad (25)$$

Where

$P_{i(a)}$ = probability of individual I taking transport alternative a (motor-car) for the journey to work.

Consider, for example, a group of commuters faced with the following transport attributes in their journey from home to work: in-vehicle time is 10 minutes longer by car; waiting time is 5 minutes more by train; walking and transfer time is 12 minutes longer by train; and the cost is N10.00 more by car. The model estimates that the probability that an individual will choose a, the car, is 0.58.

More complete urban travel demand models incorporating mode choice, time-of-day choice, destination choice and frequency of travel have been developed (Domencich and McFadden, 1975). Further reading about such developments is found in (Williams H. 1977).

In summary, the properties of behavioral modes of travel demand are:

- (1) the probability of choosing one alternative over alternative courses of action is a function of the attributes of the alternatives;
- (2) a linear, additive preference function represents the amount of satisfaction that an individual derives from the attributes associated with choice;
- (3) the logit transformation guarantees that the probability of choice is restricted to form zero to unity, irrespective of the numerical magnitude of the preference function;
- (4) the probability of choice increases as the numerical measures of the attribute of that alternatives. The probability of choice decreases as the measure of the alternatives (transport travel time, or costs, represent a dis-utility to the individual traveler).

2.7.2 MODEL CALIBRATION

Calibration of behavioural models involves testing alternative explanatory variables (attributes) in the preference function, selecting the best combination that explains the choice behaviour, and estimating the parameter associated with each variable (attribute). The model is calibrated using data describing each individual and not each zone.

Conceptually, the calibration of the preference function is similar to estimating the parameters for a multiple linear regression model. However, regression is unsuitable for statistical reasons (Watson, 1974), and the appropriate way to estimate the unknown parameters is by the maximum likelihood method (de Donnea, 1971,). Most applications of the maximum likelihood method would involve the use of a computer programme. The log likelihood (which is equivalent to the likelihood) of observing a given sample containing individuals ($i = 1 \dots I$) is:

$$LL = \sum_{i=1}^I \log \{ 1 + \exp (\alpha + \beta_1 L_i + \beta_2 T_i \dots) \} + \sum_{i=1}^I f_{ai} (\alpha + \beta_1 L_i + \beta_2 T_i \dots) \quad \text{----- (26)}$$

where

LL = log likelihood function; and

$f_{ai} = 1$ if a is chosen by individual i ;

0 if a is not chose by individual i .

The method of maximum likelihood argues that the calculated probabilities of observing the given sample is highest when the calibration parameters have their true values. The highest, or maximum, value of the log likelihood is found by differentiating equation (26) with respect to the unknown parameters, and setting the derivatives equal to zero. The solution of these equations gives an estimate of each parameter. For the multiple choice model, maximization is achieved by a standard iterative process, such as the Newton-Raphson method (Domencich and McFadden, 1975).

Although the calibrated model estimates an individual choice probability, the overall probability of choice for any defined group can be easily obtained by summing the individual estimates and dividing the figure by the number of individuals in the group. Aggregation to a spatial, zoning system is less straightforward when the individuals are impossible to identify, and when variables are represented only by calculating zonal probabilities, given a calibrated, disaggregate model, the zonal means for the explanatory variables and the intra-zonal variances of these variables.

2.7.3 MODEL VALIDATION

Many of the points made are of relevance, but additionally there are three useful goodness-of-fit statistics associated with maximum likelihood methods:

- (1) The t-test, which allows statements to be made about the confidence that may be placed in the estimates of the parameters (Hutchinson, 1974);

- (2) An index analogous to the coefficient of multiple determination, and sometimes called 'pseudo- r^2 ' which is calculated from the ratio of the value of the log likelihood function, evaluated for the estimated parameters, and the value of the log likelihood function, evaluated for all parameters set to zero (Domencich and McFadden, 1975). The index is from zero to one, with the latter indicating a good fit to the data.
- (3) The weighted proportion of the number of successful estimates of choice by the model when compared with actual choices made by individuals in the sample.



CHAPTER THREE

3. BACKGROUND INFORMATION ON THE STUDY SITE

This section contains vital information on the study site. The information includes spatial configuration of land use, transport facilities, characteristics of the traffic volume on major roads etc.

3.1 SPATIAL CONFIGURATION OF LAND USE AND TRANSPORT FACILITIES

The spatial configuration of land use in Akure metropolis is illustrated in Fig. 5a and 5b.

The land use pattern consists of High residential, medium residential, low residential, commercial, educational, industrial, military, public, recreational/transport, areas and rock outcrops. The major land use zones are as follows:

3.1.1 HIGH RESIDENTIAL ZONE

This occupies the area around the central part of the metropolis and as such is affected by the commercial activities in the Central Business District. It spreads to areas like Oyemekun, Odo Ikoyi, Irowo, etc. It is densely populated and characterized by average of thirteen persons per household. (Owolabi, 2002)

3.1.2 MEDIUM RESIDENTIAL ZONE

This covers the largest area of land in Akure metropolis. It extends to areas like Aiyedun, Isolo, Oke Ijebu, Isinkan, Oke Aro, Osinle quarters and the areas around the state specialist hospital. The area is interspersed with retail shops, primary and secondary schools. The residents are mainly farmers, civil servants, business men and women.

3.1.3 LOW RESIDENTIAL ZONE

This area is purely residential. It covers Ala quarters owned by Ondo State government, Sijuwade quarters, Ijapo estate, Oba Ile Housing estate, Shagari Housing estate, Odo road and its suburbs. Residents in this area are mainly civil servants. It is characterised by average of 6 persons per household (Owolabi, 2002).

3.1.4 EDUCATIONAL ZONE

This area is characterized by the presence of tertiary institutions namely, The School of Agriculture and Federal University of Technology. The institutions are located at the outskirts of the city along Ilesha road and Old Owo road respectively. Its dwellers are mainly teachers (lecturers) and students.

3.1.5 COMMERCIAL ZONE

This is the business district of the city where business activities are concentrated. It occupies the heart or central core of the city. The areas include Oba-Adesida Road, extending to Ondo Road, Arakale street and area surrounding Deji's palace. It is also characterized by the presence of residential houses. The average number of persons per household in this zone is twelve (Owolabi, 2002).

3.1.6 INDUSTRIAL ZONE

This area is earmarked for location of industries. It is located along Ilesha-Owo express road. There are relatively few industries there presently. They include sawmill, plastic, foam and chemical industries. The presence of residential quarters can also be noticed along side Ondo State ultra-modern market.

3.1.7 MILITARY ZONE

This area is located at the outskirts of the city along Ondo road. The residents are soldiers and members of their families. There are primary and secondary schools, health centres and mini markets in this area.

3.1.8 PUBLIC ZONE

This is a government reserved area called Alagbaka. It is the seat of Ondo State Government or centre of administration where most of Ondo State

government establishments, ministries and parastatals are located. It also contains residential quarters for senior government officials and low rank civil servants. Average persons per household in the residential facility is six (Owolabi, 2002).

3.1.9 RECREATIONAL/TRANSPORT ZONE

These areas are characterized by the presence of motor-parks, hotels and relaxation centres. There are also few residential buildings. Little commercial activities also take place in this area like selling of motor spare parts, restaurants and super markets. The areas include Ilesha Motor park and environ, Idanre Motor Park and environ, FUTA Guest House, and Owena motels.

The land use activities greatly influence the propensity of each area to generate trips. For example the high residential, medium residential and commercial areas possess great potentials for generating and attracting trips. The residents in these areas are known to patronize any available mode of transport at reduced cost. Conversely, residents in the low density area are somewhat selective in the choice of mode of transport and would consider convenience and safety.

3.2 MAJOR ROAD PATTERN

Fig. 6 shows the road pattern in Akure metropolis. The major routes are Oyemekun – Oba Adesida roads, a dual carriageway of about 8Km length,

Ondo – Arakale – NEPA roads and New Hospital road. Connecting these major routes are minor routes like stadium road, Araromi street, Isolo, Oke Ijebu, Oke Aro, Irowo streets, etc.

This arrangement clearly exemplifies the morphological linearity of the road pattern resulting in the traffic congestion on the major routes.

All the major roads are constructed with asphalt concrete and generally most of the roads have little or no room for expansion especially in the core area where development and roadside activities reach the drains.

Among the major routes, Oba Adesida road forms a meeting point for other routes hence the heavy traffic that is always noticed on the road.

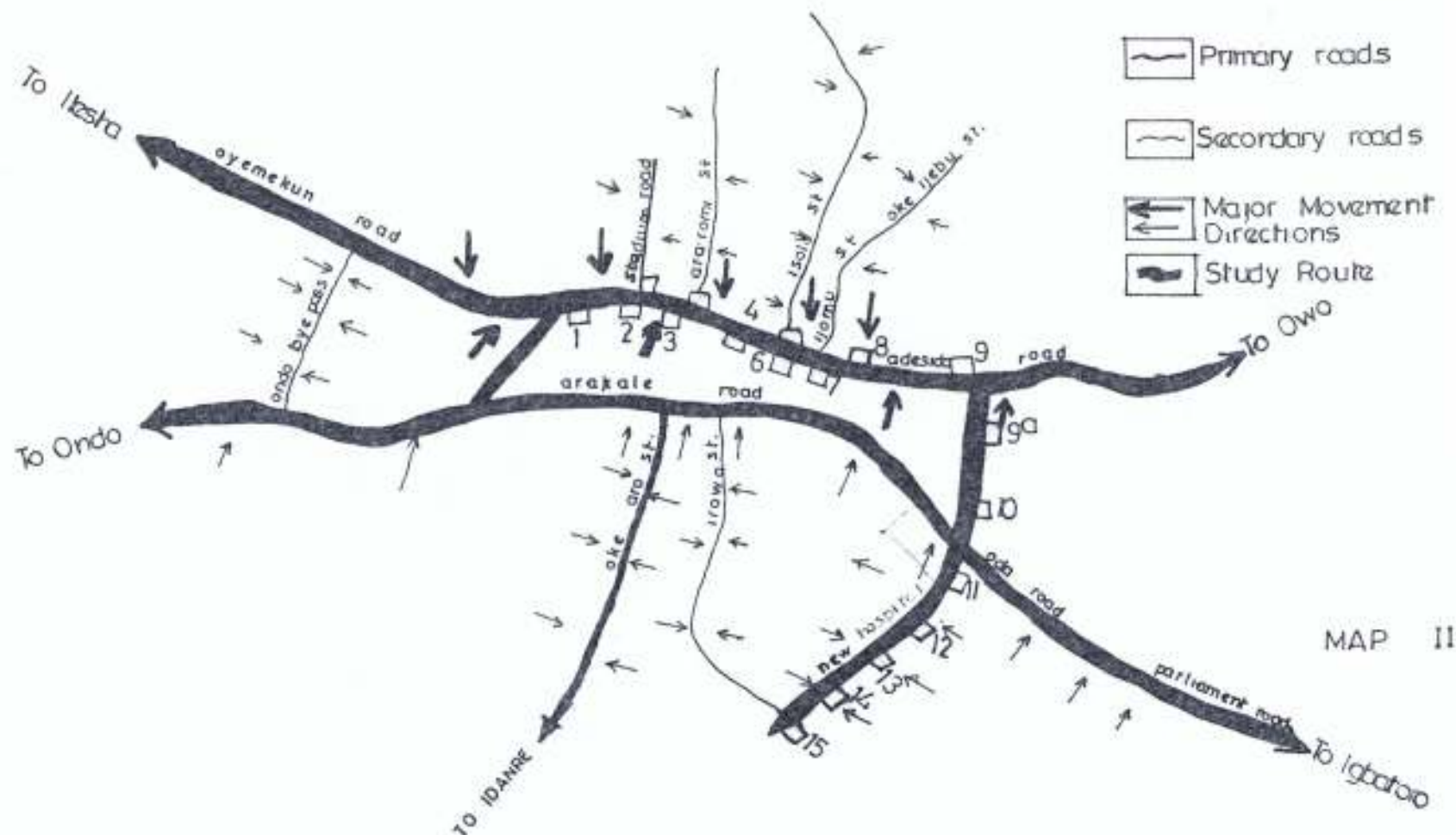
3.3 TERMINAL FACILITIES

Fig. 6 shows the existing Bus-stops in the metropolis, namely Sacred Heart, Dele stores, Old garage, Bata, Isolo, Total filling station, Ijomu, Oba-nla, 'A' Division, High court, Odopetu, NEPA, JAONI, Continental, Mary Queen of Angels and Olukayode, while Fig. 7 shows the location of authorized and unauthorized terminals in the metropolis.

While authorized terminals do not pose hindrances to smooth flow of traffic, Unauthorized terminals being located along major roads obstruct the carriage ways and hinder free flow of traffic and pedestrians.

Table 4 and Table 5 summarizes the location of Authorized and unauthorized terminals in the study area.

SACRED HEART
 DELE STORES
 OLD GARAGE
 BATA
 ISOLO
 TOTAL
 IJOMU
 OBA - NLA
 "A" DIVISION
 HIGH COURT
 ODOPETU
 NEPA
 JAONI
 CONTINENTAL
 MARY QUEEN OF ANGEL
 OLUKAYODE



SOURCE :- ONDO STATE MINISTRY OF WORKS, LAND AND SURVEY DEPT.

Table 4. LOCATION OF AUTHORISED TERMINALS IN AKURE METROPOLIS

S/N	NAME OF TERMINAL	AREA	LOCATION	DESTINATION OF MODES AND COMMUTERS
1	Ilesha Road	0.86Ha	Ilesha road (Beside and Opposite Mobil Filling Stations)	Lagos, Ibadan, Ife, Ilesha, Osogbo, etc.
2	Owo Road	0.215Ha	Owo Road (El-shadai church junction)	Owo, Benin, Auch, Ikare, etc.
3	Idanre Road	0.68Ha	Idanre Road (Oke Aro)	Idanre, Owena.
4	Ondo Road	0.703Ha	Ondo Road	Ondo, Ore, Okitipupa, etc.

Source: FIELD SURVEY, 1999

Table 5: LOCATION OF UNAUTHORISED TERMINALS IN AKURE METROPOLIS

S/ N	STREET NAME	WIDTH OF ROAD	LOCATION	DESTINATION OF VEHICLES AND COMMUTERS
1	Oba Adesida	18m (dual carriage way)	Total Filling station	Owo, Ado
2	Oba Adesida	18m (dual carriage way)	NYSC Bus-stop	Owo, Intrao city
3	Oba Adesida	18m (dual carriage way)	Oja-Oshodi street junction	FUTA
4	Oba Adesida	18m (dual carriage way)	Obanla street	Ado Ekiti, Ijero Ekiti
5	Odo-Ikoyi street	7.5m	Along the street up to the intersection with Oba Adesida Road	Lagos and Intra-city
6	Isolo street	7.5m	Beside Akure Central Mosque	Intra city
7	Ijomu/Oke Ijebu road	7.5m	Along the access road	Owo, Intra city
8	Araromi street	7.5m	Along Araromi street	Intra city
9	Ilesha/Benin Express Road	12m	AKAD Filling Station	Ibadan, Ife, Ilesha, Osogbo
10	Ilesha/Benin Express Road	12m	Opposite FUTA North gate	Ibadan, Ife, Ilesha, Osogbo
11	Ilesha/Benin Express Road	12m	Orita Obele	Ibadan, Ife, Ilesha, Osogbo
12	Owo/Akure Road	9m	Opposite Total Filling Station on College of Agric. Land	Owo, Benin, Auchi
13	Ondo road	9m	Opposite Isinkan market	Ondo, Ore, Lagos
14	Ondo Road	10m	Opposite cathedral	Ondo, Ore, Lagos
15	Idanre Road	9m	Road block	Idanre, Owena
16	Hospital Road	9m	NEPA junction	Igbatoro, Oda, Intra city
17	Hospital Road	9m	Front of state hospital	Intra city
18	Oba Adesida Road	18m (dual carriage way)	Old garage beside Afribank	Lagos, Jos, P. H., Ilorin, Idanre, Intra city
19	Ado-Ekiti Road	9m	Ado Ekiti road	Ikare, Ado, Ikole

Source: FIELD SURVEY, 1999

3.4 TRAFFIC VOLUME CHARACTERISTICS ON MAJOR ROADS WITHIN AKURE METROPOLIS

Traffic survey (using manual counting) was conducted for one week during the morning, afternoon and evening peak periods, to determine the characteristics of traffic volume on major roads within Akure metropolis (Owolabi 2000).

The roads monitored include Oyemekun / Oba Adesida, Arakale, Ondo, Hospital and Oke-Aro. (fig. 6a).

Table 6 shows the average daily traffic compositions and volumes during the morning peak period. (The daily temporal patterns are important so as to know when the peaks occur)!

The results in the table show that Oyemekun – Oba Adesida road had the highest volume of traffic, followed by Oke-Aro, Ondo, Hospital and Arakale roads respectively.

The analysis of the composition of traffic revealed that the most predominant mode of transport in the metropolis were passenger cars which constituted 70.75% of traffic, followed by motorcycles constituting 22.6% and buses, lorries and bicycles constituting 4.03%, 2.24% and 0.29% respectively.

It is interesting to note that the proportion of motorcycles on Arakale and Oke Aro roads were as high as 50% and 32% respectively, underscoring the prominence of the mode as a means of transport and as such deserves recognition and attention.

TABLE 6: AVERAGE DAILY TRAFFIC COMPOSITIONS AND VOLUME ON
AKURE TOWNSHIP ROADS DURING THE MORNING PEAK PERIOD.

ROAD MODE	OYEMEKUN/ OBA ADESIDA		ARAKALE		ONDO		HOSPITAL		OKE ARO		TOTAL	
	No	%	No	%	No	%	No	%	No	%	No	%
Cars	2187	83.13	493	44.70	950	73.28	958	77.68	1252	62.92	5840	70.75
Buses	133	5.07	36	3.27	70	5.41	26	2.09	67	3.37	332	4.03
Motorcycles	232	8.83	558	50.57	206	15.91	233	18.89	643	32.31	1872	22.69
Lorries	73	2.78	10	0.92	63	4.86	16	1.26	23	1.15	185	2.24
Bicycles	05	0.19	06	0.54	07	0.54	01	0.08	05	0.25	24	0.29
TOTAL	2630		1103		1296		1233		1990		8253	100

SOURCE: FIELD SURVEY, 1999

The charts illustrating the composition and volume of traffic on Akure township roads are shown in Figs. 8a – g.

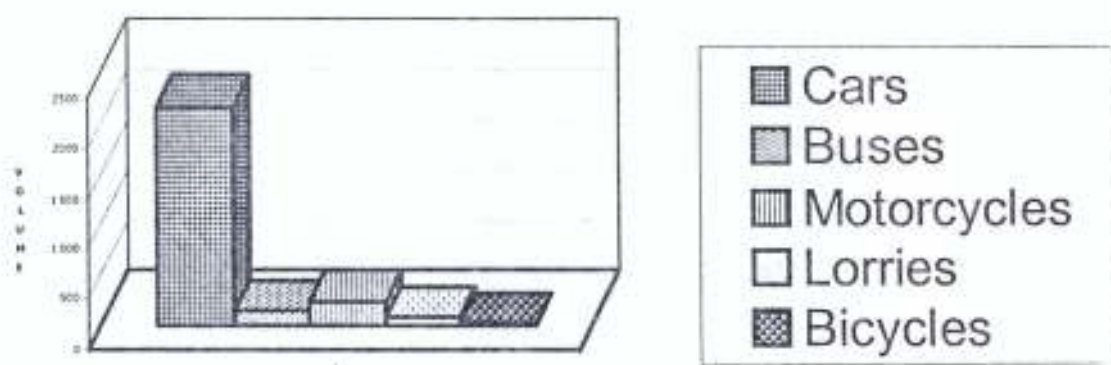


FIG. 8a: AVERAGE DAILY TRAFFIC COMPOSITION AND VOLUME ON OYEHEKUN/OBA ADESIDA ROAD DURING THE MORNING PEAK PERIOD

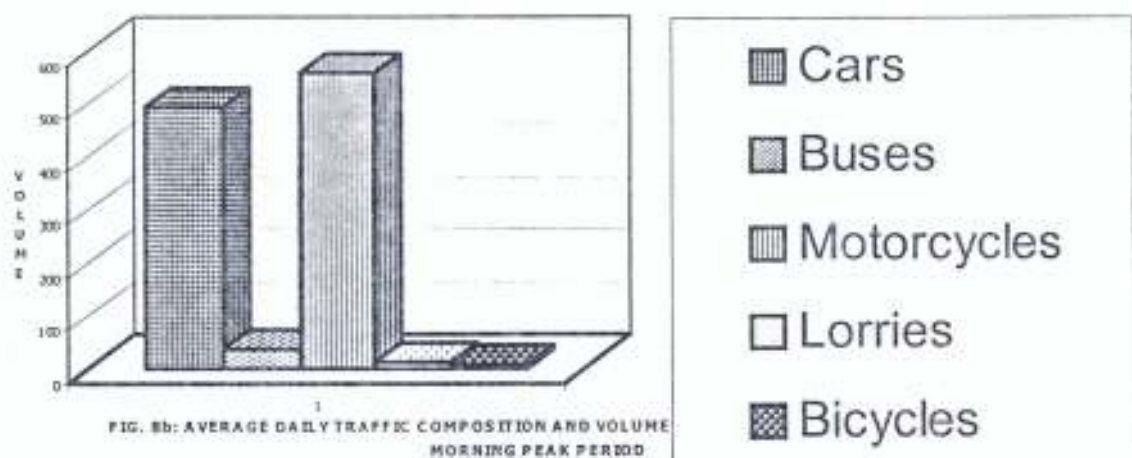


FIG. 8b: AVERAGE DAILY TRAFFIC COMPOSITION AND VOLUME MORNING PEAK PERIOD

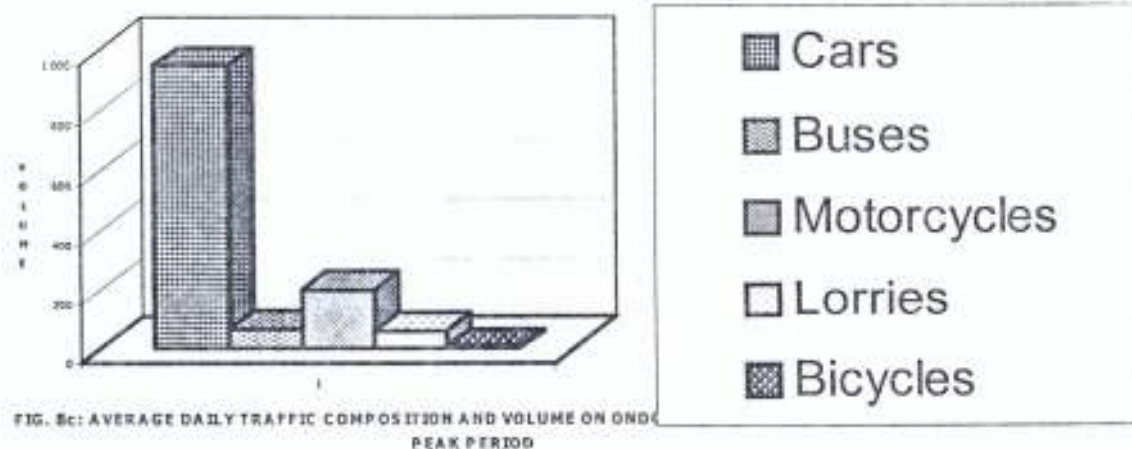


FIG. 8c: AVERAGE DAILY TRAFFIC COMPOSITION AND VOLUME ON ONDO PEAK PERIOD

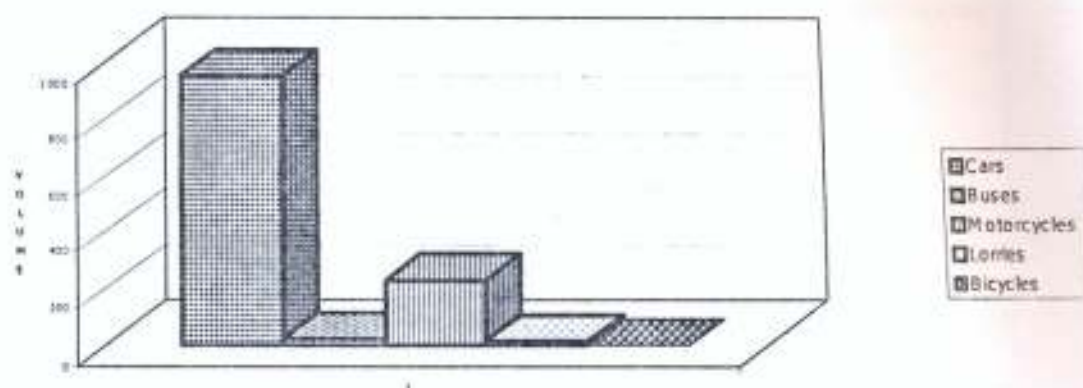


FIG. 8d: AVERAGE DAILY TRAFFIC COMPOSITION AND VOLUME ON HOSPITAL ROAD DURING THE MORNING PEAK PERIOD

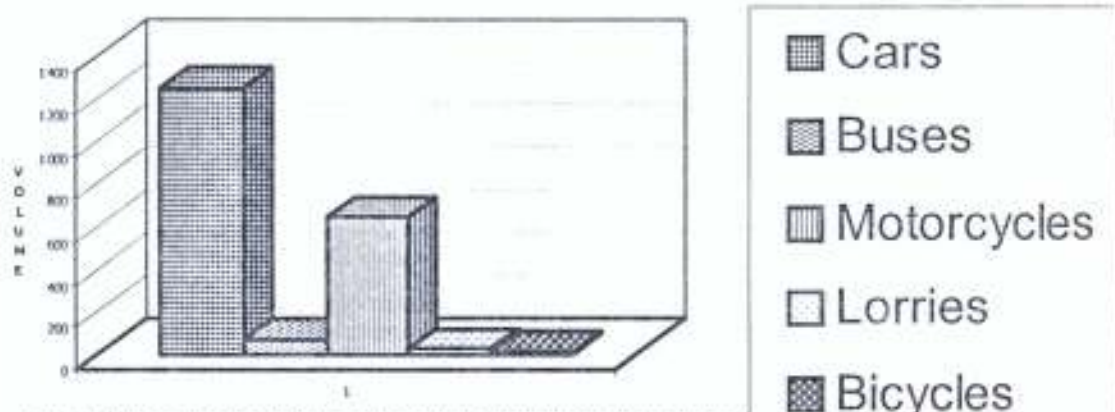


FIG. 8e: AVERAGE DAILY TRAFFIC COMPOSITION AND VOLUME ON OKE ARD ROAD DURING THE MORNING PEAK PERIOD

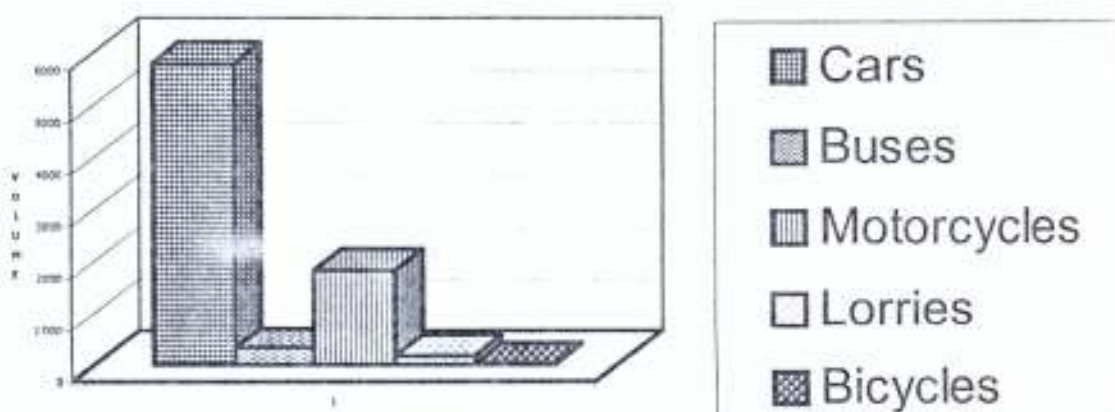


FIG. 8f: AVERAGE DAILY TRAFFIC COMPOSITION AND VOLUME ON AKURE TOWNSHIP ROADS DURING THE MORNING PEAK PERIOD

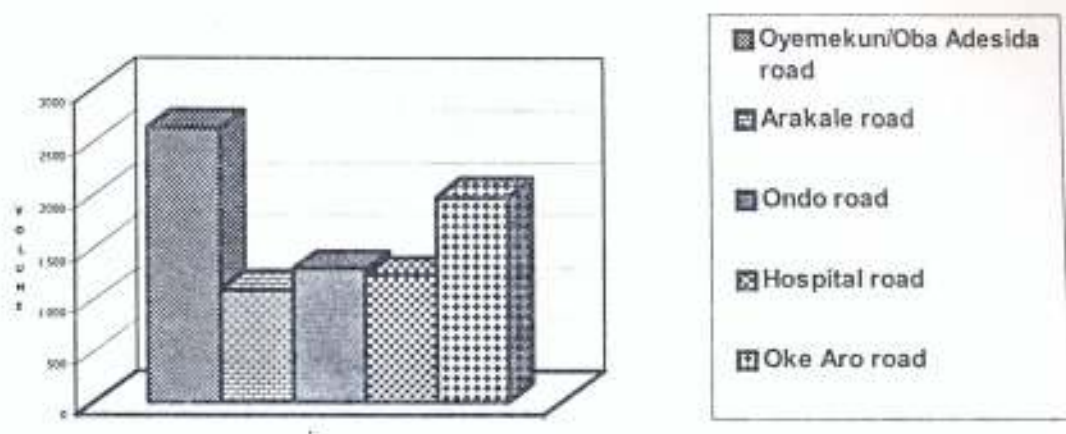


FIG. 8g: AVERAGE DAILY TRAFFIC VOLUME ON AKURE TOWNSHIP ROADS DURING THE MORNING PEAK PERIOD

3.5 AN OVERVIEW OF PARATRANSIT MODES IN AKURE METROPOLIS

The following is an overview of para-transit modes in Akure. Issues discussed include the modes, coverage, modes of operation, the major operators, usage/cost, safety records, regulation and organization etc.

3.5.1 THE MODES

The main para-transit modes which serve Akure are the shared taxi, buses,

motorcycles and "Kabukabu" (i.e. unconventional and unregistered urban carriers consisting mainly of old and fairly used vehicles).

3.5.2 OPERATIONS AND COVERAGE

From an operational standpoint, para-transit services in Akure are in two categories, namely, those that function mainly as feeders and span short distances and those that provide long, haul or main line connections. Shared taxi, motorcycles and Kabukabu dominate the former while route based, 12 to 18 seater buses characterize the latter.

Buses load at designated terminals along the main arterial (i.e. Oyemekun – Oba Adesida Road), and around NEPA office. The loading points shown in figure 7 include opposite post office, Araromi junction, Ijomu junction, Oja-oba and opposite NEPA office, respectively. Passengers are conveyed from these loading points along fixed routes to FUTA, Onyearugbulem market, Oba-Ile Housing Estate, Federal Secretariat and Danjuma areas, respectively.

Shared taxis operate on variable routes along the major roads where commuters easily access them. The first occupant normally determines the destination or direction of movement and other passengers, heading in the same general direction, are picked up “en route”.

Some of the motorcycles operate in the same way as taxis while others load at designated terminals and convey passengers to destinations within the neighbourhoods and suburbs where taxis do not often reach. The motorcycle terminals in the metropolis include First Bank, NEPA, Danjuma, Old Garage, Idanre garage, Adegbola junction, Champion junction, Ondo Bye-pass junction, etc.

The unregistered carriers (kabukabu) load at “Unauthorized” terminals and convey passengers to locations within the metropolis along routes not often plied by taxis.

In Akure, bus trips are between 4.2 – 7.7 km with an average coverage of 6km, Taxi trips are between 1.2 – 5.8km with an average coverage of 3.7km. Motorcycle trips are between 0.8 – 3.2 km with an average coverage of 1.7km, while trip distances for kabukabu is similar to that of taxi. Detail distributions are shown in Table 7.

Table 7: Coverage Of Para-Transit Modes (Km)

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Bus	50	4.20	7.70	300.00	6.0000	1.0053
Taxi	50	1.20	5.80	185.00	3.7000	1.4522
Motorcycle	50	.80	3.20	85.00	1.7000	.6433
Kabukabu	50	1.30	6.00	190.00	3.8000	1.3336
Valid N (listwise)	50					

3.5.3 OPERATORS

Operators of para-transit modes in Akure are all male who joined the business in order to survive economically either to earn a living or supplement their living standards. While most of the operators are involved in other trades some of them (about 20%) started out as conductors and garage/union workers before becoming operators.

Operators of commercial motorcycles (okada) are mostly young people. More than 50% are of the age of 18 – 30 years, 32% are between the ages of 30 and 40 while 18% are above 40 years. Detail distribution is shown in Table 8a.

The embrace of okada activities by young school leavers in Nigeria is symptomatic of the endemic unemployment among them (Fasakin, 2000).

Table 8a: Age Of Operators Of Commercial Motorcycles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Age 18-30 years	25	50.0	50.0	50.0
	Age 31 - 40 years	16	32.0	32.0	82.0
	Above 40 years	9	18.0	18.0	100.0
	Total	50	100.0	100.0	

Table 8b: Age Of Operators Of Other Modes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Age 18-30 years	8	16.0	16.0	16.0
	Age 31 - 40 years	31	62.0	62.0	78.0
	Above 40 years	11	22.0	22.0	100.0
	Total	50	100.0	100.0	

Table 8b shows that 16% of the operators of other modes are between the ages of 18 and 30 years, 62% are of the ages of 31 – 40 years while 22% are above 40 years old.

50% of okada operators are single, 40% are married while 10% are divorced. 14% of the operators of other modes are single, 68% are married while 18% are divorced as shown in Tables 9a and 9b.

Table 9a: Marital Status Of Operators Of Commercial Motorcycles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single	25	50.0	50.0	50.0
	Married	20	40.0	40.0	90.0
	Divorced	5	10.0	10.0	100.0
	Total	50	100.0	100.0	

Table 9b: Marital Status Of Operators Of Other Modes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single	7	14.0	14.0	14.0
	Married	34	68.0	68.0	82.0
	Divorced	9	18.0	18.0	100.0
	Total	50	100.0	100.0	

Okada operators are fairly educated with 78% having either primary or secondary education, 16% possess post-secondary qualifications, while 6% are illiterate.

62% of the operators of other modes have primary education, 30% have secondary education while 8% are illiterate. Detail distributions are shown in Tables 10a and 10b.

Table 10a: Educational Status Of Operators Of Commercial Motorcycles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary-Secondary	39	78.0	78.0	78.0
	Post Secondary	8	16.0	16.0	94.0
	Illiterate	3	6.0	6.0	100.0
	Total	50	100.0	100.0	

Table 10b: Educational Status Of Operators Of Other Modes

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Primary Education	31	62.0	62.0	62.0
	Secondary	15	30.0	30.0	92.0
	Illiterate	4	8.0	8.0	100.0
	Total	50	100.0	100.0	

The operators own about 60% of motorcycles currently in operation themselves, while the remaining 40% are operated on behalf of the owners. Ownership is a motivational factor universally seen as necessary for operational efficiency, profitability and sustainability of operations (Fasakin, 2002).

More than 60% of the taxicabs and buses in operation in Akure are run on behalf of “the owners” who determines the terms of operation. Operators of these modes are made to work extra hard in order to meet the target delivery for the day.

Generally the period of operation of para-transit modes is from 6.00am to 9.00pm. However about 14% of operators start earlier and 7% stop later to catch on those making early and late trips.

1 person operates 60% of commercial motorcycles while 2 or more persons operate 40% in turn. 1 person operates about 40% of taxis while 2 persons operate 60%. 2 persons operate majority of the buses.

For modes operated by two persons the handing over time is 1.00pm or other times as agreed upon by operators. The resting period for singular operator is between 12 – 2pm. Other periods of rest for operators is during the

inter trip waiting time which is maximum of 10 minutes, during the rush hours and about 20 – 30 minutes at other periods of the day.

The effective hours of daily operation per operator are generally between 5 and 8 hours. If one considers the physical rigour of operating para-transit modes, working up to 8 hours is considered hazardous to health and efficiency.

More than 14% of commercial motorcycle operators have less than 1-year experience while 56.4% have more than 2 years experience. For other modes 9.2%, 30.8%, 25.8% and 34.2% of operators have less than 1 year, 2-5 years, 6 – 10 years and more than 10 years experience respectively. This shows that majority of operators are quite experienced on the job but the commercial motorcycle operators have much less experience on the job than other Para transit modes. This finding seems to indicate the commercial motorcycles graduate to other vocations after mobilizing sufficient funds. In simple terms, operators of commercial motorcycles do not take the vocation as a career but more as a stop-gap till better opportunities come up. This observation has far reaching implications on the sustainability of the motorcycle mode of public transportation.

Most operators had prior experience in either automobile repairs or other trades and jobs before joining para-transit business. For example 28% of Okada riders were mechanics while others were carpenters, businessmen and farmers. 50% of taxi cab operators were either Mechanics, Vulcanizers or Panel beaters, 14% were civil servants while others engaged in other jobs like Tailoring,

Carpentry and Trading. 62% of Bus operators had prior experience in automobile repairs while others engaged in other jobs like Bricklaying and trading.

The average daily take-home for Okada, taxi cab and minibus operators are N350, N500 and N700 respectively after delivery and deduction of expenses incurred in running the vehicle. 60%, 32% and 28% of operators of taxi cab, minibus respectively solely depend on income from para-transit business, while others supplement their income by engaging in other jobs as previously highlighted.

Most of the operators would however consent to alternative jobs provided they are less rigorous and would result in increased income.

Most of the operators would not like to pass on the transport business to their children except as transport owners in future. They rather wish they pursued their education for now.

3.5.4 USERS

The survey shows that patrons of Para-transit modes in Akure are 46% male and 54% female. The distribution shows that 58%, 16%, and 14% of the male patronize taxi, motorcycle, and bus respectively. The remaining 12% choose to walk. The modal split distribution shows that 68%, 14%, and 10% of the female patronize taxi, motorcycle, and bus respectively, while the remaining 8% choose to walk. Detail distributions are shown in Tables 11a and 11b.

Table 11a: Male Users Patronage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Taxi	29	58.0	58.0	58.0
	Motorcycle	8	16.0	16.0	74.0
	Bus	7	14.0	14.0	88.0
	Walk	6	12.0	12.0	100.0
	Total	50	100.0	100.0	

Table 11b: Female Users Patronage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Taxi	34	68.0	68.0	68.0
	Motorcycle	7	14.0	14.0	82.0
	Bus	5	10.0	10.0	92.0
	Walk	4	8.0	8.0	100.0
	Total	50	100.0	100.0	

Also 67% of patrons of Para-transit modes are married while 33% are single. The distribution among the married for taxi, motorcycle, bus and walk trip are 70%, 10%, 14% and 6% respectively. While the distribution among the single for taxi, motorcycle, bus and walk trips are 68%, 18%, 4% and 10% respectively. Detail distributions are shown in Tables 12a and 12b.

Table 12a: Patronage Among The Married

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Taxi	35	70.0	70.0	70.0
	Motorcycle	5	10.0	10.0	80.0
	Bus	7	14.0	14.0	94.0
	Walk	3	6.0	6.0	100.0
	Total	50	100.0	100.0	

Table 12b: Patronage Among The Single

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Taxi	34	68.0	68.0	68.0
	Motorcycle	9	18.0	18.0	86.0
	Bus	2	4.0	4.0	90.0
	Walk	5	10.0	10.0	100.0
	Total	50	100.0	100.0	

3.5.5 COST OF TRAVEL BY PARA-TRANSIT MODES

The average cost of travel by Bus, taxi and motorcycles are N3.3/km, N5.4/km and N11.7/km respectively. Hence the most expensive mode per km is motorcycle. These values were obtained from Table 7 with the knowledge that at the average distance covered by each mode, the travel cost is N20.00.

3.5.6 SAFETY RECORDS

Accident records in Akure from January 2002 to July 2002 obtained from the MTD show that of all the vehicles involved in accident during the period, 35.8% were private cars, 23.45% were taxis, 17.28% were okadas, 12.96 were Buses while 10.50% were Lorries/trailers. Compared with relative use, buses are the safest while motorcycles are the least safe. Inexperience on the part of

many drivers of private cars and competition for passengers by drivers of the Para-transit modes which often results in reckless and aggressive driving and ill maintained vehicles are some of the reasons for occurrence of accidents.

3.5.7 ORGANISATION AND REGULATION

The Para-transit sector in Akure is well coordinated and administered.

These

responsibilities fall principally on the shoulders of Association and Unions.

These Associations/Unions are: -

- Amalgamated Commercial Motorcycle Owners and Riders Association of Nigeria. (ACOMORAN).
- Ondo State Taxi Drivers Co-operative Multipurpose Union.
- Road Transport Employers Association of Nigeria (RTEAN) and
- National Union of Road Transport Workers (NURTW).

ACOMORAN oversees the activities of commercial motorcycle (okada) operators, while Ondo State Taxi Drivers Co-operative Multipurpose Union is concerned with the activities of taxi cab operators. RTEAN oversees the activities of Bus operators while the NURTW is the Umbrella body for all the associations.

Most of these Unions are recognized nationwide and operate at Federal, State and Local Government levels. They have state secretariats and branches in Akure being the state capital. Each Association/Union is administered by elected officials comprising of chairman, vice-chairman, Secretary, Financial

Secretary, Treasurer, Public Relations Officer, Auditors, Trustees etc. The officers meet at least once every month to discuss Union matters.

Members register with the Associations/Unions by collecting registration forms which cost N200 for most Unions but it is N2,000 for the RTEAN. This amount also covers the cost of Identity Cards for members. While operating, members pay between N10 – N20 daily for tickets.

Part of the dues realised are used in administering the union and paying salaries of workers in the secretariat.

The Associations/Unions maintain some levels of regulatory control over Market entry, Indemnification, Pricing, Service practices and vehicle fitness, etc. Other duties to members include:-

- Protection of the interest of members and serving as media through which the government at various levels could reach members.
- Supporting the members financially especially when they are involved in accident.
- Liaison with security operatives for help that may be useful to members as well as recovery of stolen vehicles in cases of reported theft.
- Organizing seminars for members.

So far, government has not been able to do much to protect the patrons other than dialoguing at times with union leaders to reduce price in the face of

impending hike. In the absence of an effective government control machinery, the Unions have served as the only regulatory body in the operational schemes.

Union duties to Government include:-

- Participating in boosting the economy through Para-transit operations, which the Unions organize and regulate.
- Serving as intermediary between members and the Government and as such assisting the government in dissemination of information to their members.

Union duties to the Commuters include:-

- Protection of the commuters from any assault or bad behaviour and sharp practices from any of the operators.
- Helping to recover commuters' missing luggage by keeping them at the unit offices or through announcement on the media.
- Training the operators on how to treat their customers with due respect.

The Associations/ Unions also discipline erring members. The punishment

meted depends on the gravity of offences committed. Disciplinary action include Giving of verbal warning, Imposition of fine, Suspension for a certain period, Expulsion from the union for those in the act of theft and embezzlement.

CHAPTER FOUR

4 INTRA-CITY TRAVEL BEHAVIOUR SURVEY

Intra-city travel behavior survey was conducted between the last quarter of 1999 and the first quarter of 2000 and supported by control study in 2001 and 2002.

Akure metropolis was divided into 9 zones in accordance with land use configuration (as discussed in chapter three) to facilitate the collection of data and their summary.

Data were collected through intensive home interview supported by Roadside interview/rider-ship surveys, general observations and other standard information gathering techniques.

The home interview was conducted using a comprehensive two-part questionnaire – a sample of which is given in Appendix B. The first part collected information on socio-economic characteristics of households while the second part obtained information on trips made by household members.

Information gathered include household size; sex, Age and Marital status of respondents; Nature of employment, Household income, Vehicle ownership, Origin and destination of work/business trips, Origin and destination of social/recreational trips, trip distances, modes of transport used in making trips, factors affecting choice of mode, frequency of trips within the week, etc.

For the survey, a trip was defined as a single one-way journey using any means of transport. For instance if someone travels from home to work that would constitute a trip. If the same person drives from his/her work place during the lunch break to visit a friend and back, this would be recorded as two separate trips. The return home journey after work constitutes a fourth trip. In other words, "trip chains" are desegregated into direct single journeys.

4.1 SAMPLE SIZE

Bureau of Public Roads (1954) and O'flaherty (1974) suggested sample sizes for conducting home - interview Origin - Destination (O-D) Studies. The recommended sample sizes are shown in Table 13.

TABLE 13: RECOMMENDED SAMPLE SIZE FOR CONDUCTING HOME-INTERVIEW O-D STUDIES

Urban Population	Sample Size
< 50,000	1 in 5 dwelling units
50,000 - 150,000	1 in 8
150,000 - 300,000	1 in 10
300,000 - 500,000	1 in 15
500,000 - 1000,000	1 in 20
> 1000000	1 in 25

SOURCE: (O'FLAHERTY, 1974).

Using the 1991 population figure of 239, 124 and a growth rate of 3.5%, the projected population of Akure for year 2000 was estimated as 325,901. The estimation was based on equation (27), (Barclay, 1958).

$$P = P_0 (1 + r)^n \quad \text{-----} \quad (27)$$

Where

n = number of years of projection

r = (assumed as 3.5% per annum)

P_0 = population size at time zero

P = projected population at a time, n years later

Considering the projected population a sample size of 1 in 10 i.e. (10%) was adopted

rather than 1 in 15, (suggested in Table 13) to ensure wider coverage, since the projected population was at the lower limit of the 1 in 15 sample size range.

4.2 SAMPLING PROCEDURE

In order to achieve the sample size of 1 in 10 dwelling units (households), information on the number of households in land use areas of the study site was obtained.

Table 14 gives the breakdown of the approximate number of households in the land use areas (zones) of Akure metropolis and the number of households interviewed. Every 10th household on each street was interviewed in all the zones. Out of approximately 15,946 households in Akure metropolis (Lucas, 1999), 1,595 households were interviewed.

In order to achieve the target sample size, repeated visits had to be made to some of the households.

The administered questionnaires were retrieved and sorted for the purpose of summarizing and analyzing the information obtained.

**TABLE 14: APPROXIMATE NUMBER OF HOUSEHOLDS IN LAND
USE AREAS OF AKURE METROPOLIS**

LAND USE AREA	APPROXIMATE NUMBER OF HOUSEHOLDS	NUMBER OF HOUSEHOLDS INTERVIEWED
Low residential	1200	120
Medium residential	4974	497
High residential	4197	420
Commercial	2478	248
Transport/Recreation	986	98
Educational	697	70
Industrial	738	74
Military	228	23
Public	448	45
TOTAL	15946	1595

(SOURCE: LUCAS, 1999)

4.3 EFFECT OF LANDUSE AND RESIDENTIAL DENSITY ON TRIP RATE.

Tables 15a and 15b give the estimated O-D matrix for inter-zonal weekly business and non business trip exchanges respectively, while Tables 16a and 16b give the number of business and non business trips generated per household and per capita respectively in the land use areas (zones).

Fig. 9a and Fig. 9b illustrate the total number of weekly business trips generated and attracted by each zone while Fig. 10a and Fig. 10b illustrate the

total number of weekly non-business trips generated and attracted by each zone.

The aforementioned Tables and Figures clearly exemplify the effect of land use and residential density on trip rate in the study site.

The volume of business trips generated generally increased with residential density. The high residential zone generated the highest volume of weekly business trips of 126,000 while the military zone generated the lowest volume of 2206. The low volume of trips generated by the military zone may be due to the fact that most of the socio-economic activities are confined within the barracks which is already equipped with primary and secondary schools, health centres, mini-markets etc. This observation clearly shows that the military barracks is an "urban village".

The commercial zone attracted the highest volume of weekly business trips of 68,732 while the Industrial zone attracted the lowest volume of 12,976. The high volume of business trips attracted by the commercial zone is possibly due to the fact that the Central Business District (CBD) is an integral part of this zone. The CBD is where most trips in the metropolis terminate for various business transactions, and for commuters to change or access modes of transport to other parts of the town.

The low volume of trips attracted by the industrial zone could be attributed to the fact that presently there are relatively few industries in the area and activities are at low ebb.

Table 16a, revealed that (for the residential land use areas) Low residential, Medium residential, High residential and Commercial (which is predominantly interspersed with residential buildings akin to High residential land use area) generated 105.83, 136, 300 and 301 weekly trips per household respectively. This is an indication that the volume of trips per household increased with residential density.

The number of weekly business trips generated per capita (i.e. per person) in the Low residential, Medium residential, High residential and Commercial land use areas were 17.64, 15.11, 23.08 and 25.00 respectively. The number of daily business trips generated per capita were 2.52, 2.16, 3.30 and 3.58 respectively. These figures are higher than the range of 0.8 – 2.0 specified by Fouracre and Turner (1992) apparently due to increase in business activities in Akure metropolis over time. It could be observed that the number of daily business trips generated per capita in the low residential zone is higher than that of the Medium residential zone. This probably reflects the higher level of car ownership in the low residential zone. The presence of a vehicle undoubtedly increases the propensity to travel particularly for long distance and discretionary journeys.

The high daily trip rates per capita in the High residential and Commercial zones is probably a reflection of the high level of daily business activities required by an individual to fend for himself and for his family.

The medium residential zone generated the highest volume of weekly non-business trips of 67,095 while the military zone generated the lowest

volume of 1,344. The low volume of non-business trips generated by the military zone may not be unconnected with the fact that most of the social/recreational activities are confined within the barracks.

The commercial zone attracted the highest trips of 64,849 while the Educational zone attracted the lowest volume of 3872. The high volume of non-business trips attracted by the commercial zone is possibly due to the fact that the central market is located in this zone along side shopping centres and relaxation centres. The low volume of non-business trips attracted by the educational zone is apparently due to the fact that most trips to the zone are for the purposes of schooling and working. The Transport/recreation zone attracted the third largest volume of weekly non-business trips of 14,810 obviously because the key recreational/relaxation centres are located in the zone.

The analysis of the volume of weekly non-business trips generated per household and per capita in the land use areas (zones), shows in Table 16b that (for the residential land use areas) Low residential, Medium residential, High residential and Commercial (which is predominantly interspersed with residential buildings akin to High residential) generated 46, 135, 108 and 81.36 trips per household respectively. The number of weekly non-business trips generated per capita in the Low residential, Medium residential, High residential and Commercial land use areas were 7.67, 15.00, 8.31 and 6.78 respectively. The numbers of daily non-business trips generated per capita were 1.10, 2.14, 1.19 and 0.97 respectively. This shows that the Medium residential zone generated the highest number of daily non-business trips per capita.

In the study site, about 66% of the total number of trips were business trips while about 34% were non-business trips.

TABLE 15a: O – D MATRIX FOR INTERZONAL – WEEKLY – BUSINESS TRIP EXCHANGES

To	L. R.	M. R.	H. R.	CM	T/R	ED	ID	ML	PB	TOTAL
From										
L. R.	–	1200	840	2400	600	1440	360	480	5400	12700
M. R.	2485	–	20337	29323	1988	1491	994	2485	8449	67592
H. R.	15120	25200	–	27720	11340	10080	7140	8400	21000	126000
CM	8680	13640	15624	–	2728	21824	2976	1488	7688	74648
T/R	99	198	1485	3960	–	3960	297	99	2475	12573
ED	276	690	799	828	3105	–	690	1035	552	7975
ID	148	592	1480	2146	1850	1628	–	148	1110	9102
ML	23	345	596	690	138	115	69	–	230	2206
PB	90	675	315	1665	45	675	450	45	–	3960
TOTAL	26921	42540	41516	68732	21794	41213	12976	14180	46904	316776

SOURCE: FIELD DATA, (1999)

L. R.	M. R.	H. R.	CM	T/R	ED	ID	ML	PB
Low Residential	Medium Residential	High Residential	Commercial	Transport/ Recreational	Educational	Industrial	Military	Public

LEGEND

**TABLE 15b: O – D MATRIX FOR INTERZONAL – WEEKLY – NON
BUSINESS TRIP EXCHANGES**

To	L. R.	M. R.	H. R.	CM	T/R	ED	ID	ML	PB	TOTAL
From										
L. R.	–	360	1320	1320	360	120	240	360	1440	5520
M. R.	5467	–	15407	35287	3976	497	1988	1491	2982	67095
H. R.	4620	5880	–	18900	5460	1680	2100	2520	4200	45360
CM	2480	4464	5546	–	2480	992	496	992	2728	20178
T/R	396	792	495	1584	–	396	99	297	297	4356
ED	138	276	1380	2070	1380	–	207	69	414	5934
ID	148	296	1110	3700	518	74	–	74	474	6394
ML	92	194	230	368	276	23	23	–	138	1344
PB	1395	180	540	1620	360	90	90	45	–	4320
TOTAL	14736	12442	26028	64849	14810	3872	5243	5848	12673	160501

SOURCE: FIELD DATA, (1999)

TABLE 16a: NUMBER OF WEEKLY BUSINESS TRIPS GENERATED PER HOUSE HOLD AND PER CAPITA IN THE LAND USE AREAS (ZONES)

Land use Area (Zone)	Number of House-holds Sampled	Average Number of Persons Per House-Hold	Total Number of weekly trips generated	Number of weekly trips generated per house-hold	Number of weekly trips per capita	Number of daily trips per capita
L.R	120	6	12700	105.83	17.64	2.52
M.R	497	9	67592	136.00	15.11	2.16
H.R	420	13	126000	300.00	23.08	3.30
C.M	248	12	74648	301.00	25.08	3.58
T/R	98	-	12573	128.30	-	-
E.D	70	-	7975	113.93	-	-
I.D	74	-	9102	123.00	-	-
M.L	23	-	2206	95.91	-	-
P.B	45	-	3960	88.00	-	-
TOTAL	1595	-	316776	198.61	-	-

SOURCE: FIELD SURVEY (1999)

TABLE 16b: NUMBER OF WEEKLY NON BUSINESS TRIPS GENERATED PER HOUSE HOLD AND PER CAPITA IN THE LAND USE AREAS (ZONES)

Land use Area (zone)	Number of House-holds sampled	Average Number of Persons per House-Hold	Number of Weekly Trips Generated	Number of Weekly trips generated per house-hold	Number of weekly trips per capita	Number of daily trips generated per capita
L.R	120	6	5520	46.00	7.67	1.10
M.R	497	9	67095	135.00	15.00	2.14
H.R	420	13	45360	108.00	8.31	1.19
C.M	248	12	20178	81.36	6.78	0.97
T/R	98	-	4356	44.45	-	-
E.D	70	-	5934	84.77	-	-
I.D	74	-	6394	86.41	-	-
M.L	23	-	1344	58.43	-	-
P.B	45	-	4320	96.00	-	-
TOTAL	1595	-	160501	100.63	-	-

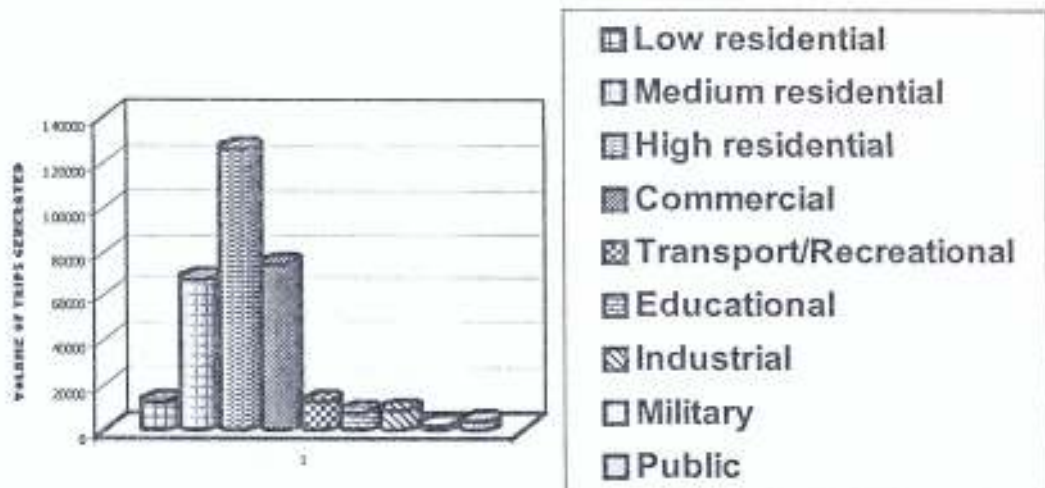


FIG. 9a: TOTAL NUMBER OF BUSINESS TRIPS GENERATED PER ZONE

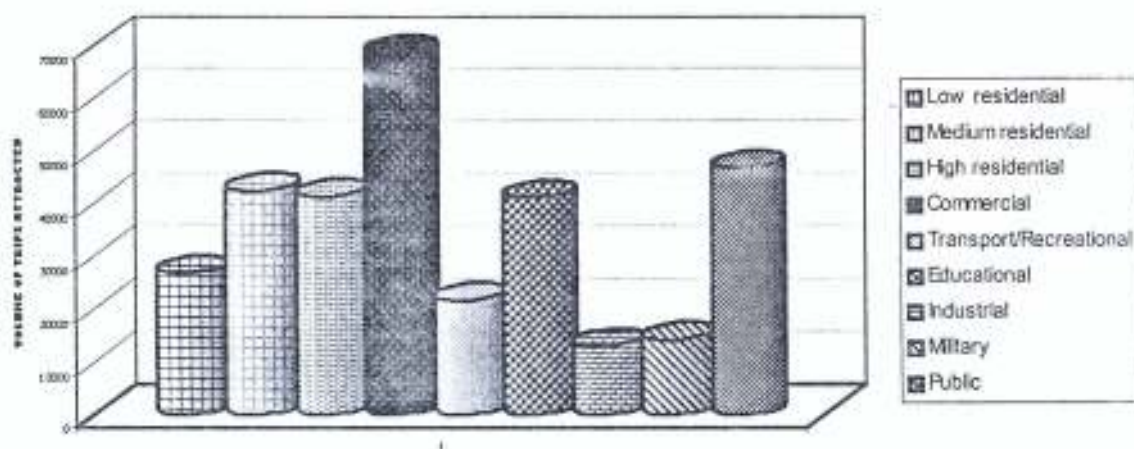


FIG. 9b: TOTAL NUMBER OF BUSINESS TRIPS ATTRACTED BY ZONE



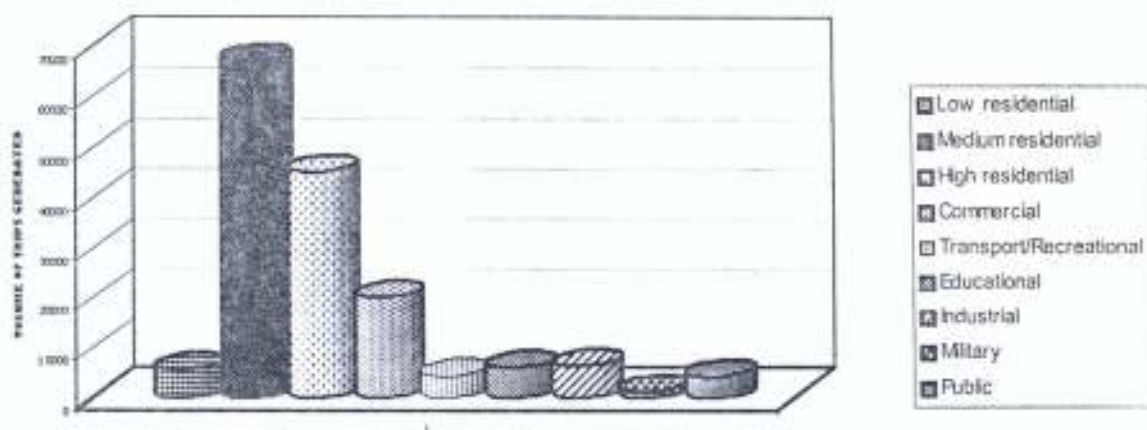


FIG. 10a: TOTAL NUMBER OF NON-BUSINESS TRIPS GENERATED PER ZONE

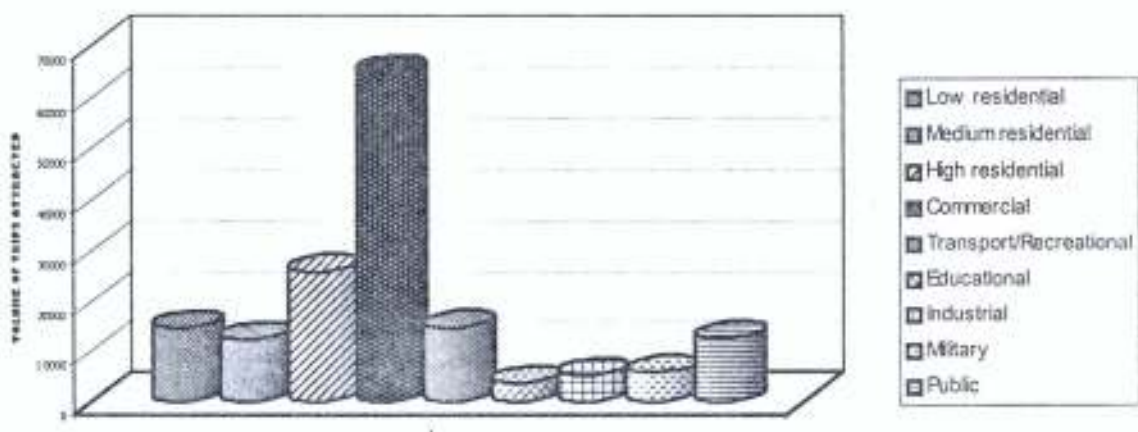


FIG. 10b: TOTAL NUMBER OF NON-BUSINESS TRIPS ATTRACTED BY ZONE

4.4 EFFECT OF INCOME DISTRIBUTION ON CAR OWNERSHIP

Table 17a shows the effect of income distribution on car ownership in the zones. The ownership of cars generally increased with income for all zones. Fig 11 illustrates the trend for all zones. The table also elucidates on the number of cars per household. The average number of cars per household ranged between 0.16 and 0.78, with the Military, Public and Low residential

zones having 0.78, 0.71 and 0.6 cars per household respectively, while Medium residential, High residential and Commercial zones had 0.2, 0.17 and 0.16 respectively. These shows that for the residential land use areas, the number of cars per household increased with reduction in residential density.

In the entire study site, the average number of cars per household was 0.27, and considering an average of 10 persons per household, the number of cars per person in the metropolis was 0.027; i.e. only 2.7% of dwellers owned cars during the period under study. The implication is that 97.3% of the populace depended on public transport which is dominated by the para-transit mode.

Table 17b shows changes in car ownership for high-income households in Solihull, (Hobbs, 1979). The number of cars per household for a household size of 6 (akin to the low residential zone in Akure metropolis) were 1.60 and 2.00 in 1963 and 1968 respectively, while the number of cars per person for the same periods were 0.27 and 0.33. In Akure metropolis, the low residential zone has been observed to have in this study a household size of average of 6 persons per household and the average number of cars per household was 0.6 in 1999 implying 0.1 cars/person which is just about 30% of the values of 0.27 and 0.33 cars per person in Solihull in 1963 and 1968 respectively! However, with the recent increase in wages, there most likely would have an upward trend.

**TABLE 17a: EFFECT OF INCOME DISTRIBUTION ON CAR OWNERSHIP
IN THE ZONES**

Income classes (N/month)	CAR OWNERSHIP IN THE ZONES								
	L. R.	M. R.	H. R.	CM	ED	ID	ML	PB	T/R
< 1000	—	—	—	—	—	—	—	—	—
1000 – 2500	—	—	—	—	—	—	—	—	—
2500 – 4000	—	2	—	—	—	—	—	—	—
4000 – 5500	2	7	2	—	—	—	—	—	2
5500 – 7000	8	9	6	3	1	2	1	2	9
7000 – 8500	18	16	13	10	2	4	2	7	11
8500 – 10000	22	25	24	13	6	8	6	10	15
> 10000	22	40	28	14	9	6	9	13	17
TOTAL	72	99	73	40	18	20	18	32	54
No. of households interviewed	120	497	420	248	70	74	23	45	98
No. of cars/household	0.6	0.2	0.17	0.16	0.26	0.27	0.78	0.71	0.55

SOURCE: FIELD DATA, (1999)

**TABLE 17b: CHANGES IN CAR OWNERSHIP FOR HIGH INCOME
HOUSEHOLDS**

Household size	Cars per household		Cars per person	
	1963	1968	1963	1968
1	0.25	0.33	0.25	0.33
2	0.02	1.30	0.51	0.65
3	1.22	1.66	0.41	0.56
4	1.55	1.75	0.39	0.44
5	1.77	1.67	0.35	0.23
6	1.60	2.00	0.27	0.33
	1.36	1.43	0.40	0.48

SOURCE: HOBBS, (1979)

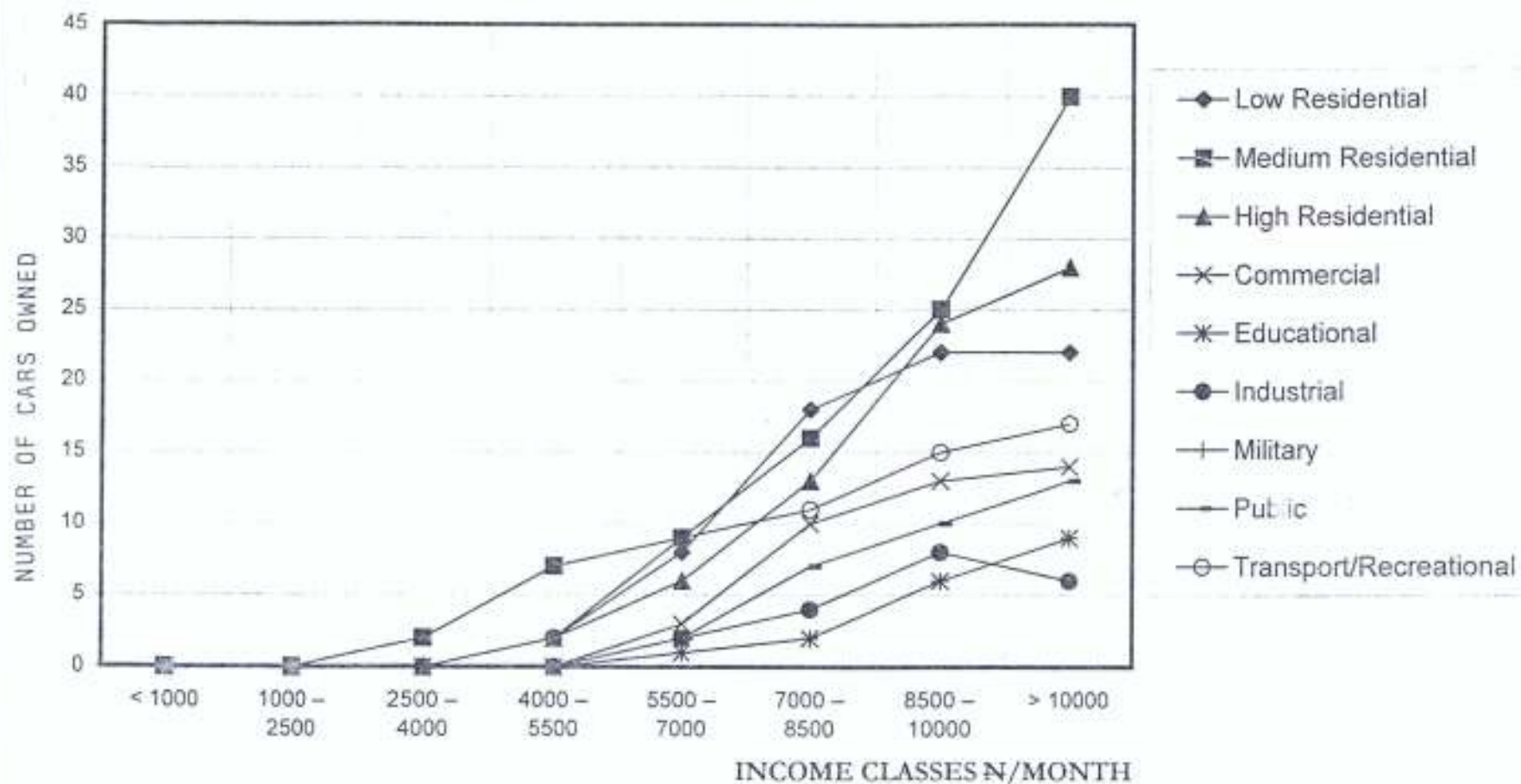


Fig. 11: EFFECT OF INCOME DISTRIBUTION ON CAR OWNERSHIP IN THE ZONES

4.5 MODAL SPLIT

Tables 18a, 18b and 19a, 19b show the modal split for business and non-business trips respectively while Tables 20a and 20b give the proportion of business and non-business trips generated by mode for all zones.

Figures 12a and 12b further illustrate the information contained in Tables 20a and 20b while fig. 13 illustrates the effect of trip type on modal split. On the average, 53% of Intra-city business trips were undertaken by taxi cabs while 22%, 14%, 6% and 5% of the trips were undertaken by private cars/"kabukabu", Buses, motorcycles and walking respectively. (Fig 12c). The ranges of business trips undertaken by taxis, private cars/Kabukabu, Buses, motorcycles and walking were 40-68%, 17-26%, 2-25%, 4-17% and 2-8% respectively. In the same vein, on the average, 45% of intra-city non business trips were undertaken by taxis cabs while 29%, 12%, 10%, and 4% were undertaken by private cars/Kabukabu, Buses, Motorcycles and walking respectively (fig. 12d). The ranges of non-business trips undertaken by taxis, private cars/Kabukabu, Buses, Motorcycles and walking were 30-35%, 23-39%, 2-42%, 3-24% and 1-10% respectively. The analysis above clearly underscores the dominance of para-transit modes as means of transport in the study site.

TABLE 18a: MODAL SPLIT FOR BUSINESS TRIPS

From \ To	L. R.	M. R.	H. R.	CM	ED	ID	PB	T/R	ML	TOTAL	Proportion
L. R.	-	T _{ij} = 1200	840	2400	1440	360	5400	600	480	12720.00	
		P/C = 360	240	720	740	120	840	120	120	3260.00	0.26
		Tk = -	-	-	-	-	960	-	-	960.00	0.075
		T/C = 480	360	1440	720	120	2160	480	360	6120.00	0.48
		BS = -	120	-	480	120	-	-	-	720.00	0.056
		M/C = 360	120	240	-	-	1440	-	-	2160.00	0.17
M. R.	T _{ij} = 2485	-	20377	29323	1491	994	8449	1988	2485	67592.00	
	P/C = 497		2982	3976	497	497	2982	497	497	12425.00	0.198
	Tk = -		1491	994	-	-	497	-	-	2982.00	0.048
	T/C = 1491		9940	16401	497	497	2982	994	994	33796.00	0.54
	BS = -		4473	5467	497	-	884	497	-	11818.00	0.19
	M/C = 497		994	2485	-	-	994	-	497	5467.00	0.09
H. R.	T _{ij} = 15120	25200	-	27720	10080	7140	21000	11340	8400	126000.0	
	P/C = 3360	4200		5040	2100	1680	6300	2100	1680	26460.00	0.21
	Tk = 840	1260		4200	-	420	840	1680	840	10080.00	0.08
	T/C = 9240	15540		13020	5460	2940	11340	5460	5040	68040.00	0.54
	BS = -	3360		-	2520	1680	-	2100	-	9660.00	0.076
	M/C = 1680	840		5460	-	420	2520	-	840	11760.00	0.093
CM	T _{ij} = 8680	13640	15624	-	21824	2976	7688	2728	1488	74648.00	
	P/C = 1904	1984	2480		3224	796	1984	248	248	12868.00	0.17
	Tk = 494	1240	2232		-	248	496	-	248	4958.00	0.06
	T/C = 5450	6944	7936		11160	992	4464	1730	992	39668.00	0.53
	BS = -	-	2480		7440	1240	-	744	-	11904.00	0.16
	M/C = 744	744	496		-	-	744	-	-	2728.00	0.036
ED	T _{ij} = 276	690	759	828	-	690	552	552	1035	5382.00	
	P/C = 138	138	207	138		138	138	138	150	1185.00	0.22
	Tk = -	-	69	-		138	-	-	-	207.00	0.038
	T/C = 138	414	345	414		414	414	414	775	3328.00	0.62
	BS = -	138	138	276		-	-	-	110	662.00	0.12
	M/C = -	-	-	-		-	-	-	-	-	-

TABLE 18b:

MODAL SPLIT FOR BUSINESS TRIPS

From \ To	L. R.	M. R.	H. R.	CM	ED	ID	PB	T/R	ML	TOTAL	Proportion
ID	$T_{ij} = 148$	592	1480	2146	1628	-	1110	1850	148	9102.00	
	$P/C = 74$	148	444	296	370		444	370	74	2220.00	0.24
	$Tk = -$	-	74	-	222		-	296	-	592.00	0.06
	$T/C = 74$	370	370	1110	444		518	740	74	3700.00	0.4
	$BS = -$	74	592	740	592		-	296	-	2294.00	0.25
	$M/C = -$	-	-	-	-		148	-	-	148.00	0.016
PB	$T_{ij} = 90$	675	315	1665	675	400	-	45	45	3910.00	
	$P/C = 45$	180	90	450	180	90		-	45	1080.00	0.27
	$Tk = -$	-	-	90	-	-		-	-	90.00	0.02
	$T/C = 45$	360	180	810	315	270		45	-	2025.00	0.52
	$BS = -$	90	45	180	180	90		-	-	585.00	0.15
	$M/C = -$	45	-	135	-	-		-	-	180.00	0.046
T/R	$T_{ij} = 99$	99	1485	3960	3960	297	2475	-	99	12474.00	
	$P/C = -$	-	198	693	792	99	1089		-	2871.00	0.23
	$Tk = -$	-	-	198	279	-	-		-	477.00	0.038
	$T/C = 99$	60	990	2079	1782	198	990		99	6297.00	0.5
	$BS = -$	39	297	990	1089	-	396		-	2811.00	0.23
	$M/C = -$	-	-	-	-	-	-		-	-	-
ML	$T_{ij} = 73$	345	598	690	115	69	230	138	-	2258.00	
	$P/C = -$	69	115	92	23	46	69	46		460.00	0.2
	$Tk = -$	46	-	46	-	-	-	-		92.00	0.04
	$T/C = 73$	161	483	506	92	23	128	92		1558.00	0.68
	$BS = -$	-	-	46	-	-	-	-		46.00	0.02
	$M/C = -$	69	-	-	-	-	23	-		92.00	0.04

SOURCE: FIELD SURVEY, 1999

LEGEND

T_{ij}	Total volume of trips from zone i to zone j	T/C	Taxi cabs
P/C	Private cars	BS	Buses

TABLE 19 a:

MODAL SPLIT FOR NON-BUSINESS TRIPS

From \ To	L. R.	M. R.	H. R.	CM	ED	ID	PB	T/R	ML	TOTAL	Proportion
L. R.		$T_{ij} = 360$	1320	1320	120	240	1440	360	360	5520.00	
		$P/C = 120$	240	360	120	120	360	120	120	1560.00	0.28
		$T_k = -$	120	-	-	-	480	-	-	600.00	0.1
		$T/C = 120$	840	740	-	120	-	240	240	2300.00	0.42
		$BS = -$	120	-	-	-	-	-	-	120.00	0.02
		$M/C = 120$	-	240	-	-	600	-	-	960.00	0.17
M. R.	$T_{ij} = 5467$		35287	15407	1988	497	2982	3976	1491	67095.00	
	$P/C = 1491$		6958	3479	497	497	994	994	497	15407.00	0.23
	$T_k = 497$		2982	1491	-	-	-	-	-	4970.00	0.07
	$T/C = 2982$		11920	6950	994	-	1491	2485	994	27816.00	0.41
	$BS = -$		4970	1491	497	-	-	497	-	7455.00	0.11
	$M/C = 497$		7455	1988	-	-	497	-	-	10437.00	0.16
H. R.	$T_{ij} = 4620$	5880		18900	1680	2100	4200	5460	2520	45360.00	
	$P/C = 1680$	1620		5880	420	420	1680	1680	420	13800.00	0.3
	$T_k = -$	840		1680	-	-	-	420	-	2940.00	0.06
	$T/C = 7140$	2940		6720	840	1260	1680	2100	2100	24780.00	0.55
	$BS = -$	-		2100	420	420	-	1260	-	4200.00	0.09
	$M/C = -$	420		2520	-	-	840	-	-	3780.00	0.08
CM	$T_{ij} = 2480$	4464	5456		992	476	2728	2480	992	20068.00	
	$P/C = 496$	744	1240		248	248	744	744	248	4712.00	0.23
	$T_k = -$	248	496		-	-	-	-	-	744.00	0.04
	$T/C = 1736$	2232	1736		496	-	1488	488	744	8920.00	0.09
	$BS = -$	744	492		248	248	-	248	-	1980.00	0.08
	$M/C = 240$	496	496		-	-	496	-	-	1728.00	
ED	$T_{ij} = 130$	276	1380	2070		207	414	1380	69	5926.00	0.24
	$P/C = 69$	69	345	483		69	138	207	69	1449.00	0.04
	$T_k = -$	-	138	-		69	-	69	-	276.00	0.52
	$T/C = 69$	138	897	1035		69	276	621	-	3105.00	0.18
	$BS = -$	69	-	552		-	-	483	-	1104.00	-
	$M/C = -$	-	-	-		-	-	-	-	-	-

TABLE19b:

MODAL SPLIT FOR NON-BUSINESS TRIPS

From To	L. R.	M. R.	H. R.	CM	ED	ID	PB	T/R	ML	TOTAL	Proportion
ID	T _{ij} = 148	296	1110	3700	74	-	444	518	74	6364.00	
	P/C = 74	74	296	740	74		148	148	74	1628.00	0.26
	Tk = -	-	-	74	-		-	-	-	74.00	0.01
	T/C = 74	148	518	666	-		222	296	-	1924.00	0.3
	BS = -	74	296	2220	-		-	74	-	2664.00	0.42
	M/C = -	-	-	-	-		74	-	-	74.00	0.1
PB	T _{ij} = 1395	180	540	1620	90	135	-	360	45	4365.00	
	P/C = 315	45	180	450	45	90		135	45	1305.00	0.29
	Tk = 180	-	-	45	-	-		-	-	225.00	0.05
	T/C = 720	45	315	720	45	45		180	-	2070.00	0.47
	BS = -	-	-	-	-	-		-	-	-	-
	M/C = 450	90	45	405	-	-		45	-	1035.00	0.24
T/R	T _{ij} = 396	792	495	1584	396	99	297	-	297	4356.00	
	P/C = 198	297	198	594	-	99	198		99	1683.00	0.39
	Tk = -	-	-	-	-	-	-		-	-	-
	T/C = 198	396	297	594	198	-	99		198	1980.00	0.45
	BS = -	99	-	396	198	-	-		-	693.00	0.16
	M/C = -	-	-	-	-	-	-		-	-	-
ML	T _{ij} = 92	184	230	368	23	23	138	276	-	1334.00	
	P/C = 46	46	69	115	23	23	46	92		460.00	0.34
	Tk = -	-	-	46	-	-	-	-		46.00	0.03
	T/C = 46	115	138	207	-	-	69	138		713.00	0.53
	BS = -	23	-	-	-	-	-	46		69.00	0.05
	M/C = -	-	23	-	-	-	23	-		46.00	0.03

SOURCE: FIELD SURVEY, 1999

TABLE 20a: PROPORTION OF BUSINESS TRIPS GENERATED BY MODE FOR ALL ZONES

MODES ZONES	PRIVATE CARS	TREKKING	TAXI CABS	BUSES	MOTORCYCLES
L.R	0.26	0.075	0.48	0.056	0.17
M.R	0.198	0.048	0.54	0.19	0.09
H.R	0.21	0.08	0.54	0.076	0.093
C.M	0.17	0.06	0.53	0.16	0.036
E.D	0.22	0.038	0.62	0.12	-
I.D	0.24	0.06	0.40	0.25	0.016
P.B	0.27	0.02	0.52	0.15	0.046
T/R	0.23	0.038	0.5	0.23	-
M.L	0.2	0.04	0.68	0.02	0.04
Overall Average for all zones	0.222	0.051	0.534	0.139	0.055

SOURCE: FIELD SURVEY (1999).

TABLE 20b: PROPORTION OF NON- BUSINESS TRIPS GENERATED BY MODE FOR ALL ZONES

MODES ZONES	PRIVATE CARS	TREKKING	TAXI CABS	BUSES	MOTORCYCLES
L.R	0.28	0.1	0.42	0.02	0.17
M.R	0.23	0.07	0.41	0.11	0.16
H.R	0.3	0.06	0.55	0.09	0.08
C.M	0.23	0.04	0.44	0.09	0.08
E.D	0.24	0.04	0.52	0.18	-
I.D	0.26	0.01	0.30	0.42	0.10
P.B	0.29	0.05	0.47	-	0.24
T/R	0.39	-	0.45	0.16	-
M.L	0.34	0.03	0.53	0.05	0.03
Overall Average for all zones	0.284	0.044	0.454	0.124	0.096

SOURCE: FIELD SURVEY (1999).

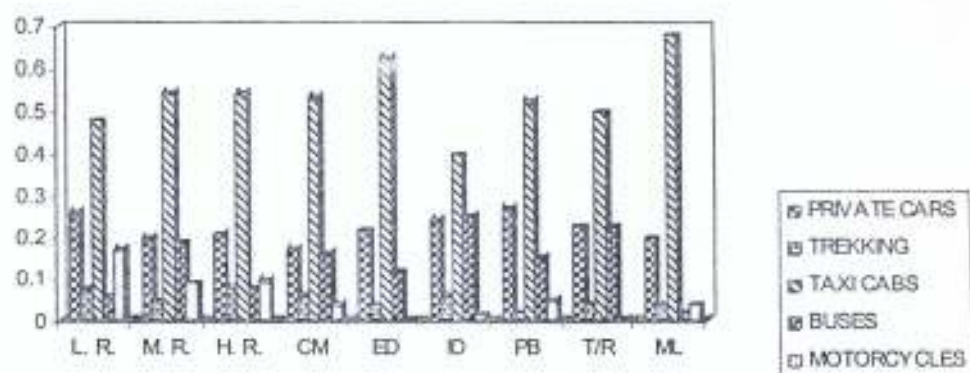


fig. 12a: PROPORTION OF BUSINESS TRIPS GENERATED BY MODE FOR ALL ZONES.

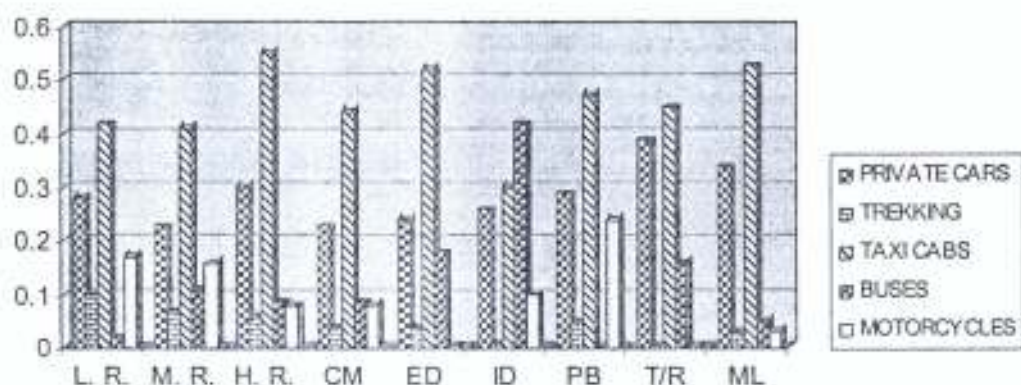


fig. 12b: PROPORTION OF NON BUSINESS TRIPS GENERATED BY MODE FOR ALL ZONES

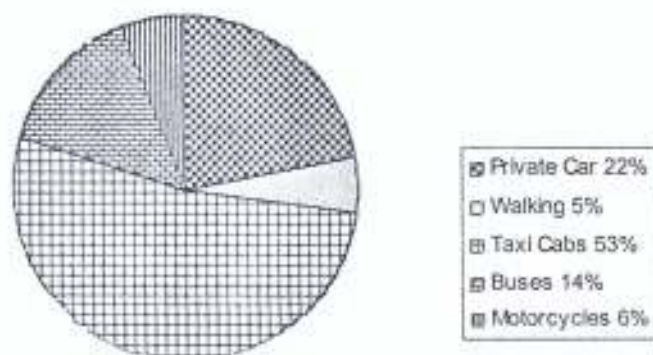


Fig 12c: PROPORTION OF BUSINESS TRIPS BY MODE

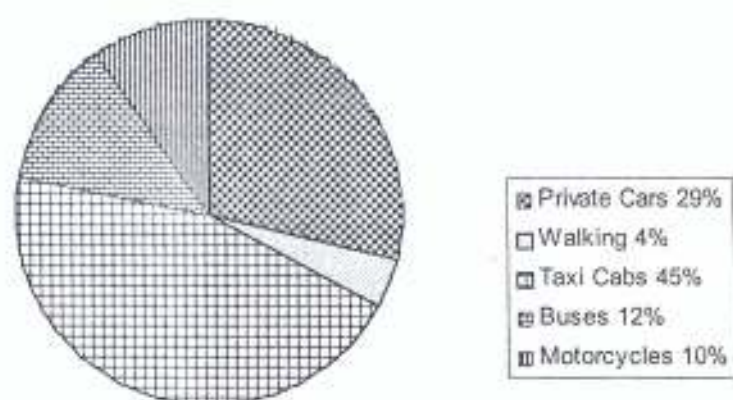


Fig 12d: PROPORTION OF NON BUSINESS TRIPS BY MODE

4.5.1 EFFECT OF TRIP TYPE ON MODAL SPLIT

Fig. 13 illustrates the effect of trip type on modal split. The proportions of business trips by walking, Taxi cabs and buses were higher than the proportions of non-business trips by the same modes. The proportions of business trips by private cars and motorcycles were however lower than the proportion of non-business trips by these modes. The reversal in trend for the two modes is possibly a reflection of the fact that those who make non business trips i.e. visit to friends and relations, attend, social, recreational functions etc do so because they can afford it, as the cost of travel by private cars and motorcycles in the study site are higher than the cost of travel by other modes (Owolabi, 2002). Also, the need to reach destination promptly for business trips makes it important to use reliable modes, hence the wider use of cars and motorcycles for trips than for non-business trips.

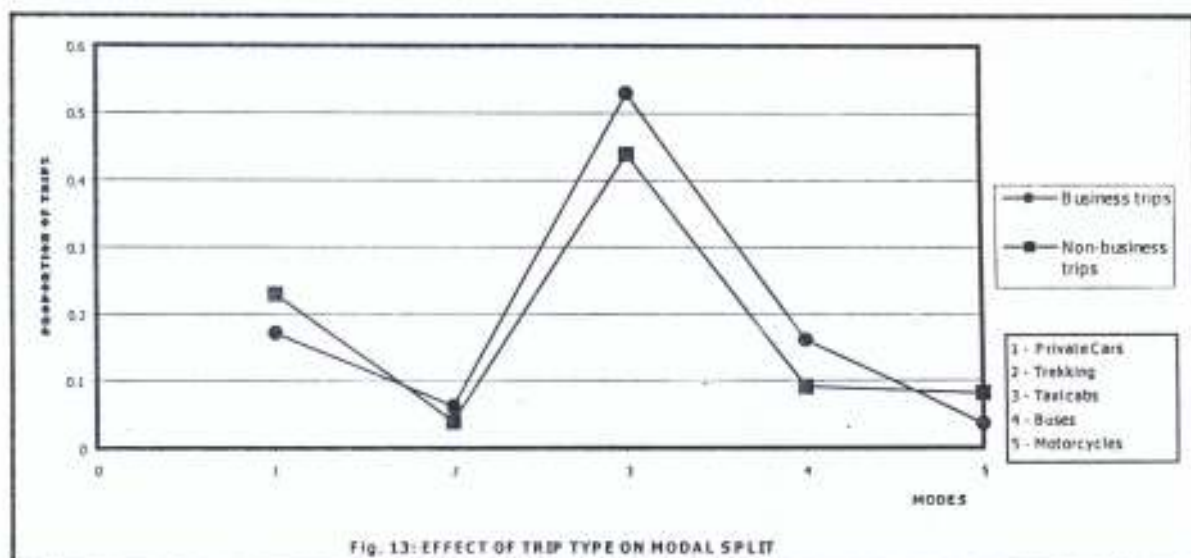


Fig. 13: EFFECT OF TRIP TYPE ON MODAL SPLIT

4.5.2 ATTITUDES TO PARA-TRANSIT SERVICES IN THE STUDY AREA.

Table 21 and Figure 14 illustrates the reasons for commuters' choice of para-transit modes for business trips. The reasons considered include. Cost, speed, availability, absence of alternative, comfort and convenience.

The analyses reveal that majority of those who patronize taxicabs do so because it is readily available (44.4%) and comfortable (34.9%). Reasons adduced by commuters for patronizing motorcycles are that it is convenient (33.4%), readily available (29.6%), faster (18.5%) and the only mode available to them (18.5%). Those who patronize Buses do so because it is cheaper. The 'convenience' of motorcycle for travel might have been based on its ability to penetrate suburbs where other modes would not reach.

Taking the Para-transit modes together, majority of commuters patronize them either because they are readily available (38.7%) and comfortable (33.3%).

Without prejudice to the safety records of para-transit modes in Akure metropolis as earlier discussed in chapter three, commuters do not consider safety as a major factor in choosing travel mode perhaps because of lack of alternatives!

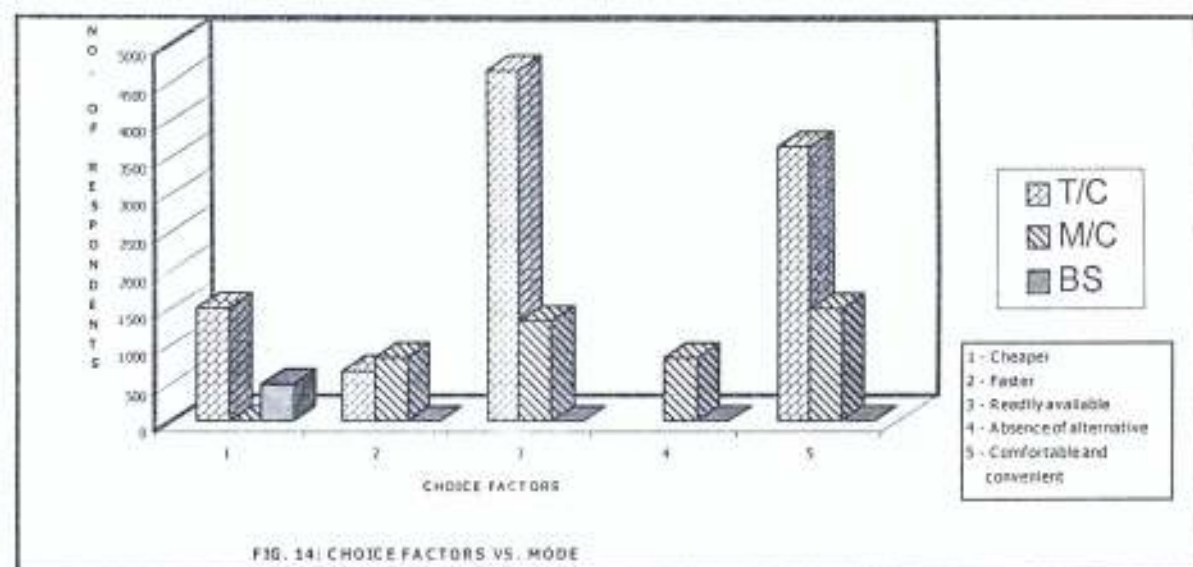


TABLE 21 REASONS FOR COMMUTERS CHOICE OF MODE OF PUBLIC TRANSPORT FOR BUSINESS TRIP

REASONS	T/C		M/C		BS		TOTAL	%
		%		%		%		
Cheaper	1494	14.3	-	-	498	100	1992	12.9
Faster	664	6.4	830	18.5			1494	9.7
Readily available	4648	44.4	1328	29.6	-		5976	38.7
Absence of alternative	-	-	830	18.5	-		830	5.4
Comfortable and convenient	3652	34.9	1494	33.4	-		5146	33.3
TOTAL	10458	100	4482	100	498	100	15438	100

SOURCE: FIELD DATA. (1999)

CHAPTER FIVE

MODELING OF MODAL CHOICE IN AKURE METROPOLIS

5.1 Preamble

The Behavioural travel Demand Model was used in analyzing the effects of transport attributes and socio-economic characteristics of commuters on modal choice. The behavioural travel demand model is quite revealing of the influence of service qualities of the different modes and individual peculiarities in modal choice. These features of behavioural travel demand models make them more robust than the erstwhile deterministic travel demand models discussed in section 2. The relevant transport attributes in relation to the models are: In-vehicle travel time, waiting time, walking time and travel cost, while the relevant attributes of the individual include annual income, most especially in developing economies. Domencich & Mc Fadden. (1998).

Domencich and Mc Fadden (1998) defines the preference or utility function for individual while choosing between two modes a and b as

$$P_{ab} = \frac{\{ (I_a - I_b) + (W_b - W_b) + (R_a - R_b) \} - \beta (C_a - C_b)}{(Y_a - Y_b)} \quad \text{-----(28)}$$

Where P_{ab} = Preference function for individual

$(I_a - I_b)$ = Difference in In-vehicle travel time between modes a and b.

$(W_a - W_b)$ = Difference in waiting time between modes a and b

$(R_a - R_b)$ = Difference in walking time involved in using modes a and b

$(C_a - C_b)$ = Difference in travel cost between modes a and b

$(Y_a - Y_b)$ = Difference in annual income of commuters using modes a and b in thousands of Naira.

John Black (1981) defines the preference function in terms of transport attributes only as

$$P_{ab} = K + \beta_1 (I_a - I_b) + \beta_2 (W_a - W_b) + \beta_3 (R_a - R_b) + \beta_4 (C_a - C_b) \dots \dots \dots (29)$$

Where P_{ab} = preference function for individual I

K = value of constant to be determined

Where P_{ab} = preference function for individual i

K = value of constant to be determined

$\beta_1, \beta_2, \beta_3, \beta_4$ = coefficients to be empirically determined.

5.2 DETERMINATION OF MODEL PARAMETERS

In order to calibrate the model in equation 29 local data was sourced. Data on transport attributes were collected for equidistant trips by all modes within Akure metropolis during the rush hours. Information on annual income of commuters were simultaneously gathered. The data were imputed and analyzed using computer software namely SPSS Version 10 and S PLUS 2000 Professional. Table 22 a-f and 24..... give the coefficients and model

summary for all possible pairing of modes. The modes were represented as follows:

Taxi = a

Motorcycle = b

Kabukabu = c

Bus = d

Applying the determined coefficients, the expressions for the values of preference functions for all possible pairing of modes are as follows:-

$$P_{ab} = 0.126 + 1.272 (I_a - I_b) + 1.019 (W_a - W_b) + 0.937(R_a - R_b) - 0.0258 (C_a - C_b) \dots\dots\dots(30)$$

$$P_{ac} = 0.315 - 0.742 (I_a - I_c) - 0.738 (W_a - W_c) - 0.684 (R_a - R_c) - 0.0259 (C_a - C_c) \dots\dots\dots(31)$$

$$P_{ad} = 3.237 - 0.512 (I_a - I_d) - 0.0881 (W_a - W_d) - 0.426 (R_a - R_d) + 0.02302 (C_a - C_d) \dots\dots\dots(32)$$

$$P_{bc} = 1.691 + 0.264 (I_b - I_c) + 0.08551 (W_b - W_c) - 0.0519 (R_b - R_c) + 0.01213 (C_b - C_c) \dots\dots\dots(33)$$

$$P_{bd} = 4.864 - 0.178 (I_b - I_d) + 0.127 (W_b - W_d) - 0.193 (R_b - R_d) + 0.07427 (C_b - C_d) \dots\dots\dots(34)$$

$$P_{cd} = 0.773 - 1.535(I_c - I_d) - 0.866 (W_c - W_d) - 1.341 (R_c - R_d) + 0.0004272 (C_c - C_d) \dots\dots\dots(35)$$

A pair wise comparison was adopted because often times in the study area, commuters are compelled to choose between only two available modes along their routes.

The values of the constant terms in the models (i.e. equations 30 – 35) indicate clearly that both the taxi mode and the motorcycle mode have major inherent advantages, especially over the bus mode (evident from equations 32

and 34). Differences in journey time durations feature most prominently in influencing choices between taxi and motorcycle modes (equation 30) and between taxi and kabukabu modes (equation 31). In the former, high journey time differential favour the taxi mode while in the latter, they favour kabukabu modes.

Similarly, differences in waiting time influences most prominently choices between taxi and motorcycle modes (equation 30), taxi and kabukabu modes (equation 31) as well as between kabukabu and bus modes. As waiting time differences increase, patrons are more likely to switch over to the taxi mode rather than motorcycle. On the contrary, the same situation is likely to divert patronage away from the taxi mode to the kabukabu mode and from the kabukabu mode to the bus mode.

Differences in walking time feature most prominently in influencing choices between taxi and motorcycle modes (equation 30), taxi and kabukabu modes (equation 31) as well as between kabukabu and bus modes (equation 35).

As walking time differences increase, patrons are more likely to switch over to the taxi mode rather than the motorcycle. On the contrary, the same situation is likely to divert patronage away from kabukabu to taxi mode and from the kabukabu mode to the bus mode.

Similarly, difference in travel cost influence most prominently choices between motorcycle and bus modes (equation 34). High cost differential favour the motorcycle mode.

5.3 ESTIMATION OF PROBABILITIES OF MODAL CHOICE

As discussed in section 2.6 under behavioral models, the probability of individual is taking transport alternative a when confronted with choice between alternatives

a and b

$$q_{ab} = \frac{\exp P_{ab}}{1 + \exp P_{ab}} \dots \dots \dots (25)$$

Hence, to estimate the probability that an individual i will take a taxi when confronted with choosing between taxi and motorcycle (q_{ab}) the value of the estimated preference function P_{ab} is substituted in equation 25. The descriptive statistics for the estimated probabilities are given in Table 24.

The Probability that an individual will choose to travel by taxi in preference to motorcycle has an average value of 0.058. This is an indication of preference for motorcycle travel which could be due to the fact that the walking time involved in using the mode is minimal (i.e. it renders doorstep services) in comparison to the taxi mode.

The probability that an individual will choose to travel by taxi in preference to kabukabu has an average value of 0.26. This is an indication of preference for Kabukabu, which could be due to the fact that the waiting time involved in using the mode is less than that of taxi.

The probability that an individual will choose to travel by taxi in preference to bus has on average value of 0.76. This is an indication of *preference for taxi possibly due to less waiting and walking time involved in using the mode when compared with the bus.*

The probability that an individual will choose to travel by Motorcycle in preference to Kabukabu and by motorcycle in preference to bus have average values of 0.82 and 0.78 respectively. This is an indication of preference for motorcycle due to reasons earlier explained.

Lastly, the probability that an individual which choose Kabukabu in preference to bus has an average value of 0.889. This indicates preference for Kabukabu possibly due to less waiting time involved in using the mode.

The possible high patronage enjoyed by motorcycle and Kabukabu as apparent in the above analysis may be a reflection of the fact that the modes catch on the inadequacies of the conventional ones i.e taxi and bus to offer "acceptable" service to commuters in terms of reduced waiting and walking times.

5.4 GOODNESS OF FIT OF MODELS

The goodness of fit of the models or their robustness could be determined from the R square values. The R square values for the models range between 0.721 – 0.785. This shows that the behavioural travel demand model is quite robust in replicating the observed data and it is very appropriate.

5.4.1 Validity Tests

The Standard Error test and the student's test of null hypothesis were used in determining the confidence that may be placed in the estimates of the parameters.

The tests of significant showed that for preference function Pab, the coefficients of ΔW (Difference in waiting time between modes a and b), ΔI (Difference in In-vehicle travel time) and ΔR difference in walking time involved were statically significant while the constant term and the coefficient of ΔC (Difference in cost) were not statistically significant.

For preference function Pac, the tests of significance showed that the coefficients of ΔI and ΔR were statistically significant while the constant term and the coefficients of ΔW and ΔC were not statistically significant.

For preference function Pad the tests of significance showed that the constant term and the coefficient of ΔI were significant while the coefficients of ΔW , ΔR and ΔC were not statistically significant.

For preference function Pbc the tests of significance showed that the constant term and the coefficient of ΔI were statistically significant while the coefficients of ΔW , ΔR and ΔC were not statistically significant.

For preference function Pbd the tests of significant showed that the constant term was significant while the coefficients ΔI , ΔW , ΔR and ΔC were not significant.

For preference function Pcd the tests of significance showed that the constant term and the coefficients of ΔI , ΔW and ΔR were significant while the coefficient of ΔC was not significant.

TABLE 22a: Model Coefficients for Pab

Model	Unstandardized Coefficients		Standardized Coefficients	t.	Sig.
	B	Std. Error	Beta		
(Constant)	.126	.723		.174	.862
Ia - Ib	1.272	.240	.438	5.302	.000
Wa - Wb	1.019	.186	.433	5.467	.000
Ra - Rb	.937	.201	.401	4.660	.000
Ca - Cb	-1.58E-02	.014	-.148	-1.790	.080

TABLE 22b: Model Coefficients for Pac

Mode	Unstandardized Coefficients		Standardized Coefficients	t.	Sig.
	B	Std.	Beta		
(Constant)	.315	.928		.340	.736
Ia - Ic	-.742	.220	-.192	-3.373	.004
Wa - Wc	-.738	.405	-.249	-1.820	.075
Ra - Rc	-.684	.286	-.322	-2.390	.021
Ca - Cc	-2.59E-02	.033	-.108	-.788	.435

TABLE 22c: Model Coefficients for Pad

Model	Unstandardized Coefficients		Standardized Coefficients	t.	Sig.
	B	Std. Error	Beta		
(Constant)	3.237	.224		14.476	.000
Ia - Id	-.512	.157	-.427	-3.257	.002
Wa - Wd	8.81E-02	.101	-.115	-.872	.388
Ra - Rd	-.426	.154	-.363	-2.768	.008
Ca - Cd	2.302E-02	.023	-.121	.983	.331

TABLE 22d: Model Coefficients for Pbc

Mode	Unstandardized Coefficients		Standardized Coefficients	t.	Sig.
	B	Std.	Beta		
(Constant)	1.691	.503		3.359	.002
Ib - Ic	.264	.091	.142	2.90	.044
Wb - Wc	8.551E-02	.335	.038	.255	.800
Rb - Rc	-5.19E-02	.089	-.089	-.586	.561
Cb - Cc	1.213E-02	.059	.031	.205	.839

TABLE 22e: Model Coefficients for Pbd

Mode	Unstandardized Coefficients		Standardized Coefficients	t.	Sig.
	B	Std.	Beta		
(Constant)	4.864	.818		5.946	.000
Ib - Id	-.178	.404	-.064	-.441	.661
Wb - Wd	.127	.135	.138	.939	.353
Rb - Rd	-.193	.127	-.221	-1.524	.134
Cb - Cd	7.427E-02	.082	.130	.910	.368

TABLE 22f: Model Coefficients for Pcd

Mode	Unstandardized Coefficients		Standardized Coefficients	t.	Sig.
	B	Std.	Beta		
(Constant)	.773	.321		2.407	.020
Ic - Id	-1.535	.183	-.956	-8.366	.000
Wc - Wd	-.866	.075	-.896	-11.623	.000
Re - Rd	-1.341	.137	-1.121	-9.796	.000
Cc - Cd	4.272E-04	.006	.005	.073	.942

TABLE 23: Model Summary

Model	R Square
Pab	0.721
Pac	0.811
Pad	0.758
Pbc	0.727
Pbd	0.719
Pcd	0.785

TABLE 24: DESCRIPTIVE STATISTICS FOR ESTIMATED PROBABILITIES

	N	Mean	Std. Deviation	Variance
q _{ab}	50	5.799E-02	5.563E-02	3.094E-03
q _{ac}	50	.2584	.1956	3.825E-02
q _{ad}	50	.7581	.3306	.109
q _{bc}	50	.8200	.3745	.104
q _{bd}	50	.7826	.3245	.105
q _{cd}	50	.8825	.2978	8.871E-02
Valid N (listwise)	50			

Details of estimated probabilities of modal choice are given in table 25 in appendix A

6. PROPOSED STRATEGIES FOR RATIONALIZING AND ENHANCING PARA-TRANSIT SERVICES IN AKURE METROPOLIS

Based on the findings on the operation characteristics of the Para – transit mode in Akure metropolis, the resultant intra modal competition as opposed to complementing themselves and the attendant problems, the following are the proposed strategies for rationalizing and enhancing para-transit services in the metropolis.

6.1. HIGHLIGHTS OF THE INTRA-MODAL COMPETITIONS

The results and observations of the Para transit operations within Akure metropolis show that the various modes compete rather than complement one another. This is obviously not to the advantage of the patrons. A better arrangement would be one where the inherent advantages and preferred features of the various modes are considered in prescribing roles for them through careful design. For example, results captured in equations 30 – 35 in chapter five indicate that:

- Long journeys and long waiting time favour buses over other modes, while short trips and short waiting time favour the motorcycle mode.

- Long walking time favour the taxi mode over other modes while short waiting time favour the motorcycle mode.
- High travel cost favour the motorcycle mode over other modes while low travel cost favour the bus mode.

Besides the limitations due to service characteristics, factors due to inadequacies of operators, institutional issues and environmental factors also combine to accentuate the problems faced by public transport patrons in Akure metropolis. These problems were identified in the earlier sections of the thesis. The strategies and proposals contained in this chapter are aimed at tackling the problems.

6.2 COMPREHENSIVE REDESIGN OF PUBLIC TRANSPORT SERVICE

A radical redesign of public transport service for Akure metropolis is needed. Such a design should make provision for the hierarchies of service needed for smooth functioning of a metropolis. The needed hierarchies are:

- Local/ distributor and collection service
- District or Neighbourhood service
- Trunk Line service

The author's views are as follows:

Local Distributor / Collection Service

These, essentially, should be routes confined to minor arterials and local streets with motorcycles and the rickety kabukabus as the main vehicles. The termini, on the major streets, should be the loading points for the Neighbourhood Service. This is appropriate for the interior parts of the city.

- District or Neighbourhood Service – should emphasize linkages among neighbouring zones without compromising too much on speed. The current taxis and buses would serve appropriately with routes specified but short and the termini should serve as loading points for the Trunk Line Service. This type of service is appropriate for routes linking Oyemekun-Oba Adesida road.
- Trunk Line Service – should emphasize Speed and limited stops. High capacity buses (>20 passengers) and kabukabu in good condition should form the nucleus but as demand builds up, large buses and light trains can replace them. Certainly the routes/corridors served would mature into the high capacity corridors served by metros. At the moment, the trunk line service can be regarded as the “express routes”. Such a service is suitable for Oyemekun-Oba Adesida road.

6.3 MANAGEMENT AND ORGANIZATIONAL OPTIONS.

The current activities of the different route associations and unions of service providers for each para-transit option are useful and constitute a form of self-discipline needed for good operational practices.

To complement what is done by route associations and unions, little prodding is needed by Akure South Akure North local governments since route associations are self initiated. As such, route associations are parochial, focused mainly on the welfare of members, not the riding public. Governments should take steps to reward associations that do things within the broader public interest, such as setting safety standards and enforcing orderly conduct at terminals.

Government promotion might take the form of capital grants, underwriting and subordinating loans, tax exemption, or management assistance.

6.3.1. Strengthening Route Associations for Improved Service Delivery

In Akure metropolis, route association have become de facto cartels (solely) determining market entry and fares. The risk of cartelization can be reduced in several ways. One is to reward non-oligopolistic behaviour. This can be done by tying public assistance to open competition without saturating the market and cultivating a mutual respect and constraints among regulators and associations. Second, government can effect, through licensing and registration that the geographic boundaries of associations overlap.

Associations which compete amongst each other are less likely to gain monopoly control over routes. A way may be worked out by which associations that are assigned unprofitable routes are compensated with profitable ones as well. Hopefully, internal sharing arrangements that would enable members operate on both route types with net benefits can also be arranged by the route associations. In other words, a more formalized route association is needed.

6.3.2 Extension Service as Input to Institutional Strengthening

Most para-transit operators know a lot about running and maintaining vehicles and very little about book keeping, fleet management labour relations or marketing.

Short courses and workshops or other in – field training programmes in the areas of accounting, finance, and business management could go a long way toward improving the organization of services in many settings. Government agencies should provide these routinely as a form of extension service. Where new schemes such as exclusive franchising or competitive tendering are introduced, attention to matters of management training and institution building is all the more important. This will minimize the activities of middlemen” such as franchise holders, absentee owners, touts sub-franchisers (who broker deals between franchise holders and operators), and the bureaucracy of regulators, planners and policy makers, thus making service co-ordination easy.

6.3.3 Reducing Graft and Corruption

The inability of many para-transit operators to sustain the business is rooted in the systematic problem of widespread corruption and graft.

In many instances, politicians at the upper tiers of government tacitly allow unlicensed transportation services with the knowledge that they themselves financially gain from the system of pay – offs.

In Akure where there is a sizeable para-transit sector, sometimes extortion occurs in a decisively bottom-up fashion, with money passing from drivers at the lowest rung to neighbourhood bosses at the middle rung and ultimately to government officials often from police and military institutions.

In a perverse way, corruption allows illegitimate drivers to operate while the same time preventing them from ever earning what should have accrued to them from their investments and labours as public transport service providers. These also encroach on the profit margins of legitimate operators. Effectively, operators end up paying amounts in excess of what they might otherwise have had to pay to formally register and perhaps even purchase liability insurance. Unfortunately, payments go to enrich privileged individuals rather than to finance public transport improvements.

Anything done to stem corruption would doubtlessly benefit the para-transit sector. To those who make a living pedaling and hauling others to and fro, corruption stands as a gargantuan hurdle to personal advancement, and for this reason alone should not be ignored by transport policy makers.

6.4 REGULATORY REFORMS

In coping with para-transit operations, public authorities must decide the appropriate level of intervention along a spectrum ranging from inaction to banishment. The four main choices are Acceptance, Recognition, Regulation and Prohibition.

Extreme policy choices, like acceptance or prohibition are not the solution to the problems posed by the para-transit operation in Akure metropolis. A more prudent course of action is to recognize or regulate para-transit activities. The key distinction between these two “middling” options is that “Recognition” allows the market place to mediate level of supply whereas under “regulation” market, entry and exit externally controlled.

Recognition should involve the issuance and enforcement of rules and standards, mainly concerning permissible hours and areas of operations, curbside behaviour, vehicle specifications, and labour practices. All carriers who meet minimum standards should be free to start a business and should be licensed accordingly. Services should be monitored to ensure rules are adhered to and standards are met. Through regulation, operators are held accountable to a standard that safe guards public safety and well being. Regulations also extend important protection to para-transit operators. One, they help shield operators from the whims of enforcement officers, many of whom (as noted above), see para-transit operators as easy prey for bribes and shake downs. In the absence of regulations, officials are allowed to make up their own rules and

policies, usually to the detriment of operators as well as the riding public. Registration also provides protection against unscrupulous and predatory operators who attempt to intimidate their competitors. And by eliminating over competition, regulations can help ensure a fair return on investment, enabling legitimate operators to purchase insurance, make repairs, renew their licenses, and generally stay above board.

Regulation should focus on the area of safety and insurance coverage because too many times passengers of uninsured carriers have their lives ruined by injuries suffered in traffic accidents without any recompense.

6.5 FINANCIAL INITIATIVES

Two types of financial initiatives are suggested for the material benefit of the para-transit sector in Akure metropolis. One is improving access to credit, a move which would impart equity benefits by allowing cash – poor disadvantaged operators to accumulate capital assets.

The other is financial incentives, like tax reduction and fee exemptions which could improve efficiency by stimulating productive forms of free – enterprise transport.

6.6 INFRASTRUCTURE IMPROVEMENTS

Four types of infrastructure investments would substantially improve the quality of para transit services in Akure metropolis and reduce negative spillovers like traffic congestion along the main trunks and blockage of intersections.

The first is the construction of off street improvements like terminals and staging zones, the second is the provision of on street facilities such as dedicated high – occupancy vehicle (HOV) lanes. The third is the construction of inner ring road to enhance diversion of traffic from the main trunks to less congested outlets, while the fourth is the upgrading of some roads especially those that serve suburbs parallel to the main trunks.

6.6.1 Off – Street Terminals

Terminals are important not only to manage and expedite commute boarding, alighting, and transfers, but also to remove vehicles from surface streets during periods of slack demand and to assist in decongestion the road during the peak periods. Fig 15 shows the off-street parking proposal for Akure metropolis.

6.6.2 Dedicated Lanes

Movement conflicts results in the vulnerability of many para transit modes to accidents as earlier discoursed. Dedicated lanes should be provided where possible for cyclists and other slow moving modes along busy stretches of road.

6.6.3 Construction of Inner Ring Road

The proposal for an Inner ring road is shown in fig 16. When constructed it will enhance diversion of traffic from the main trunks to less congested outlets.

6.6.4 Upgrading of Minor Roads

Figure 16 for the shows the roads to be upgraded to facilitate commuting in the metropolis.

6.7 TRAFFIC MANAGEMENT

Less expensive than capital investments are strategies that optimize the use of existing road space, sometime, referred to as Transportation Demand Management (TDM).

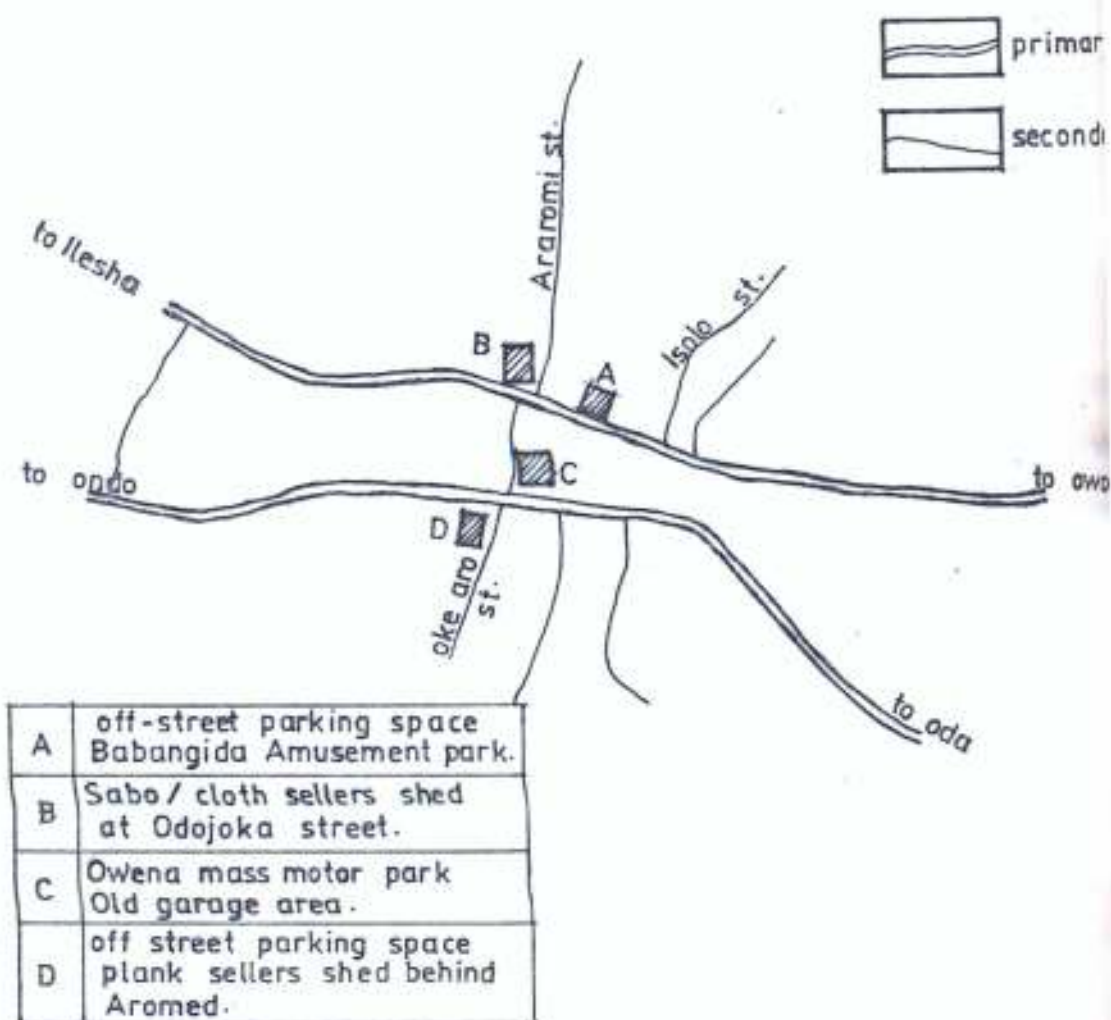


Fig: 15 off street parking facilities

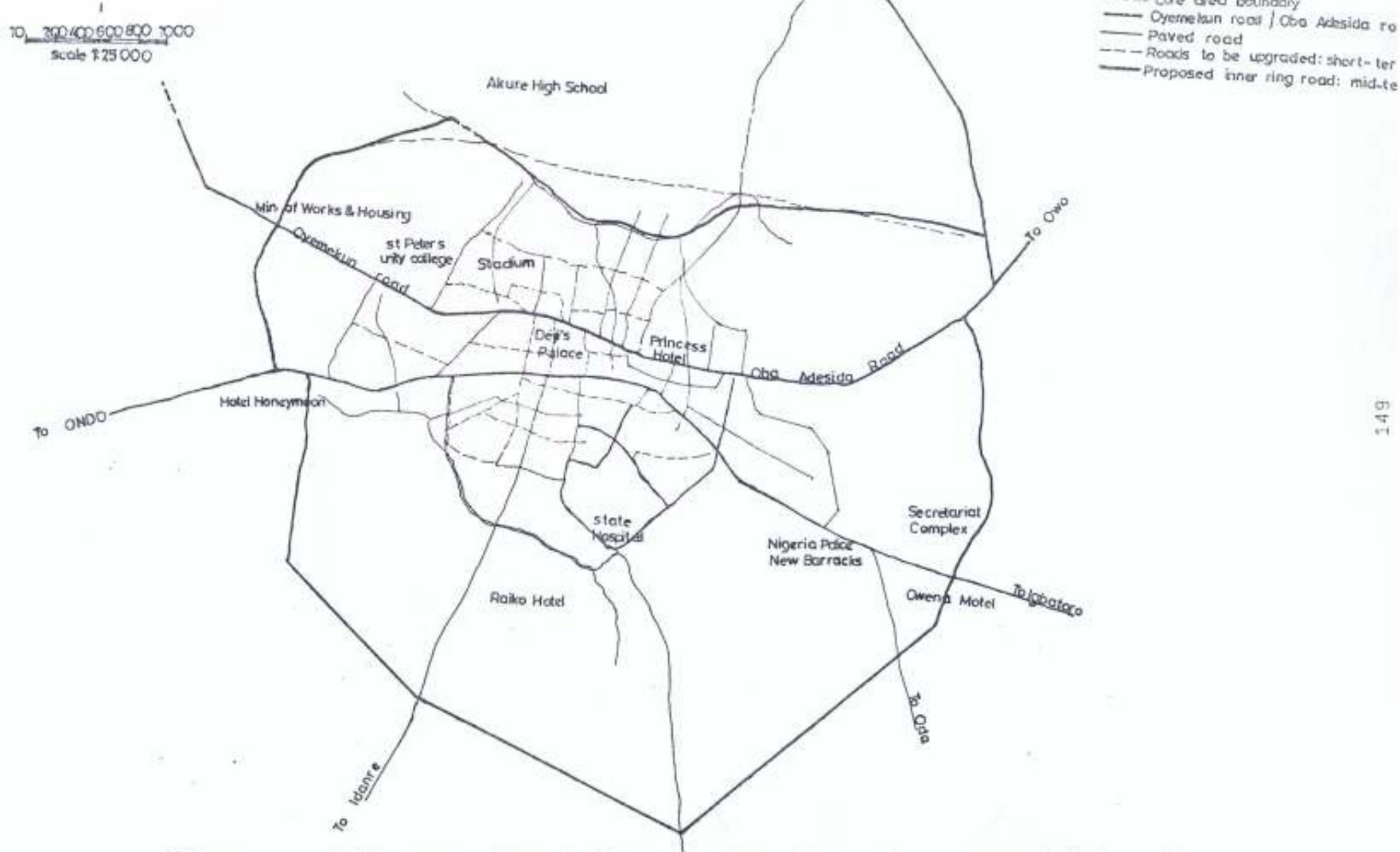


Fig.16 ✕ Mid-term Road Construction Plan for Akure Metropolis

TDM encompasses everything from changing signal phasing to favour-busy approaches to banning truck deliveries during rush hours. These are fast action, quick relief strategies.

In a developing city like Akure, traffic management schemes like curb rationing, physical channelization of traffic streams and controlled queuing of vehicles can be far more cost effective than “gold plated” facilities like metros and express ways. As such, the non-functional traffic signal at the NEPA junction should be resuscitated. Intersection hitherto unchannelized like the Isikan – Arakale junction should be channelized. The one side parking rule for Arakale road should be strictly forced on – street trading and activities at illegal terminals which have reduced the effective width of most major roads in the metropolis by at least 2m should be forbidden. All busy intersections presently without any form of control like the 4 leg intersection around cash hold petrol station should be equipped with traffic control devices or at least manned by traffic wardens.

6.8 TRAINING

Training and education about traffic rules, safe driving practices, and vehicle maintenance would help bring much needed order and discipline to the para-transit sector in Akure metropolis.

Training is especially needed in light of the poor educational levels of many para-transit operators as earlier established.

Illiteracy forms huge barriers to ascertaining knowledge about and learning the particulars of rules and regulations governing vehicle licensing, registration, and operating practices. Thus outreach programmes that are the verbal and conversational opposed to text base are apt to yield the greatest pay-off.

6.9 MASS TRANSIT COMPLEMENT

Re – introduction of mass transit services is advocated through collaborative effort between government and private entrepreneurs, including para-transit operators with artisanal background like auto mechanic, electricians etc. This is to enhance the operations and sustainability of the system. This has become necessary because the services offered by the para-transit mode has proved inadequate during the rush hours.

The scheme could lead to the removal of some of the para-transit modes from the main trunks to the less competitive rousts not fairly served by the present arrangement of dominance by the para-transit mode. This would also assist in decongesting the main streets during the peak periods.

6.10 LAND USE POLICIES

Major aspects of the findings that should influence land use policies in Akure are:

- Majority of poor commuters are captive to the motorcycle mode for direct access to their residences.

- Most operators of the motorcycle mode regard the vocation as a "stepping stone" to more worthwhile engagements and they engage in it because there are no other options.
- Most users of the motorcycle mode use the mode, not out of preference but because there are no alternatives.

There can be no doubt from these findings that the motorcycle mode of service may die a natural death at some future point in time when the potential operators find more worthwhile engagements. It is also possible that if a more acceptable mode emerges, the motorcycle mode of operation may be edged out of existence.

In anticipation of a future without the motorcycle mode of paratransit service, urban sprawl facilitated by it (i.e. low income housing scattered in the periphery of urban centers) should be guided against. A way out is for governments to directly invest in compact low-income housing or to encourage mortgage institutions to invest in such schemes.

CONCLUSION

The entire evaluation of intra modal competition in Akure metropolis Para transit system has shown the significant problems of transportation system in the metropolis that need to be addressed.

The results showed that Oyemekun - Oba Adesida road had the highest volume of traffic followed by Oke Aro, Ondo, Hospital and Arakale roads respectively. The analysis of the composition of traffic also revealed that the most predominant mode of transport in the metropolis were passenger cars which constituted 70.75% of the traffic followed by motorcycle constituting 22.6% and buses, lorries and bicycles constituting 4.03, 2.24 and 0.29% respectively.

The volume of business trips generated generally increased with residential density. The high residential zone generated the highest volume of weekly business tips of 126,000 while the military zone generated the lowest volume of 2206. The low volume of trips generated by the military zone may be due to the fact that most of the socioeconomic activities are confined within the barracks which is already equipped with primary and secondary schools, health centers, mini-markets etc. this observation clearly shows that the military barracks is an "urban village".

The commercial zone attracted the highest volume of weekly business trips of 68,732 while the Industrial zone attracted the lowest volume of 12,976.

The high volume of business trips attracted by the commercial zone is possibly due to the fact that the Central Business District (CBD) is an integral part of this zone. The CBD is where most trips in the metropolis terminate for various business transactions, and for commuters to change or access modes of transport to other parts of the town.

The low volume of trips attracted by the industrial zone could be attributed to the fact that presently there are relatively few industries in the area and activities are at low ebb. The numbers of daily business trips generated per capita were 2.52, 2.16, 3.30 and 3.58 respectively. These figures are higher than the range of 0.8 – 2.0 specified by Fouracre and turner (1992) apparently due to increase in business activities in Akure metropolis over time. It could be observed that the number of daily business trips generated per capita in the low residential zone is higher than that of the Medium residential zone. This probably reflects the higher level of car ownership in the low residential zone. The presence of a vehicle undoubtedly increases the propensity to travel particularly for long distance and discretionary journeys.

The proportion of business trips by walking, Taxi cabs and buses were higher than the proportion of non-business trips by the same modes. The proportion of business trips by private cars and motorcycles were however lower than the proportion of non-business trips by these modes. The reversal in trend for the two modes is possibly a reflection of the fact that those who make non business trips i.e. visit to friends and relations, attend social, recreational functions etc do so

because they can afford it, as the cost of travel by private cars and motorcycles in the study in the study site are higher than the cost of travel by other modes. (Owolabi et al, 2002).

The author having examined this has come up with an improved schematic design model of Akure metropolis' road system, which will accommodate the volume of traffic of the time and the near future.

The investigations in the course of this study have also revealed and confirmed that transportation is a critical factor in regional growth which determines the extent to which an area can capitalize on its economic endowment and as such has to be enhanced. The proposed strategy for enhancement discussed in chapter six which include comprehensive redesign of public transport service, management and organizational options, regulatory reforms, financial initiatives, infrastructure improvements, traffic management and training will go a long way in ameliorating the transportation system in the metropolis.

Also the proposed schematic design of Akure metropolis road network if properly implemented will go a long way in facilitating interaction via the Para transit mode.

REFERENCES

- Adams J. (1981)** Transport planning vision and practice. Routledge and Kegan Paul Ltd., 1st Edition pp 7-8.
- Adebisi O. (1990)** Motorcycles as viable means of transport in urban centres in Nigeria. A paper presented at the third international Transport seminar on transport policy held at Akure 14-16th Nov.
- Adeniji (1983).** Travel Pattern and Travel Methods in Nigeria Urban Centres: A case study of Ibadan NISER, Ibadan 1983, pg 1-4.
- Adeniji K. (1986)** Improved Urban Transportation Systems and the Rapidly growing Towns and Cities in Nigeria. A time for Action. In Adeniyi E. O and Bello – Imam I. B (eds) Development and the Environment Proceeding of a National Conference (N.S.E.R IBADAN 1986) PP 389-395.
- Adesanya A. O. (1986)** Planning for Journey to work. A case study of Jos unpublished master of Urban & Regional Planning Dissertation University of Ibadan.
- Adesina F.(1994)**“Coups, Okada takes over” Weekend Concord Saturday January 8.
- Akinrinde A.(1989)** Fore ward for digest of Transport statistics Federal Ministry of Transport, Lagos, 1989.
- Ayeni. B. (1979)** Concepts of Techniques in Urban Analysis (London: Croon Helm).
- Badami M. (1998)** Improving air quality in Dehil, Habitat Debate Vol. 4, No 2 pg 22-27.

Balassian. R. and Braga M (1999) Buses and Vans: Assessing Public Transport competition in Rio de Janeiro Brazil. Paper Presented at the sixth International Conference on Competition and ownership in land passenger transport, South Africa,

Barbero J. (2000) : Recent Changes and Preparative in Buenos Aires Urban Transportation Buenos Aires Metrovias S. A Unpublished Paper,

Barclay, C. W (1958): Techniques of population Analysis. New York
Harcourt Brace and World.

Black J. (1981): Urban Transport Planning Theory and Practice Groom Helm,
London pg 97-104.

Bolade, T. (1993): Urban Transport in Lagos the Urban Age. Vol. 2
No 1 fall pp 7-8.

Brand D. (1974): Separable versus simultaneous travel choice Behavior.
Transportation Research Board special report, 149, 187-206.

Bureau of Public Roads (1954): Conducting a home – interview origin and
destination survey Procedure Manual 2B . U. S Public Administration services

BURTON M. J. (1985): Introduction to Transportation Planning: 3rd Edition
London: Hutchinson.

Cervero R. (1997): Para transit in America redefining mass Transportation
Westport Connecticut; Praeger.

Cervero R. (2000): Informal Transport in the Developing world. United
Nations centre for Human settlements (Habitat)

De donnea FX (1971): The Determinants of transport mode choice in Dutch cities some Disaggregate stochastic Models Rotterdam University Press.

Domencich T. A. and Mc Fadden D (1975): Urban Travel Demand: A Behavioral Analysis Amsterdam North Holland.

Domericich T. A & Mc Fadden D (1998): Behavioral Travel Demand Modeling.

Etherington K. and simm D (1996): Paratransit and Employment in Phnom penh: The Dynamics and Development of Potential Cyclo Riding Journal of transport Geography, Vol. 4, No. 1, Pg 37-53.

Fasakin J. O. (1999): The Commercial Motorcycles in the Nigerian Public Transport System- A land use analytical Approach to its operational Characteristics in Akure Township (A PHD Research Proposal; Dept of Urban and Regional Planning Federal University of Technology, Akure).

Fashakin O. J. (2000): The commercial motorcycle in the Nigerian Transport system: A land use Analytical Approach to its operational characteristics in Akure Township (ph.D Research methodology and Field work Results Federal University of Technology, Akure Nigeria.

Fertal M. J Weiner E. Balek A. J and Sevin A. F (1970): Modal split Documentation of Nine Methods for Estimating Transit Usage. Washington D. C: Department of Transportation.

Fouracre P. R. and Turner J. (1992): travel Characteristics in developing cities 6th World Conference in transport research, Lyon.

Hathway (1985): Low cost vehicles: options for moving people & goods



intermediate Technology Publications pp74-77.

Hensher D. A (1972): The Consumers choice function: A study of Traveller Behaviour and values unpublished ph.D thesis, University of Near South Wales.

Hensher D. A (1977): Demand for Urban passenger Transport In Hensher (edition) 1977b Pg 72-99.

Hensher, D. A and stopher , P.R (1979): Behavioural Travel Modeling. London: Groom Helm.

Hobbs F. D (1979): traffic Planning and Engineering Pergamon Press.

Hutchinson B.G (1974): Principles of Urban Transport Systems Planning. New York: Mc Graw Hill.

Japan International Co-operation Agency (1986): The Metro manila Transportation Planning study, Manila, Ministry of Transportation and Communications.

Japan International Co-operaton Agency (1990): The study of Medium to Long term Improvement/ Management plan of Road and Transport in Bangkok, Ministry of transportation.

Karim- et al (1998): Mass Transport & Appropriate in Metropolitan Dhaka, Paper Presented at the 91st Annual meeting of the air and waste management association san Diego California June 1998.

Kassoff, H and Deutschman H.P. (1969): Trip Generation: A critical
Apraisal

Highway Research Record 297, 15-30.

- Lucas Ace (1991):** A report on number of House holds in land use area of Akure metropolis (World Bank Project)
- Meyer J. R. and Straszheim M. R. (1971):** Techniques Transport Planning Volume one, Pricing and project Evaluation. The Brooking Institution Washington, D.C.
- O. Flaherty C. A. (1974):** Highways and traffic 2nd Edition London Edward Arnold, pg 119-127.
- Ogunsanya A. A (1977):** Issues and Problems in Nigerian Transport Systems Journal of the Nigerian Institute of Transport Technology (The Trainer) Vol. 1 No. 1 pp 4 -100.
- Ogunsanya A. A (1997):** 'Issues and problems in Nigerian Transport system "Journal of Nigerian Institute & Transport Technology (The Trainer) Vol. 1 No. 1, pp4-10.
- Ogunsanya A. A and Galatima M. (1993):** Motorcycles in Public Passenger transport Service in Nigeria: Case study of Yola Town, Urban Passenger Transportation in Nigeria, S. Ikya ed – Lagos, Heinemann Hooks.
- Okoko E. E (2002):** A predictive modeling of spatial interaction pattern in the Transport System in Akure, Nigeria Unpublished PH.D Thesis, Federal University Technology, Akure, Nigeria.
- Oni S. I (1993):** Motorcycling in Nigerians Urban Public transport NISER Ibadan.

Owolabi A.O (2000): Intramodal Competition in Urban Para transit System; Case study of Akure Metropolis. Unpublished PH.D research report Federal University of Technology Akure, Nigeria.

Owolabi A. O. (2002): Intramodal Competition in Urban Para transit systems: A case study of Akure metropolis (Ph. D Research field work results, FUT Akure, Nigeria).

Palen. J. J (1987): The Urban World published by McGraw-Hill inc. 1987 pp 380-400.

Paul-Mjunder P. and Shafali M (1997): Examining Gender Dimensions in Transportation in Dhaka Metropolitan Area, Washington D. C. The World Bank and Dhaka, Navi Uddug kendra (NUK).

Peters D. (1998): Managua plans to Bike Around Transport pit falls sustainable Transport. No 8, p.6.

Plan-pro corporation, Department of Traffic and Transport, and Bangkok Metropolitan Administration, (1998): The Final Report of the study in Mass Van Transit, Bangkok.

Rondinelli D. A and Cheema G.S (1988): Urban Services in developing Countries. Public and Private roles in Urban development Published by Macmillan Press Ltd.

Stopher PR and Meyburg A. H (1975): Urban Transportation Modeling and Planning, Lexington, Massachusetts Lexington Books.

Watson P.L (1974): Choice of estimation procedure for models of binary Choice: some statistical and Empirical evidence. *Regional and urban Economics*, 4, 187-200.

Williams H. C. W. L (1977): On the formulation of travel Demand Models and Economic Evaluation Measures of user benefit *Environment and Planning A*, 9 285-244.

Wilson A. G (1969): The use of Entropy maximizing Methods in the Theory of Trip Distribution, Modal Split and route Assignment *Journal of Transport Economics and Policy*, 3, 108-26.

Wilson A. G (1970): Entropy in urban and Regional modeling. London: Pion.

APPENDIX A

TABLE 25 : PROBABILITIES OF MODAL CHOICE.

q_{ab}	q_{ac}	q_{ad}	q_{bc}	q_{bd}	q_{cd}
0.04	0.38	0.98	0.91	1	1
0.02	0.19	0.97	0.87	1	0.95
0.01	0	0.97	0.9	1	0.99
0.02	0.51	0.97	0.22	0.97	0
0.04	0.7	0	0.95	1	0.96
0.02	0.48	0.98	0.97	0	0.97
0.04	0.55	0.99	0.98	1	0.99
0.08	0	0.99	0.75	1	1
0.06	0.3	0	0.91	1	0.97
0.01	0.24	0.78	0	1	0.99
0.3	0.46	0.95	0.1	1	0.98
0.03	0.38	0.76	0.87	0.87	0.99
0.01	0.08	0.87	0.17	0.68	0.97
0.01	0.39	0.56	0.64	0.89	0
0.08	0.23	0.99	0.06	0.03	0.99
0.01	0.31	0.95	0.87	0	0.97
0.02	0.29	0.98	0.09	0.91	0.99
0.17	0.11	0.99	0.2	1	0.99
0.15	0.65	0.98	0.64	0.59	0.97
0.01	0.04	0.56	0	0.87	0.99
0.04	0.34	0.95	0.04	0.99	0.87
0.02	0.31	0.84	0.07	0.98	1
0.03	0.41	0.87	0.49	0.49	0.96
0.02	0.09	0.91	0	0.75	0
0.06	0.25	0.94	0.03	0.33	0.99
0.01	0.28	0.96	0.7	0	0.96
0.02	0.1	0.99	0.11	0.9	0.99
0.07	0.39	0.99	0.02	1	1
0.04	0.18	0.99	0.89	1	0.99
0.02	0.99	0.6	0	0.87	0.99
0.06	0.22	0.95	0.53	1	0.99
0.02	0.11	0.94	0.06	1	0.99
0.15	0.27	0.19	0.61	0.85	0.99
0.06	0.14	0.97	0	1	0
0.03	0.26	0.99	0.16	1	0.97
0.04	0.08	0.88	0.04	0	0.96
0.05	0.07	0.03	0.04	0.81	0.99
0.14	0.1	0.38	0.01	0.91	1
0.13	0.08	0.98	0.03	1	0.98
0.11	0.24	0.02	0	0.85	0.99
0.03	0.34	0.84	0.58	1	0.95
0.06	0.33	0.92	0.03	0.87	1
0.12	0.1	0.04	0.61	0.68	0.97
0.02	0.07	0.44	0	1	0
0.09	0.11	0.06	0.16	1	0.98
0.03	0.11	0.96	0.02	0	0.97
0.04	0.24	0.97	0.04	0.85	0.99
0.08	0.27	0.56	0.75	0.69	0.99
0.07	0.09	0.98	0.89	0.67	0.97
0.15	0.06	0.51	0	0.87	0.99

APPENDIX B

DEPARTMENT OF CIVIL ENGINEERING
FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE
ONDO STATE, NIGERIA.

Engr. A.O. OWOLABI

Ph.D Research

Topic: INTRA-MODAL COMPETITION IN URBAN PARA-TRANSIT
 SYSTEMS: CASE STUDY OF AKURE METROPOLIS

QUESTIONNAIRE

This is a questionnaire designed for a Ph.D Research on the above topic. We shall be grateful for your prompt response in completing the form. All information shall be treated as confidential.

TO BE ANSWERED BY HOUSEHOLD HEAD

(A) INFORMATION ON WORK/BUSINESS TRIPS

1. Residence in Akure _____
2. Marital status: Single _____ Married _____
3. Place of work _____
4. Do you own (a) private vehicle (s) presently on the road
(a) Yes _____ (b) No _____ (c) How many? _____
If yes, state type (a) Car _____ (b) Bus _____ (c) _____
(d) bicycle _____ (e) Others _____
5. How do you get to your place of work?
(a) Walking _____ (b) Taxi _____ (c) Motorcycle _____
(d) Private vehicle _____ (e) Bus _____
6. What mode of transport do you use from work place
(a) Walking _____ (b) Private vehicle _____ (c) Taxi _____
(d) Bus _____ (e) Motorcycles _____

7. Number of persons in your household (family) _____
8. How many members of your household are employed? _____
9. Household income (monthly salary/monthly profit)
 - (a) Below N3,500 (specify) (b) N3,500 – N5,500 (c) N5,500 – N7,500 (d) N7,500-N10,000 (e) N10,000 – N15,000 (f) N15,000 – N20,000 (g) Above N20,000
10. Does your wife have a private vehicle (presently on the road)? (a) Yes _____ (b) No _____
11. Where is her place of work sited in Akure? _____
12. How does she get to her place of work? (a) Walking _____ (b) Taxi _____ (c) Private vehicle _____ (d) Motorcycle _____ (e) Bus _____
13. What mode of transport does she use from her place of work to the house?
 - (a) Walking _____ (b) Taxi _____ (c) private vehicle _____ (d) Motorcycle _____ (e) Bus _____
14. Places of work of other employed persons in your household

15. Number of these employed persons that go to their places of work through
 - (a) Walking _____ (b) Taxi _____ (c) Private vehicle _____ (d) Motorcycle _____ (e) Bus _____
16. From their places of work to the house (a) Walking _____ (b) Taxi _____ (c) Private vehicle _____ (d) Motorcycle _____ (e) Bus _____
17. How many are your children in nursery/primary schools that go to their schools by
 - (a) Private vehicle _____ (b) Taxi _____ (c) Motorcycle _____ (d) Bus _____ (e) Trek _____?

18. Places where their schools are situated in Akure _____

19. How many are your children both in secondary and higher institution within Akure and to school in (a) Private vehicle _____ (b) Taxi _____ (c) Motorcycle _____ (d) Bus _____ (e) Trek _____?
20. Places where their schools are situated in Akure _____

21. What is the approximate distance between your house and place of work?
(a) Less than 2Km _____ (b) 2 – 4 Km _____ (c) More than 4Km _____
22. What mode of transport do your children in primary school take from school to house? Indicate number. (a) Private vehicle _____ (b) Taxi _____ (c) Motorcycle _____ (d) Bus _____ (e) Trek _____
23. What mode of transport do your children in both secondary and higher schools take from school to house? Indicate number. (a) Private vehicle _____ (b) Taxi _____ (c) Motorcycle _____ (d) Bus _____ (e) Trekking _____
24. What factors affect your choice of mode of public transport?
(a) Cheaper _____ (b) Faster _____ (c) Readily available _____
(d) Absence of alternative _____ (e) Comfortable and convenient _____
(f) Safe _____

[B] INFORMATION ON NON BUSINESS SOCIAL (RECREATIONAL) TRIPS

S/N	PLACES VISITED	LOCATION IN AKURE	HOW MANY TIMES DO YOU VISIT IN A WEEK	MODE OF TRANSPORT
1	Market			
2	Church, Mosque or any religious centre			
3	Recreation centre			
4	Shopping centre			
5	Friend's house			
6	Relations' house			

QUESTIONNAIRE

Personal Information (tick as appropriate)

1. Name:.....
2. Address (Residential):.....
3. Age range: Below 20 ☐ 20 - 30 ☐ 30 - 40 ☐ 40 - 50 ☐ 50 - 65 ☐ Above 65 ☐
4. Sex: Male ☐ Female ☐
5. Marital Status: Single ☐ Married ☐
6. Educational Status: Primary School ☐ Modern School ☐ Secondary School ☐ Technical College ☐ National Diploma/NCE ☐ B.Sc./HND and above ☐
7. Place of Work or School (address):.....
8. Professional Status: Artisan (Mechanic ☐ Bricklayer ☐ Rewire ☐ Carpenter ☐ Panel beater ☐ Welder ☐ Vulcanicer ☐ Tailor ☐ Barber ☐ etc) Others ☐
9. Occupation:.....
10. Employment Status: Senior Staff ☐ Junior Staff ☐ Proprietor ☐ Others ☐
11. Income per month: Below N3,500 ☐ N 3,500 - N5,500 ☐ N5,500 - N7,500 ☐ N7,500- N10,000 ☐ N10,000 - N15,000 ☐ N15,000 - N20,000 ☐
Above N20,000 ☐
12. Do you own a vehicle presently on road? Yes ☐ No ☐
13. How many vehicle? 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ above 5 ☐
14. What type of vehicle do you own? Car ☐ Bus ☐ Motorcycle ☐ Truck ☐ Bicycle ☐

For Patrons:

1. State problems confronting you in the use of public transportation in Akure metropolis
-

KINDLY GIVE THE REQUIRED INFORMATION ON YOUR WEEKLY TRIPS (tick as appropriate)

S/N	Places visited.	Location in Akure	Which days of the week do you make the trip?	Mode of transport to the place	Mode of transport from the place	Period of the day that the trip was made	Time spent in walking from your house to the bus stop or main road	Time Spent at bus stop before getting a vehicle	Time Spent in vehicle to get to the place	Time Spent in walking from the bus stop to your destination	Volume of traffic during the time of making the trip	How far is the place to your house (trip length)	Cost of trip	Reason for choice of vehicle
1	Working place, offices, school, workshop etc		☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Morning ☐ Afternoon ☐ Evening ☐ Night	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Low ☐ Moderate ☐ High	☐ Less than 1km ☐ 1-2km ☐ 2-4km ☐ 4-6km ☐ 6-8km ☐ greater than 8km	☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 & above	☐ Cheaper ☐ Faster ☐ Reliable ☐ No alternative ☐ Safe ☐ Available ☐ Convenient ☐ Door step Services /flexibility
2	Recreation Centre		☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Morning ☐ Afternoon ☐ Evening ☐ Night	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Low ☐ Moderate ☐ High	☐ Less than 1km ☐ 1-2km ☐ 2-4km ☐ 4-6km ☐ 6-8km ☐ greater than 8km	☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 & above	☐ Cheaper ☐ Faster ☐ Reliable ☐ No alternative ☐ Safe ☐ Available ☐ Convenient ☐ Door step Services /flexibility
3	Church, Mosque or any religion		☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Morning ☐ Afternoon ☐ Evening ☐ Night	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Low ☐ Moderate ☐ High	☐ Less than 1km ☐ 1-2km ☐ 2-4km ☐ 4-6km ☐ 6-8km ☐ greater than 8km	☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 & above	☐ Cheaper ☐ Faster ☐ Reliable ☐ No alternative ☐ Safe ☐ Available ☐ Convenient ☐ Door step Services /flexibility
4	Market		☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Morning ☐ Afternoon ☐ Evening ☐ Night	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Low ☐ Moderate ☐ High	☐ Less than 1km ☐ 1-2km ☐ 2-4km ☐ 4-6km ☐ 6-8km ☐ greater than 8km	☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 & above	☐ Cheaper ☐ Faster ☐ Reliable ☐ No alternative ☐ Safe ☐ Available ☐ Convenient ☐ Door step Services /flexibility

KINDLY GIVE THE REQUIRED INFORMATION ON YOUR WEEKLY TRIPS (tick as appropriate)

S/N	Places visited	Location in Akure	Which days of the week do you make the trip	Mode of transport to the place	Mode of transport from the place	Period of the day that the trip was made	Time spent in walking from your house to the bus stop or main road	Time Spent at bus stop before getting a vehicle	Time Spent in vehicle to get to the place	Time Spent in walking from the bus stop to your destination	Volume of traffic during the time of making the trip	How far is the place to your house (trip length)	Cost of trip	Reason for choice of vehicle
5	Shopping Centre		☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Morning ☐ Afternoon ☐ Evening ☐ Night	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Low ☐ Moderate ☐ High	☐ Less than 1km ☐ 1-2km ☐ 2-4km ☐ 4-6km ☐ 6-8km ☐ greater than 8km	☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 & above	☐ Cheaper ☐ Faster ☐ Reliable ☐ No alternative ☐ Safe ☐ Available ☐ Convenient ☐ Door step Services /flexibility
6	Friends		☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Morning ☐ Afternoon ☐ Evening ☐ Night	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Low ☐ Moderate ☐ High	☐ Less than 1km ☐ 1-2km ☐ 2-4km ☐ 4-6km ☐ 6-8km ☐ greater than 8km	☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 & above	☐ Cheaper ☐ Faster ☐ Reliable ☐ No alternative ☐ Safe ☐ Available ☐ Convenient ☐ Door step Services /flexibility
7	Social functions		☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Morning ☐ Afternoon ☐ Evening ☐ Night	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Low ☐ Moderate ☐ High	☐ Less than 1km ☐ 1-2km ☐ 2-4km ☐ 4-6km ☐ 6-8km ☐ greater than 8km	☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 & above	☐ Cheaper ☐ Faster ☐ Reliable ☐ No alternative ☐ Safe ☐ Available ☐ Convenient ☐ Door step Services /flexibility
8			☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Sunday	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Private car ☐ Bus ☐ Motor cycle ☐ Bicycle ☐ Taxi ☐ Walk ☐ Official Car	☐ Morning ☐ Afternoon ☐ Evening ☐ Night	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Less than 10mins ☐ 11-20mins ☐ 21-30mins ☐ greater than 30mins	☐ Low ☐ Moderate ☐ High	☐ Less than 1km ☐ 1-2km ☐ 2-4km ☐ 4-6km ☐ 6-8km ☐ greater than 8km	☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 & above	☐ Cheaper ☐ Faster ☐ Reliable ☐ No alternative ☐ Safe ☐ Available ☐ Convenient ☐ Door step Services /flexibility

HOUSEHOLD INFORMATION

1. How many people are living in your household?.....
2. How many people living in your household are employed?.....
3. How many vehicles are owned in your household (state whether personal or government/official).....
4. Household income (Total) ☐ N3,600- N6,000 ☐ N6,000- N10,000 ☐ N10,000- N15,000 ☐ N15,000 - N20,000 ☐ Above N20,000
5. Does your wife /husband has a private vehicle presently on the road? ☐ Yes ☐ No
6. Where is her place of work situated in Akure?.....
7. How far is her place of work to the house? ☐ Less than 1km ☐ 1- 2km ☐ 2 - 4km ☐ 4- 6km ☐ 6- 8km ☐ 8km and above
8. How does she get to her place of work? ☐ Private car ☐ Walk ☐ Taxi ☐ Bus ☐ Motorcycle ☐ Bicycle ☐ Official Car
9. Mode of transport to the house from her place of work? ☐ Private car ☐ Walk ☐ Taxi ☐ Bus ☐ Motorcycle ☐ Bicycle ☐ Official Car
10. What is the cost of the trip to her place of work? ☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 ☐ N30 and above
11. How does your husband/wife get to the market? ☐ Private car ☐ Walk ☐ Taxi ☐ Bus ☐ Motorcycle ☐ Bicycle ☐ Official Car
12. Mode of transport to the house from the market? ☐ Private car ☐ Walk ☐ Taxi ☐ Bus ☐ Motorcycle ☐ Bicycle ☐ Official Car
13. How far is the market to her house? ☐ Less than 1km ☐ 1- 2km ☐ 2 - 4km ☐ 4- 6km ☐ 6- 8km ☐ 8km and above
14. What is the cost of the trip to the market? ☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 ☐ N30 and above
15. Place of work of other people employed in your household? i. ii. iii. iv.
16. Number of these employed people that go to their places of work through (indicate number in the box provided) ☐ Private car ☐ Walk ☐ Taxi ☐ Bus ☐ Motorcycle
☐ Official Car ☐ Bicycle
17. Mode of transportation from their places of work to the house (indicate number in the box provided) ? ☐ Private car ☐ Walk ☐ Taxi ☐ Bus ☐ Motorcycle
☐ Official Car ☐ Bicycle

18. How many children do you have?.....

19. How many of your children in Nursery/Pry Schools that go to their schools in ☐ Private car ☐ Walk ☐ Taxi ☐ Bus ☐ Motorcycle
☐ Official Car ☐ Bicycle

20. Where is their school situated in Akure (Address) i. ii. iii. iv.

21. How far is their school to the house ☐ Less than 1km ☐ 1- 2km ☐ 2 - 4km ☐ 4- 6km ☐ 6- 8km ☐ 8km and above

22. Period of the day that the trip is made to their school? ☐ Morning ☐ Afternoon ☐ Evening ☐ Night

23. Cost of their trip to school? ☐ N5 ☐ N10 ☐ N15 ☐ N20 ☐ N25 ☐ N30 ☐ N30 and above

24. How many of your children are in secondary and higher institution?.....

25. Where is their school situated in Akure? i. ii. iii. iv.

26. Mode of transport of their trip to school (indicate number in the box provided) ? ☐ Private car ☐ Walk ☐ Taxi ☐ Bus ☐ Motorcycle ☐ Bicycle ☐ Official Car

27. Mode of transport of their trip from school (indicate number in the box provided) ? ☐ Private car ☐ Walk ☐ Taxi ☐ Bus ☐ Motorcycle ☐ Bicycle
☐ Official Car