ANALYSIS OF MODAL SPLIT CHARACTERISTICS FOR EFFICIENT TRANSPORT PLANNING POLICY IN KADUNA METROPOLIS

M. Sc. (URP) THESIS

BY

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ANALYSIS OF MODAL SPLIT CHARACTERISTICS FOR EFFICIENT TRANSPORT PLANNING POLICY IN KADUNA METROPOLIS

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A thesis submitted to the Postgraduate School, Ahmadu Bello University, Zaria in Partial fulfillment of the requirements for the award of M.Sc (Urban and Regional Planning) Degree

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x

December, 1999

DEDICATION

I hereby affirm that this thesis has been composed by myself and that it is the outcome of my research work. It has not been accepted in any previous application for higher degree.

....14/02/2020.....

Signature Date

CERTIFICATION

This thesis entitled, ***ANALYSIS OF MODAL SPLIT CHARACTERISTICS FOR EFFICIENT TRANSPORT PLANNING POLICY IN KADUNA METROPOLIS,*** meets the regulation governing the award of the degree of M.Sc. (Urban and Regional Planning) Ahmadu Bello university, Zaria, and as approved for its contribution to knowledge and literary presentation.

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Yunana Teku

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ABSTRACT

Transportation is central to the sustenance of rural, urban, regional or national economy. It is vital to the flow of knowledge, information, human mobility, goods and services. The state of the transport system and facilities enhance or retards growth and development in urban areas.

In Nigeria, the problem of passenger transportation in urban centre has become established and needing planned intervention. Kaduna is a town that provides evidence of this fact. Being a multi-functional town that serves military, administrative, commercial and industrial purposes, the consequences for not acting purposefully (planning) will be pervasive.

This study examines an aspect of transport planning, that is, model split. It seeks to understand factors that influence or motivate trip makers in their choice of transport mode as a basis for proposing policies to improve the efficiency of transport and urban system in Kaduna.

Data-sets collected were from field observation and questionnaire administration, and review of records. Results from the analysis show income strongly influence trip-makers selection of transport mode. It affect, car ownership, residential location, and use of public transport and journey purpose. While it was difficult to assess the effect of travel time and travel cost, it was observed that income affect even travel time and travel cost.

The increase in transport demand brought about by urban growth (changes in land use structure), population growth and improved living standard necessitated the introduction of many modes to meet transportation need. This has led to the uncontrolled growth of private car, proliferation of public transports (taxi, bus, motor cycle) and more people walking due to economic hardship, limited road space and competition arising from road users, have led to traffic congestion, excessive use of energy (fuel) and environmental pollution, conflicts, etc. Poverty , weak institutional controls and concentration of traffic generation activities in the CBA have made traffic control even more difficult.

The need to find a solution to the transport problems is urgent. The study recommended policies and measure in relation to disincentives to private car use, enhancing public transport system and reducing motor vehicle pollution and energy conservation. It also suggested the combination of persuasion and restrain measures where government plays a leading role in making appropriate legislation and enforcement. In addition there should be participation or involvement of stockholders in the decision making process. In this way, it is hope that priority will given to each mode of transportation in relation to the urban development.

The study concludes that solutions to urban transportation problems could be found when there is systematic and deliberate coordination between urban planning (effective control of land use development) and transport planning.

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CHAPTER ONE
DESIGN OF THE STUDY

1.10 **Introduction:**

Transport programmes have been introduced by government at Federal, state and local levels in Nigeria without thorough understanding and analysis of the interactive relationship between transport and the spatial development of land uses. The outcome has been that most programmes or projects have failed to achieve their desired objectives.

Transportation planning in general is aimed at searching for best solutions to transport problems, given resources available. In Nigeria, transportation planning has been reactive rather than creative. Little attempt has been made to study the details of transport and land use as a basis or the policies and programmes. For example, as a result of Federal Government intervention in urban transport problems, mass transit vehicles were introduced in urban roads without investigating the land use structure. The unsuitability of transit vehicles increased traffic congestion. This study attempts to examine an aspects of such details, that is modal split in Kaduna with a view to recommending efficient transport planning policies. As a metropolis experiencing urban growth and complex transport systems, understanding the details like the modal split opens up more alternatives for effective action.

1.20 THE RESEARCH PROBLEM

Kaduna is one of the major cities in Nigeria where the problems of transportation have been become intense and needing planned intervention. The town has grown in size and influence since Nigeria's independence in 1960. Apart from the regional influence it exerted during colonial regime as administrative headquarter of Northern Nigeria, its commercial and industrial growth has provided income and employment opportunities. These factors have led to the influx of people in quest for jobs and other opportunities in the metropolis.

At the spatial level, the town has witnessed rapid physical expansion along the north-south axis, westwards and now east wards. The distribution of workplaces have also diversified. The result of these changes are that physical distances have increased between residences and work places, shopping and recreational areas. Trip makers have to travel longer distance at high financial and time costs. Passenger journey times are longer than they should. The high cost of private cars or automobiles makes it imperative that majority of the trip-makers are increasingly having to depend on the available public transport systems made up of buses, taxis and motor cycles.

There have been transport policy responses made at both federal and state government levels to address the Urban transportation problems. Government have responded to the needs of personalized transport by massive investment in road development. This involves the widening and reconstruction of existing urban roads with corresponding

little attention paid on the development of public transportation. The establishment of the federal urban mass transit authority (FUMTA) and Kaduna State transport authority (KSTA) could be seen as attempts aimed at addressing the problems of public transport services.

In general, studies have been conducted, on various aspects of urban transportation problems. Some studies attempt to identify or provide information on the causes of urban transportation problems. Most studies have concluded that when there is a mismatch between other land uses and transportation, the concomitant result of congestion, delays, parking difficulties, etc becomes inevitable. For instance Ayeni (1983) described traffic congestion, delay, accident and environmental pollution as the most visible and pressing of transport problems.

In proffering solution to problems of congestion, lock (1965), Bala (1976), Megbolugbe (1976) focused on ways of improving or developing mass transit as a means of decongesting urban roads. Some researchers have focused on other aspects of the transport component such as traffic management and parking. Ogunsanya (1984) examined the impact of the odd and even car numbers traffic restraint method in Lagos metropolis. The results of his analysis indicate that the technique worked only during the first few months of its introduction. Haruna (1992) analysed the need for planning of parking as an integral part of the overall transport system.

Ameh (1988), Yusuf (1994) examined the movement pattern and their characteristics in Nigeria's urban centres. He established that

journey to work or simple work trip is the most dominant of all the trips made by individuals. Of these trips, most of it is carried out by road using either private car or public transport. Adagbasa (1974) examined the interactive relationship between land use and transportation. Within the content of this relationship he showed how it resulted into transport problems in Benin town.

This study examines a neglected aspect of the transport system, that is modal split characteristics. It seeks to understand the dynamic character of urban movements and why trip-makers select particular mode of travel with respect to the spatial pattern of Kaduna metropolis. It is hoped that the outcome of the study would form the basis for a suitable and efficient transport policy for the town.

3.30 AIM AND OBJECTIVES:

3.30 Aim

The aim of the study is to examine the modal split characteristics of traffic in Kaduna as a basis for proposing policies to improve the efficiency of the urban transportation system.

3.31 Objectives

The objectives set towards achieving the above aim are:

(i) To review the concept of modal split and factors that determine its characteristics at urban level:

(ii) To examine the existing pattern of land use and transportation problems in Kaduna metropolis:

(iii) To investigate the modal split on major roads including its determinant and problems.

(iv) To propose policies that will enhance the efficiency of the transport
systems in Kaduna.

3.40 SCOPE AND LIMITATION

Trip type determines how trip-makers select between transport modes. This is because the variables used in the modal split model could be different. This study is however concerned with intra-urban trips and the variables that influence modal choice. Some of the variables chosen includes income level, car-ownership, journey purpose, travel time and travel cost. The study is restricted to land transportation and it is not gender biased.

In order to carry out this research, some data were sourced from filed survey and published materials. One major problem encountered was the difficulty of generating income data and public apathy to questionnaire. However a response rate of 70 percent is achieved which was fairly good.

3.50 STURCTURE OF THESIS

This thesis is divided into three parts which represent a continuum rather than discrete units as shown in fig. 1.1. Part one consist of chapters one and two. Chapter one contains general introduction into the work. Chapter two is review of literature on the concept of modal split and the factors influencing modal choice.

Part II is made up of Chapter three and four. Chapter three contains the design of the study while chapter deals with data collection, method and analysis.

Part III has only chapter five which deals with policy recommendations and conclusion.

PART I

CHAPTER ONE
Introduction
Research issue
Aim & Objectives
Scope and Limitation
Structure of Thesis

CHAPTER TWO
Literature Review
Modal split in the transportation planning process
concept of modal split factor
influencing modal choice

PART II

CHAPTER THREE
Study Area
Historical Background
Population
Existing Land Use
Urban transport planning & Physical Planning

CHAPTER FOUR
Data collection, Analysis and Findings
Methods of Data Collection
Methods of Data Analysis
Findings.

PART III

CHAPTER FIVE
Recommendations And Conclusion

Fig 1.1: Structure of the thesis

CHAPTER TWO
LITERATURE REVIEW

2.10 MODAL SPLIT IN THE TRANSPORTATION PLANNING PROCESS

The urban transportation planning process involves three fundamental and related stages. They are:

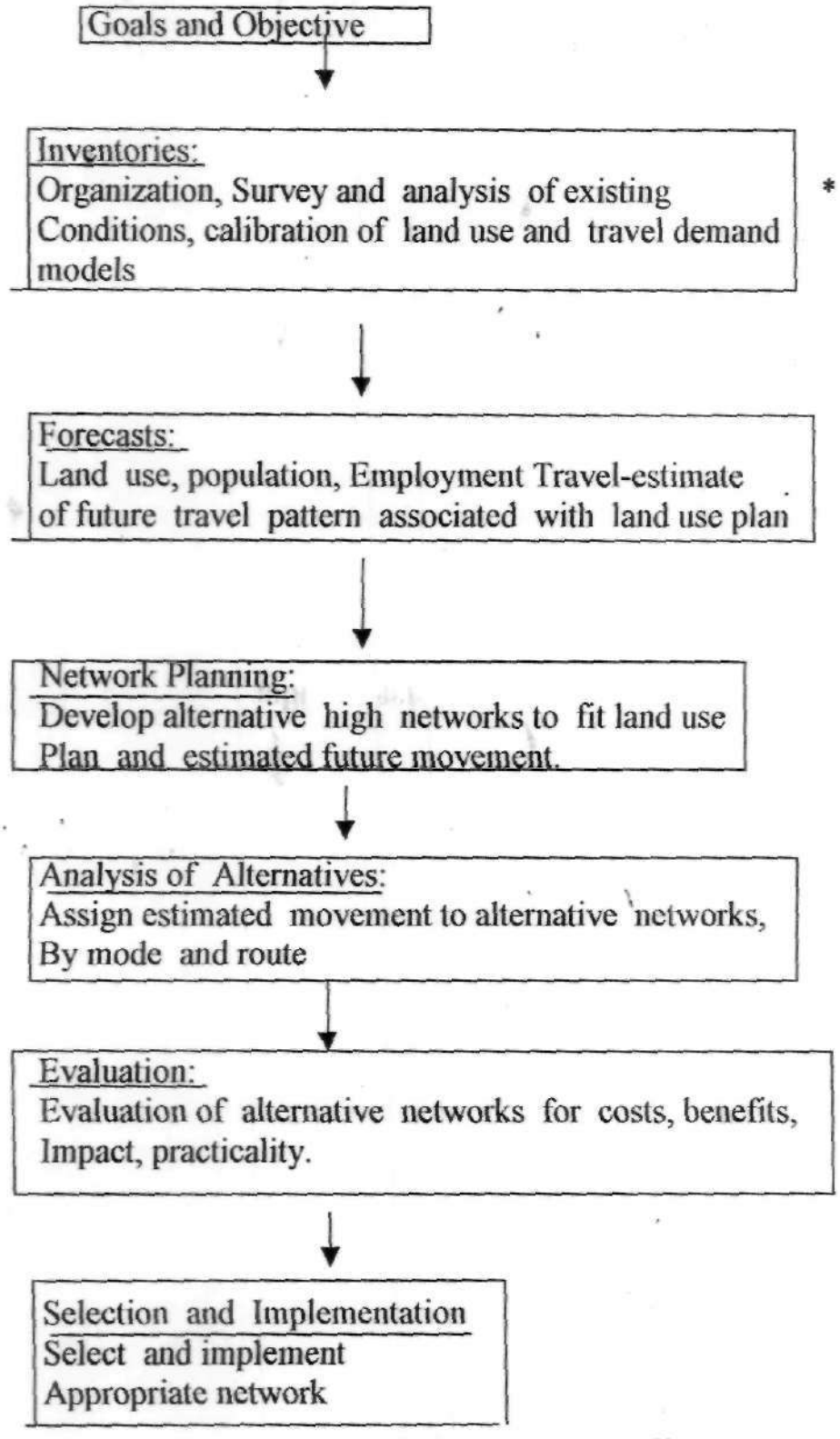
(a) Survey and analysis stage- that is establishing the present demand for movement, how it is met and the relationship between demand for movement and the urban environment.

(b) Prediction and plan formulation stage

(c) Evaluation stage

Travel demand analysis involves four basic sequences. They are trip generation, trip distribution, modal split and trip assignment. Each of these components explains and predicts different aspects of travel behaviour (demand)particularly if the circumstance of city structure, population and socio-economic attributes are changing fast as in Kaduna Metropolis. Thus, modal split belongs to the survey and analysis stage as shown in figure 2.1. A thorough understanding of this aspect of transportation planning is not only necessary but goes a long way to show the kind of prescription made in transport plan or policies.

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*- The place of modal split.

Fig 2.1 Land use- Transport planning process. Source Bureau of public Roads (1970) urban Transportation planning. General information and introduction to system. Washington DC.

2.20 The Concept of Modal Split

Different views have been given on the meaning of modal split. Two extreme views have been expressed. The first focuses on the distribution of total person trips into different modes, while the second view attempts to understand why individuals select particular modes of travel.

Bruton (1970) defined split as the proportionate division of the total numbers of person trip between different means or modes of travel. It can be expressed numerically as a fraction or number of fractions, ratio, or percentage division between bus, car, rail and other modes of the total number of trips. This is exemplified in Table 2.1.

Table 2.1 :Distribution of work Trip by Transport Modes in Selected Large Cities in India.

Transport Mode	Delhi (%)	Ahmedabad (%)	Madurai (%)	Lucknow (%)
Bus	56	17	42	5
Car	16	8	13	3
Scooter/m/cycle	23	53	30	44
Cycle	4	18	14	23
Others	1	4	1	15
Total	100	100	100	100

Note: Walk trips not included:

Source: Singh, S. (1993), Managing Transportation needs in metropolis cities in ITPI Journal, Vol. II No 3 pp 63.

Other scholars like Warnes and Daniel (1980) describe modal split as the process of arriving at a decision about which mode to use in any particular set of circumstances. Papacostas (1990) also defined modal split as being concerned with the behaviour of trip-makers regarding the selection of travel mode. This is the approach that is often used and described as modal choice analysis and it is applied in studying behavioral patterns during preparation of transportation plans. Also, modal split has been used within the context or transport (traffic) restraint policies aimed at influencing trip-makers behavior. Examples of these are odd and even car numbers in Lagos, parking policies, one-way etc.

The adopted conception in this study is a blend of the first view and the second. It attempts to examine the total distribution of trips among the available modes and factors responsible for the individuals' selection of such mode . This is then followed by an examination of these relationship with the land use activity. The principle is that land uses and transportation have symbiotic and re-enforcing relationships.

2.30 FACTORS INFLUENCING MODAL SPLIT

Trip-makers select between several travel modes. They may include walking, cycle, car, bus, train, etc. the process of taking such decisions is neither static nor random. The process is dynamic and complex. Sometime the criteria used are difficult to measure or quantify,

for example comfort, convenience, etc. The reasons or factors underlying the choice of a particular mode of travel may vary between three sets of factors:

(i) Individuals making the trip (trip-maker characteristics)

(ii) Trip –type (journey characteristic) and;

(iii) Relative level of services and cost associated with the available modes (transportation system characteristics).

Transportation studies on modal split analysis have focused on these three sets of factors. These factors have been investigated or researched by scholars around the world as discussed below. It is widely held that when significant change in these sets of factors occur, trip-makers respond in varying degrees by shifting from one mode to another. For example, a significant increase in the parking fee charge at a destination may induce some people to shift from driving personal car to using a public bus.

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2.31 CHARACTERISTICS OF TRIP-MAKERS

The socio-economic status of trip-maker has been found to affect the choice of a particular mode. (Krapkor, 1986; Adeniji, 1987) Some of the factors known to be responsible for this are:-

I **Income**: A person income determines their ability to own a car and maintain it. Car ownership is therefore a function of income and income influences model choice. That is, income determines the ability of a person to choose a particular mode. Wilson (1967) studied modal split in Coventry and showed that there is a relationship income and the

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use of public transport. He observed that people who earn less than $1,500 per annum, used public transport.

ii **Car ownership**: this is another significant factor that influences or affects modal choice. Families or households with car(s) have a higher tendency to make more trips than families without car(s) (Bruton, 1970). This is because families without a car will actually depend on the use of public transport, which in most cases is unreliable rather than families with a car whose use is flexible and reliable.

iii **Density of Residential Development**: studies have show that a relationship exists between net residential density and modal choice (Schwar, 1961). Areas with low density development occupied by middle and high income groups do not require public transport. This is because there is high level of car ownership among these income groups. Whereas high density areas occupied by low income earners require public transport because car-ownership tends to be lower and the demand for such services is higher. Thus, public transport service can be economically provided in high density residential developments.

iv Other socio -economic factors such as family size, the age –sex structure of the family, the employment of the head of household or family, etc also influence the choice of a mode. In a study in Milwaukee, a correlation between public transport use and some selected socio-economic variable or characteristic was established (see Table 2.2).

Table 2.2 Correlation of public transport use with selected socio economic variables in Milwaukee.

		Correlation	Coefficient
	Item	Negative	Positive
1	Percent with units of 2 or more cars	0.75	
2	Percent with units with no car		0.71
3	Percent with units owner-occupied	0.66	
4	Median school years compels	0.65	
5	Percent of divorced females		0.63
6	Median gross rent	0.62	
7	Percent civilian labour force unemployment		0.60
8	Median value of each dwelling unit	0.58	
9	Median income of families	0.55	
10	Percent of married women, husband present in labour force	0.55	
11	Percent of housing unit deteriorated and dilapidated		0.52
12	Percent of males in high status	0.47	
13	Percent of separated males		0.46
14	Number of Negroes		0.35
15	Percent of labour force females		0.33

Note: it can be seen from the table that high socio-economic status and its associated attributes are negatively associated/related with public transport use.

Source: Hadden J.K (1964) the use of public transportation in Milwaukee. Wisconsin. The Eno foundation of Traffic transportation quarterly, XVIII, No2, PP 230

2.32 CHARACTERISTICS OF THE JOURNEY

The characteristic of the trip or journey to be undertaken affect the choice or a travel mode. Some of the factors found as being responsible for this are:

I **Length of Trip (Journey Length).**

The length of a trip affects the individual's choice of mode of transport different methods have been in measuring journey lengths. One way is by measuring the distance between zone centriods for both private car and public transport. Another way is by measuring the time taken to complete a door journey, otherwise known as total journey time. Both methods have been used by researchers. However, the latter is more preferred because it incorporates the time spent in a vehicle as well as the time spent outside the vehicle (excess travel time) during a trip. Therefore, the total travel time made by public transport includes time spent in public transport vehicle to another (x_1) time spent changing from one public transport vehicle to another (x_2), time spent waiting for public transport vehicle (x_3), time spent walking to public transport at origin (x_4) and time spent walking to public transport at destination (x_5), that is ($x_1 + X_2 + x_3 + x_4 + x_5$).While, the total journey time by car is given as time spent during a car (x_6), time spent parking vehicle at destination (x_7) time spent walking from parked vehicle at destination transport (x_8) that is, ($x_6 + x_7 + x_8$). This formular was developed for use by the national transportation agency (1962) in Washington.

Total journey time is either expressed in time difference (that is, time by public transport ($x_1+x_2+x_3+x_4+x_5$) minus time by private car ($x_6 + x_7 + x_8$) or time ratio (that is time by public transport divided by private car): The use of time difference is preferred because it reveals the relative importance of the transport mode and how individuals react to, for example, inconvenience, in model choice. For instance, assuming a journey from point A to point B by private car is 10km per hour, and

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by public transport is 5k per hour. A journey of 1km gives a time difference of 6 minutes and time ratio of 0.5. But for a journey of 6km, the time difference is 36 minutes while the time ratio is 0.5: It should be noted that while time ratio remain unchanged, time differences increases with distance. Therefore, as journey length increase, the value of time becomes very important.

ii **Trip purpose:** it has been observed also that some relationship exist between trip purpose and of transport mode. More often, home-based journeys attract more public transport use than non-home-based journeys such as for shopping. It is more likely that an individual would choose to travel to eotk or school by public transport, but would prefer the private car if available for social trips shopping trips etc.

iii **Location:** The location of an individual in relation to his home or workplace affects his choice of mode. For example, an individual who lives 500metres away from his office may choose to walk or cycle, but if he lives 5 kilometers away he may have to choose between using public transport.

iv **Time of Day:** the time of the day when the trip is made whether morning, afternoon or night also affects the selection of travel mode. Most night trips especially are done by private cars because, public transport service operators are closed for the days work.

2.33 CHARACTERISTICS OF THE TRANSPORTATION SYSTEM

The level of service or characteristic offered by available completing transport mode has been found to influence the choice of travel mode. Some of the factors found responsible for this are:-

I. **Travel Time**. Travel time has been found to influence modal choice as already discussed in section 2.32 (I). Time –saving influence individuals' choice of transport mode. For example, given a distance of 5km, a time-saving of 6 minutes may act as a stimulus for another transport mode than if it were 36minutes.

ii **Travel Cost** : This is another variable that influences modal choice. The travel cost for public transport is expressed as fare paid for public transport (x_9). While the travel cost for private car is given as cost of petrol (x_{10}) plus cost of engine oil (x_{11}) plus half the cost of parking ($0.5x_{12}$), all added and divided by average car occupancy (x_{13}). The travel cost for each mode is often treated as per capital or individual cost rather than group cost since the unit of analysis is the individual. As already discussed in section 2.32(1) travel cost can be expressed in ratio or difference.

iii **Travel Service** : The service offered by competing transport modes has also been found to influence modal choice. The service offered or cost incurred differ in terms of comfort, convenience, reliability, ease of changing from one mode to another, safety, etc. these variables or factors are subjective and difficulty to quantity. But a variables that indicate the inconvenience of travel by each mode

is usually computed. Two methods have been developed to calculate this aspect of modal split. The first method is excess travel time (ETT) developed by NCTA in 1962. Excess travel time . ETT is defined as the time spent outside the vehicle during a trip. From section 2.32(1), the excess travel time by public transport is calculated as $(x_2+x_3+x_4+x_5)$; and the excess travel time by private car is (x_7+x_8). The ETT can be represented as a difference or ratio between the transport modes. As a ratio it is represented as

$$\frac{X_2+x_3+x_4+x_5}{X_7+X_8}$$

The other method is psychological scaling technique. It is a method which a proxy for the amount of difficult associated making a given journey by each mode. The method of representing such a variable involves assigning a unit to each section of the undertaking a journey. Fig 2.2 shows an example of this method.

Private car Journey

Walk to car	-	1	unit
Drive	-	1	unit
Parking	-	1	unit
Walk to destination	-	1	unit
Total	-	4	units

Public transport Journey

Walk to public transport vehicle at origin	-	1	unit
Wait for public transport vehicle	-	1	unit

Travel on public transport vehicle	-1	unit
Changing between public transport vehicle	-1	unit
Walk from public transport at destination	-1	unit
	5	units

Fig 2.2 Travel service variable

Source: Watson (1974).

The later method is more preferred because of its flexibility. It shows how levels of inconvenience associated with travelling in a vehicle is evaluated for example, if walking is seen twice as waiting time, walking sections of travel is assigned 2units while waiting 1 unit. This method also allow other factors of inconvenience such as luggage, children, etc. to be included in the modal.

(iv) **Accessibility Ratio:** Accessibility is a term used to describe how conveniently land- uses are located in relation to each other and how easy or difficult it is for people to reach given the transport network (Black, 1981). Accessibility indices measure the ease with which activity in one area can be reached from one particular zone or area on a specific transportation system. There are different ways that accessibility index can be measure. One way of measuring the index is through quantity of services provided by the transport modes. This can be computed using the formula provide in the south eastern Wisconsin Regional and use transportation study in 1963 as:

$$Q_1 = \sum_{J=1}^{n} Aj\,(f1j)$$

Where

Q_1 = Accessibility index for zone 1 to all other zones (by public transport or private car)

Aj =Attraction in zone j(by public transport or private car)

Fij =Travel time friction factor for travel from zone 1 to zone j On the particular transportation system being considered.

n = Total number of zones

Friction factor (F_{ij}) $\dfrac{1}{(\text{door-to-door travel time})^b}$

Another way of measuring accessibility index is through the number of transport routes serving a zone, the frequency of service and the area of the zone. This method was used for the London traffic survey in 1966 as.

$$AI = \frac{\sum\sqrt{N_{ij}}}{\sqrt{A_j}}$$

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Where

AI = Accessibility index

N_{ij} = Off peak frequency of houses on route I and passing through zone J

A_j = Area of the zone (in hectares)

Therefore, Accessibility Ratio = private car accessibility index

Public transport accessibility index

It can be seen from the foregoing discussions that many of the variables or used that influence modal choice used in different models of modal split analysis. Table 2.3 shows a summary of the variables used in modals for difference towns or cities around the world.

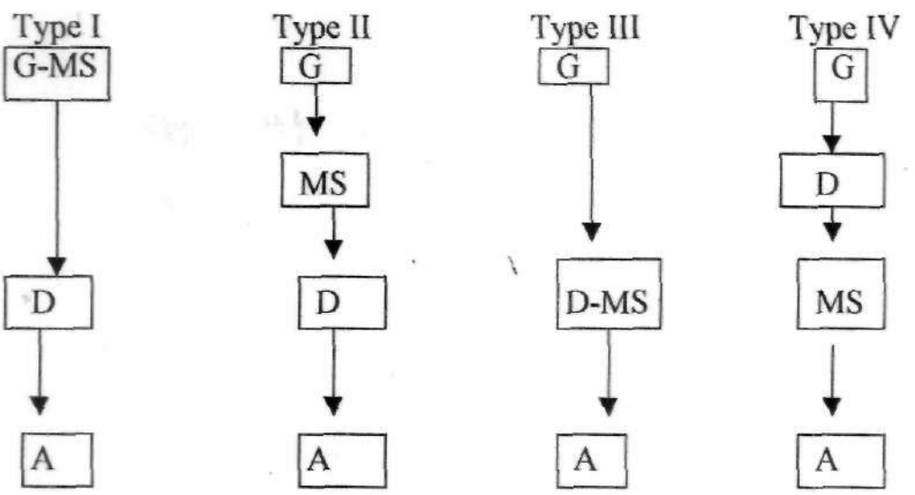
Table 2.3: **Variables used in modal split models for different towns or Cities**

	Trip-end Model				Trip-interchange Model				
Variables	chicago	Pittsburg	Eric	Pugetsound	South-Esterwiston	Washington DC	Twin cities	Sanjuan	Buffal
Trip characteristics									
No of trip purpose	2	3	1	4	7	2	3	2	2
Length of trip									x
Time of day						X			X
Orientation to CBD	x	x							
Trip-maker characteristics									
Car-ownership	x	x		x	x			x	X
Residential Density		x		x			x		
Income				x		X	x		
Workers per household							x		
Distance to CBD		x							
Employment density									
Transportation characteristics									
						X	x	x	X
Travel Travel time cost						X		x	
Parking cost						X	x		X
Excess Travel time						X			
Accessibility			x	X	x				

Source: Fertal M.J. et al (1970) Modal split-Documentation of nine methods for estimating transit usage. Dept of transportation, Washington DC. PP3.

2.40 APPROACHES TO MODAL SPLIT ESTIMATION

As discussed many factors influence individual choice of selection of a particular mode of travel. Some of the factors are objective and measurable, others are subject and difficult to quantify. As a result a variety of modal split approaches have been developed.



Note: Type I – Modal Split Combined With trip generation

Type II- Between trip generation And distribution

Type III- Combined with trip Distribution

Type IV- Between trip distribution and Trip assignment

Key	
G-	Trip Generation
D-	Trip Distribution
MS-	Modal Split
A-	Trip Assignment

Fig. 2.3: Alternative positions of modal split analysis

Source: Black J. (1981): Urban Transportation Planning ; Groom Helm, London, pp.84

In fig. 2.3, Type I and II models are known as trip - end (pre-distribution) models. These models allocated total person trips to alternative modes of travel before the trip- distribution stage. Type III is known as the gravity type model while type IV is known as the trip interchange (post-distribution) model. The trip interchange model allocate total trips to alternate modes after the total trip have been distributed between zones of origin and destination.

Two types of techniques can be used for the modal split analysis in type I. They are multiple liner regression technique and category analysis . a typical multiple linear regression technique is usually in the form of an equation like.

$$P_y = b_o+b_1+\log x_1+b_2 \log x_2+b_3\log x_3 \ldots b_n \log x_n$$

Where:

P_y = percentage (proportion) of trips by public transportation or by private car.

b_1-b_n = Correlation coefficients

x_i-x_n = Independent variables. It could be travel time, Travel cost, car ownership, income etc.

b_o = regression constant

For category analysis, households are cross classified by car ownership, household size or family structure and income. This is

followed by the calculation of the mean traffic production by each transport mode for each cross- classification from the home interview survey.

In type II modal split models, the graphical diversion curve technique is used. The percentage of zonal trips using one transport mode, say public transport, is plotted against a selected land-use variable such as zonal car ownership, travel time ratio, etc. A best –fit line or curve is drawn through the data points, and this represents the empirical diversion curve for the town or city. An example of a diversion curve is shown in fig. 2.4

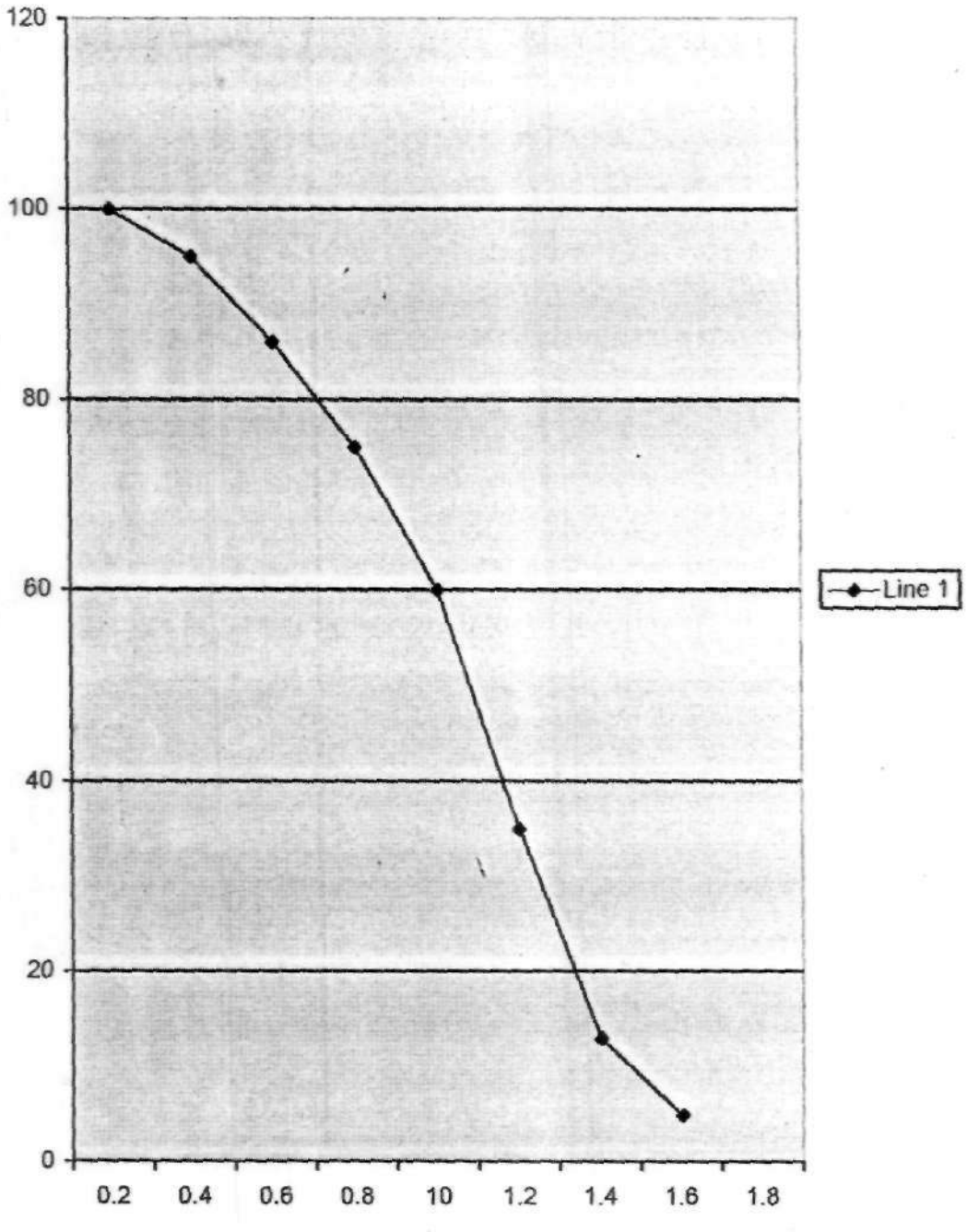


Fig 2.4: A Typical Diversion Curve

Source: Papacostas C.S (1990) Fundamentals of Transportation Engineering. Pretice Hall New–CILI PP 239.

Type III modal split models exploits the gravity model in trip distribution. An exponential function of transport impedance is used to estimate the

amount of inter-zonal traffic on each transport mode. This model is expressed in a mathematical equation as:

$$Qij\,(1)/\sum_{M=1} Qij\,(m) = \frac{1}{1+\text{Exp}\,\{-B(Tij_{(2)}-Tij_{(1)})\}}$$

$Qij(1)$= Estimate of the number of trips from zone i To zone j by transport mode i.

$Qij_{(m)}$= Estimate of the number of trips from zone 1 to zone j by transport mode m

$Tij(1)$= Transport impedance from zone 1 to zone j by transport mode 1.

$Tij(2)$= Transport impedance from zone 1 to zone j by transport mode 2.

B= Gravity model calibration parameter.

Type IV modal split modals could be in the form of diversion curves (as in fig. 2.4) multiple linear regression and gravity model.

The use of each type of modal split model has to be done with great care. For instance, the trip end approach to modal split is capable of showing total person trips distribution of public transport and private car between pairs of zones- especially if the difference in lengths of journey by car and public transport is considered. This point could be considered a major weakness of the trip-interchange modal.

Table 2.3 shows the summary of the various models used in modal split for different towns, or cities using different variables that

influence modal choice. Other transport studies in Nigeria showed the importance of those variables too. Adeniyi (1987) showed how diversities exist in urban travels, user preferences, ridership density and affordability influence trip- maker's choice of mode. Krapor (1986) also demonstrated how car ownership and level of income influence the use of public transport. One major weakness with these studies is that research findings have not been related to land uses.

CHAPTER THREE.

THE STUDY AREA.

3.10 LOCATION

Kaduna metropolis is located within the geographic centre of Northern Nigeria. The metropolis lies between latitude $10^{o}4^{1}$ and $10^{o}7^{1}$ North of the equator and longitude $7^{o}2^{1}$ and $7^{o}6^{1}$East of the Greenwich Meridian as shown in Fig.3.1 and Fig.3.2. The metropolis is made up of mainly four Local Governments Kaduna North and Kaduna South, and parts of Igabi and Chikun Local Governments.

3.20 THE GROWTH AND EXPANSION OF KADUNA METROPOLIS.

Kaduna was conceived as an administrative and military capital of what was then the capital of protectorate of Northern Nigeria. It later transformed into the regional headquarter for the defunct Northern Region after independence. By 1967 when new states were created, Kaduna became the administrative capital of North-central state. Even when new states and capitals were created in 1976, 1987 and 1996 respectively, Kaduna remained a state capital.

Owing to its legacy as an old administrative town, its greatest impetus for growth came with the extension of the railway from Lagos in 1911, the movement of any units from Zungeru to Kaduna in 1913 and Federal Government presence and textile industries. The town's vintage position as a nodal town served as an attraction for industrial development and associated with it large scale commercial activities and human interaction. The

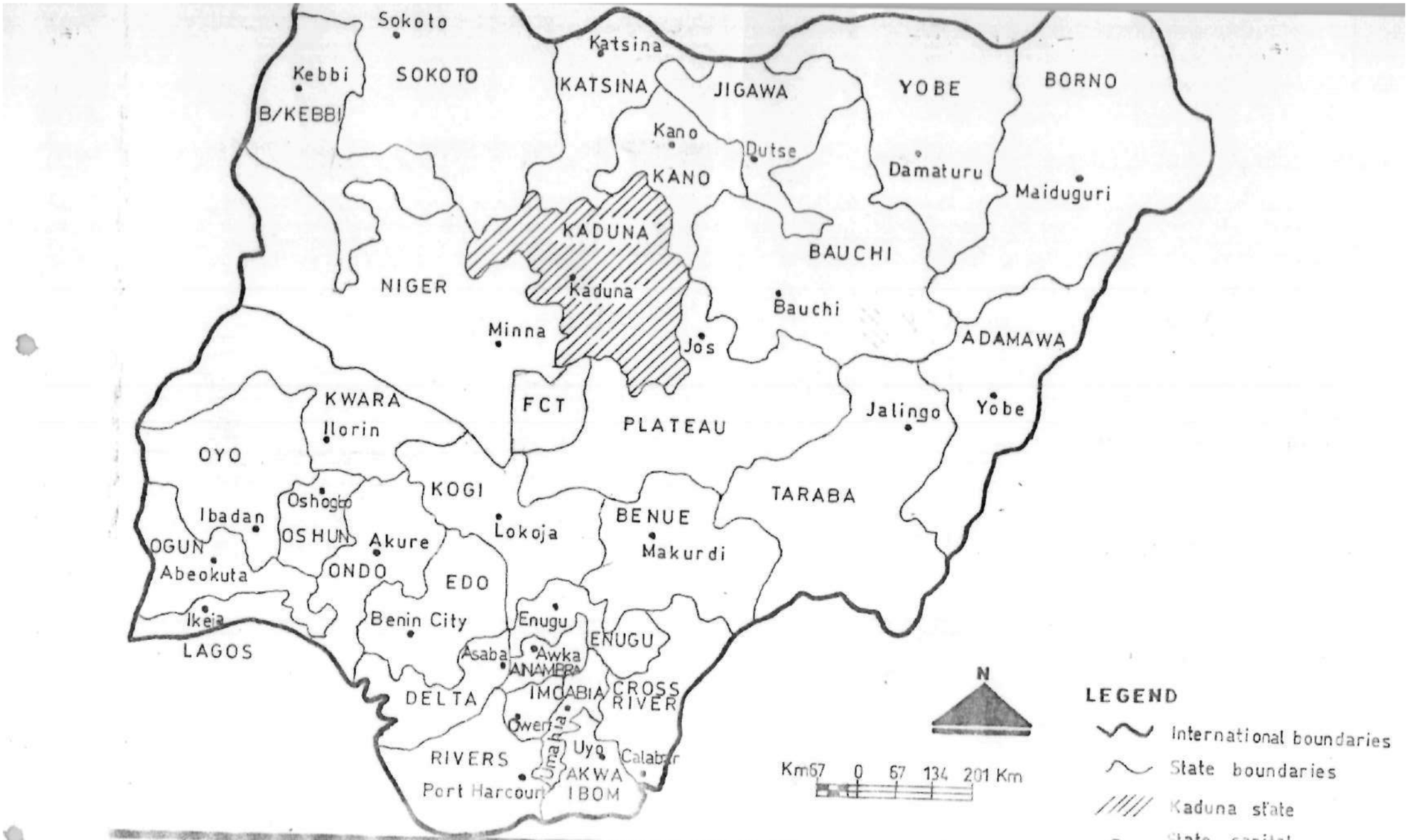


Fig 3.1 KADUNA WITHIN NATIONAL SETTING

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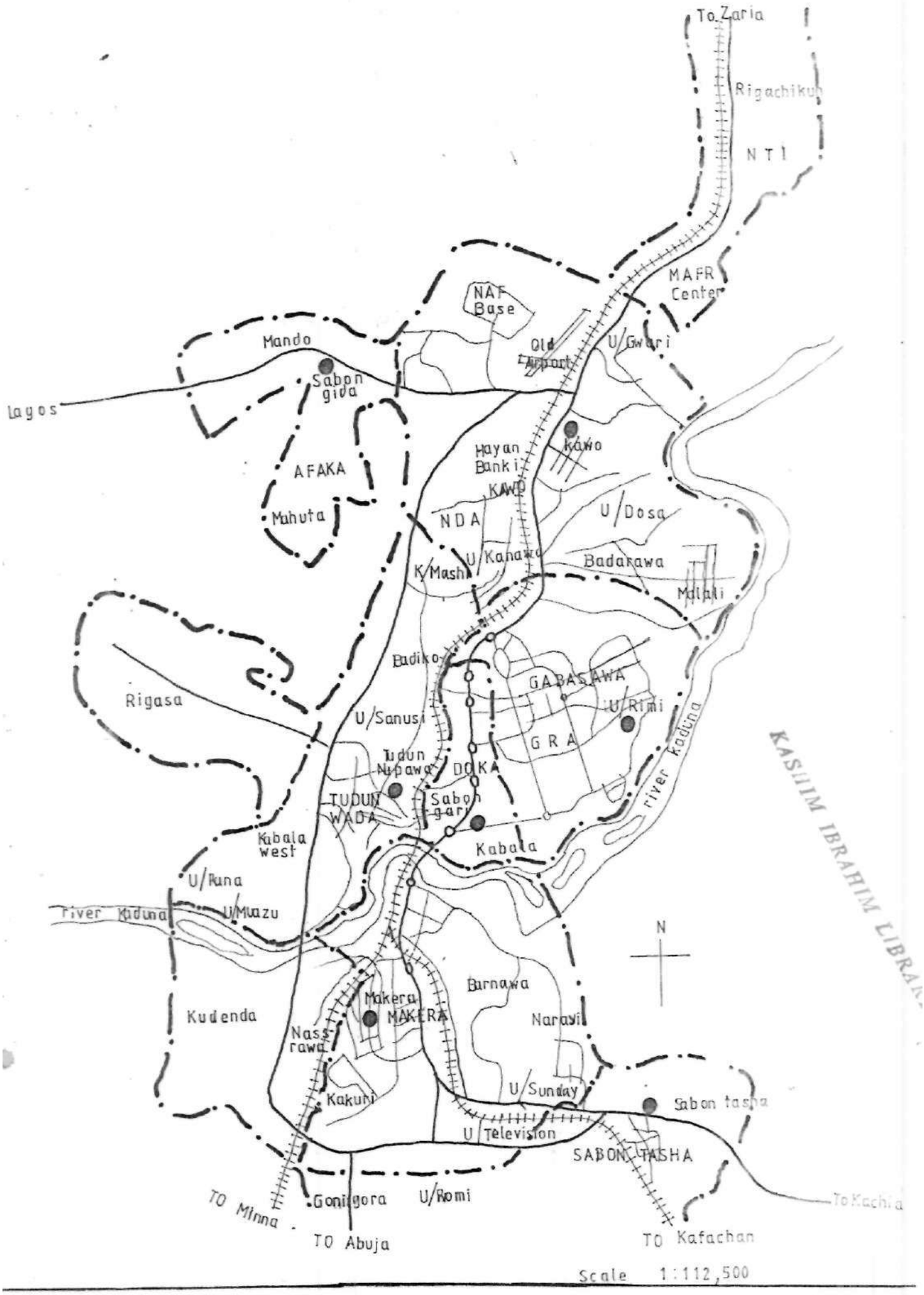


Fig 3.2 THE STUDY AREA

Teku Y
M.Sc(URP)

implication of these developments was a tremendous spatial expansion, increased population over-stretching of utilities and services, increased demand for land, etc.

The initial growth of the town was centered around the administrative nuclear, and European quarters now Government Reserve Area (GRA) and Sabon – Gari in the Northern parts of Kaduna River. While the railway station, survey department, Makera and Kakuri were the early areas of development in the southern part of Kaduna River. Later changes in industrial and commercial activities have made sub-urban location attractive. This developments also gave rise to emergence of settlements like Kawo, Unguwan Kanawa, Unguwan Shanu, Unguwan Dosa, Badarawa, Television, Nassarawa, Barnawa, Narayi, etc..

The construction of the western by-pass (now named Nnamdi Azikiwe way) further enhanced the physical expansion and development of Kaduna metropolis westwards. The intermittent religious conflicts in 1987 and 1992, and relocation of the federal capital to Abuja in 1992 influenced the growth process to the South along Kachia and Abuja road. With the initiation of the eastern sector physical development plan in 1995, it is hoped that the physical growth of Kaduna would expand east-wards when the plan is implemented.

3.30 PHYSICAL CHARACTERISTICS

3.31 Climate and hydrology.

Kaduna experiences two climatic seasons; the dry season and wet season. The dry season consist of hot and harmattan period stretching between the months of November and March. The harmattan is often cold accompanied by strong wind blowing from North – East Sahara region. The wet (rainy) season is experienced between the month of April and October. The rain storms are usually violent and windy some times accompanied with thunder and lighting thereby causing destruction to lives and properties. The average annual rainfall is 164mm, while its highest temperature range between 90° – 105° Fahrenheit (27° – 32°c) in April, and its lowest between 45° – 60° Fahrenheit (14°c – 18°c). These seasons have for implications for agricultural planning and practice.

One of the major influence for location of Kaduna by Lord Lugard is its abundant water resources both surface and underground. (Max Lock 1965). The water table is quite high and wells are sunk to a depth of about 5metres. The water used for industrial, agricultural and domestic uses are soured from River Kaduna. It is the dominant source of water supply in the town. The river is a major tributary to River Niger and it origin from the Jos Plateau

3.32 TOPOGRAPHY, SOIL AND VEGETATION

Kaduna town is located with the North central high plains. The topography consists of the rolling terrain with relief situated 450 – 500metres above sea level. There are sporadic rise of solid granite inselbergs to the East and South-East of the town. The land is covered by the North

Guinea Savannah vegetation type which consists of tress like locust bean, baobab, silk cotton, dates and shrubs. These is no evidence of mineral deposits in the town. However, the laetrile and granite are considered moderately suitable materials for building. The soil texture is waterlogged and marshy .

3.40 THE POPULATION OF KADUNA METROPOLIS

Kaduna metropolis, no doubt, has witnessed tremendous population growth. From a total number of 40,000 people in 1952, the figure grew rapidly to 149,910 people in 1963. This is about 275 percent increase as shown in table 3.1.

Table 3.1: Population Statistics for Kaduna Metropolis 1952 – 1997.

Year	Population Estimate	% Increase
1952	40,000 [1]	
1963	149,910 [1]	275
1983	450,000 [2]	300
1991	711,155 [3]	58
1997	960,000 [4]	35
2007	1,552,363 [4]	63

Note: Figures provided in 1991 – 2007 could be slightly higher since there is not proper records on migration birth and death rate statistics.

Source: (1) Lock (1967), (2) Kulshresthra et al (1983),
(3) National population (NPC) Records (1991),
(4) Estimates by Author.

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By 1997, the figure rose to about 960,000 people. This show an increase of about 540 percent between 1963 and 1997. Some sources use 7 percent to estimate the population for Kaduna metropolis (Dept. of Statistics, Governor's Office, 1990), while others like United Nations' Population Fund use 3.5%. The former is rather on the high side. In between these two extremes, the growth rate of 5% (National Urban Growth Rate) was used in this study to estimate the 1997 population for Kaduna town. From Table 3.2, which ever growth rate that is used to estimate the population in 1997, it is certain that the population of Kaduna is growing but how fast is a debate outside the scope of this research.

Table 3.2 Population Projection for Kaduna Metropolis.

YEAR	POPULATION GROWTH RATE (%)	POPULATION ESTIMATE
1991	Base Year	711,155
1997	2.5	824,722
1997	3.5	874,191
1997	5.0	953,061
2007	5.0	1,552,362

Source: Computed by Author.

Table 3.3 and Fig. 3.3 show the population distribution according to districts. Further examination showed that the current population in estimation for Kaduna metropolis is far in excess of Max Lock's proposal by about 15% (see table 3). This is attributable to natural increase due to high birth (fertility).

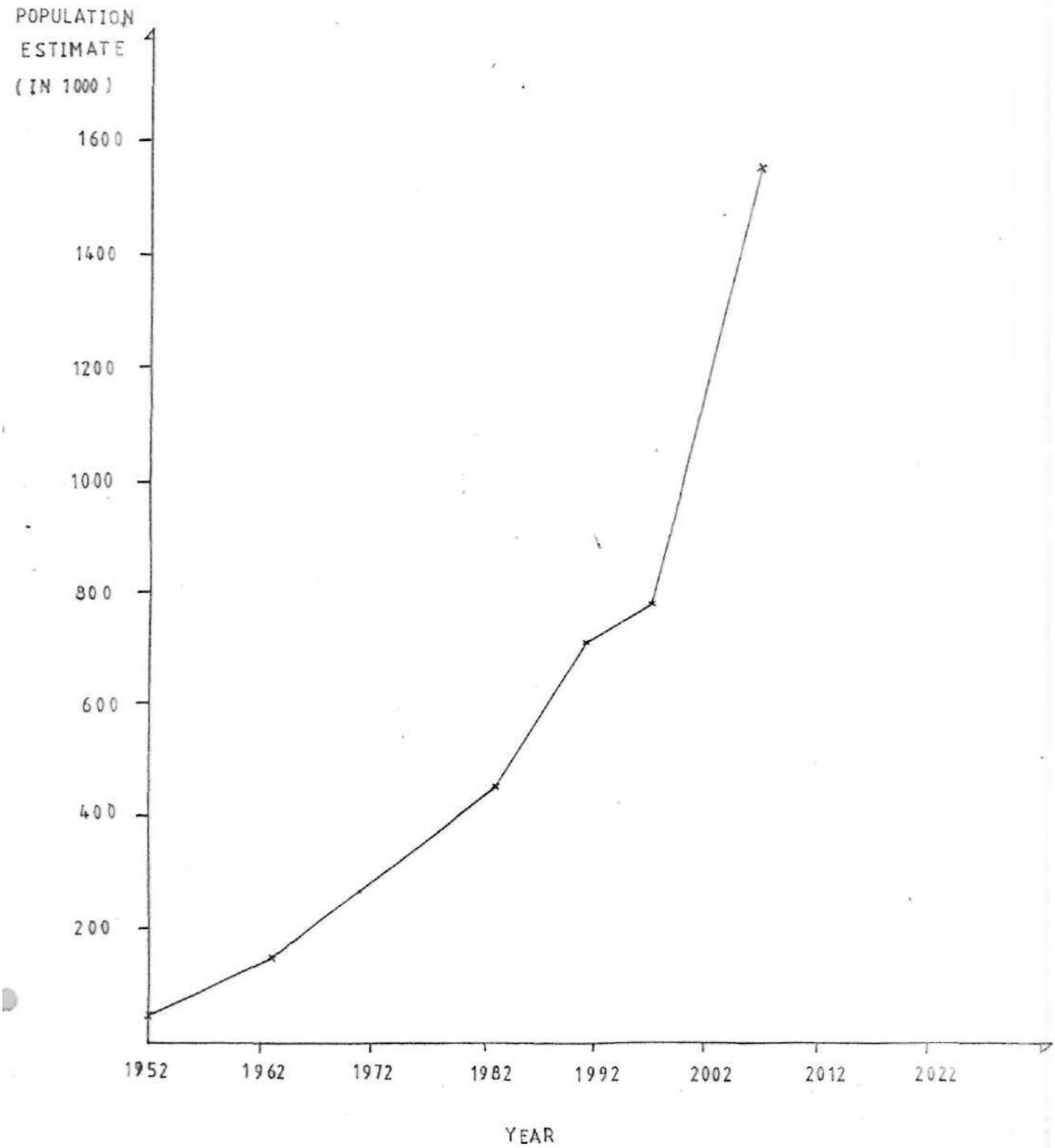


Fig 3.3 POPULATION GROWTH AND PROJECTIONS FOR KADUNA METROPOLI

Table 3.3 **Comparison of Population Statistics between Max Lock's Proposal and 1997 Population Estimate.**

VARIABLE	POPULATION ESTIMATE	PERCENTAGE INCREASE
Max Lock's Proposal (1967 – 2017)	350,000	156
Population Estimate in 1997	960,000	

Source: Max Lock (1967) and Author.

Rate and low death (mortality) rate. Another reason is migration due to the town's expanding industrial and commercial base and employment opportunities.

Table 3.4: **Comparison of Land use Distribution between 1965 and 1997.**

Land use category	1965 Area (Ha)	%	1997 Area (Ha)	%
Residential	14664.98	21.0	8750	42.0
Commercial	145.69	2.0	900	4.0
Industrial	246.86	4.0	1950	9.0
Public/semi public	1290.96	19.0	5500	27.0
Recreation/open space	124.41	2.0	320	2.0
Quasi vacant land1	1602.59	23.0	1490	7.0
Transportation	-2	-	1750	8.0
Armed service	1966.76	29.0	-3	-
Total	6842.28	100	20,660	100

Note:

1 - These are committed lands that are not being put into use.

2 - In 1965 lock's studies, land uses were measured in gross including streets and roads reservation.

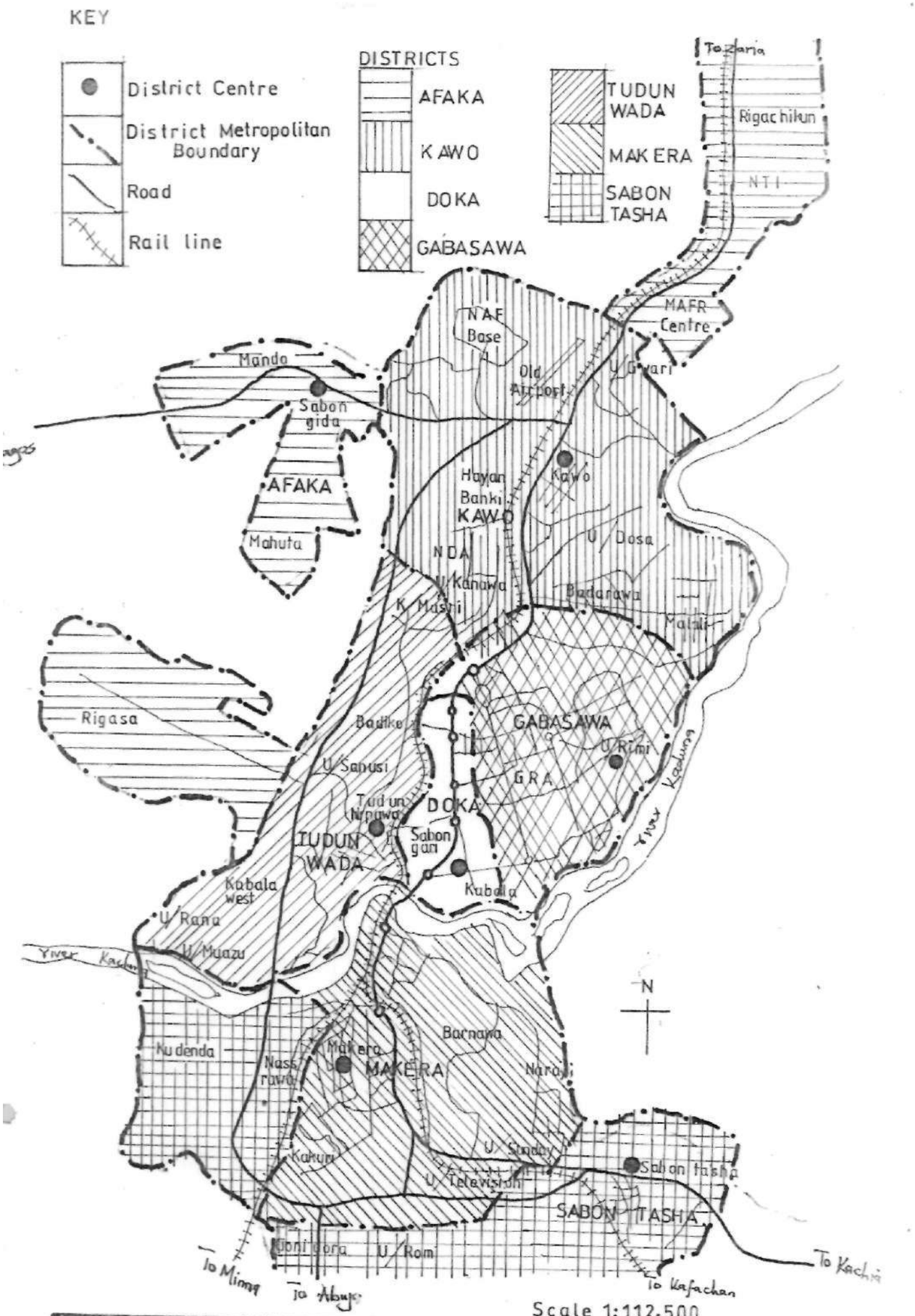


Fig 3.4 ADMINISTRATIVE DISTRICTS OF KADUNA

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M Sc URP

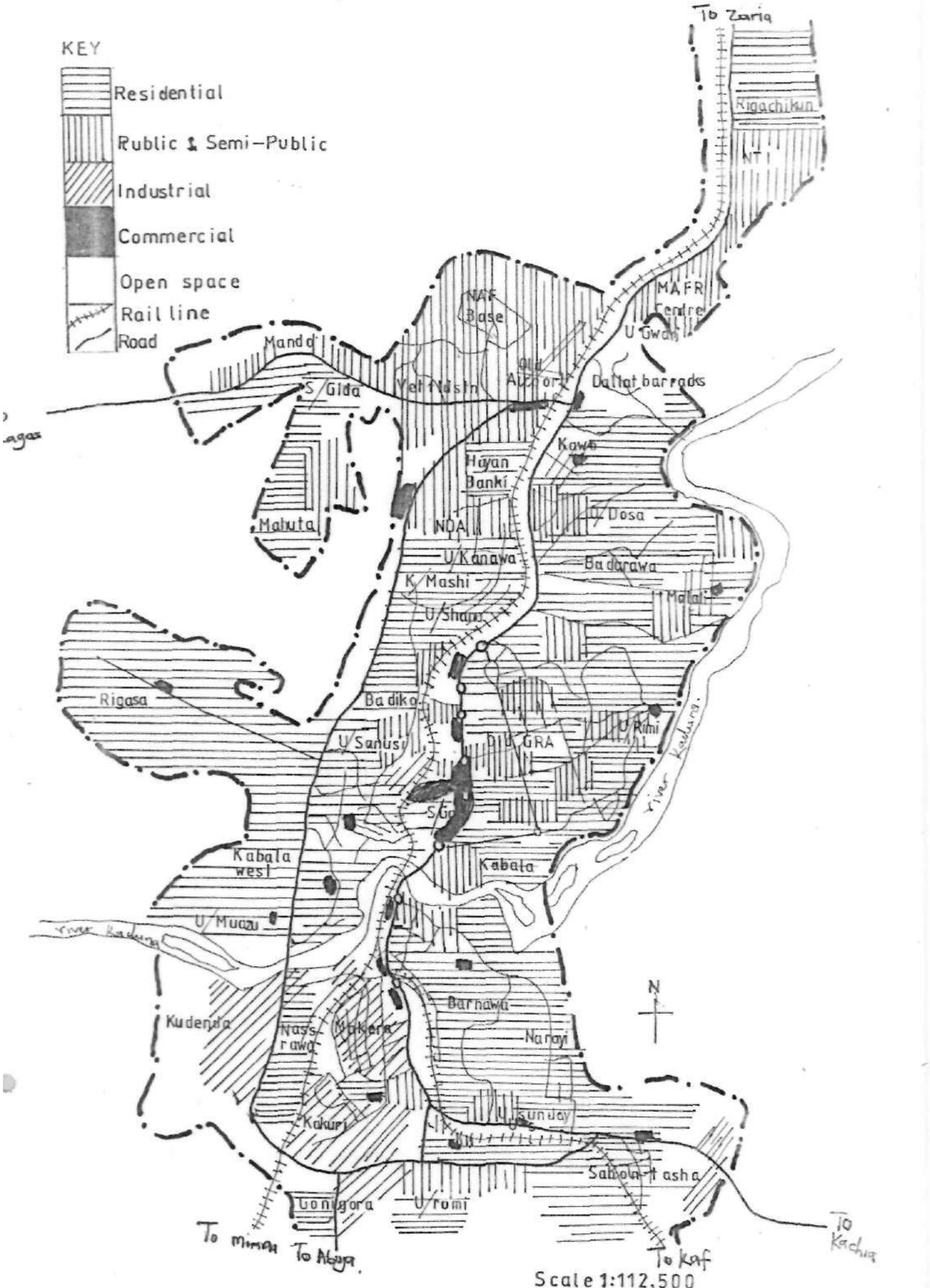


Fig 3.5 THE EXISTING LANDUSE STRUCTURE

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M ScURP

3 - Now classified under public land use
Source: Fig 3.3 and Lock (1965).

Table 3.5: Land use Development According to District in Kaduna

Land use category	Afaka	Gabasawa	Doka	Tudun Wada	Sabon Tasha	Kawo	Makera
Residential	40.0	62.0	51.3	58.0	47.4	52.0	38.0
Commercial	4.0	5.0	23.0	15.0	6.3	24.0	3.0
Industrial	18.0	1.0	1.0	8.0	18.0	10.0	45.0
Public/semi public	25.0	11.0	5.0	10.8	4.0	4.0	6.0
Open space	8.0	15.0	10.7	2.2	10.6	4.0	3.0
Transportation	5.0	6.0	9.0	6.0	3.7	5.5	5.0
Total	100	100	100	100	100	100	100

Source: Fig 3.4

Residential and public land uses are the most dominant as depicted in table 3.4 and fig. 3.4. These land uses put together account for 69% of the development area. The residential developments are distributed into high, medium and low density as show in fig. 3.4. the used covered under public land use include government administrative buildings, educational institutions, Armed forces and police buildings, para-military institutions, etc

Commercial and business activities are concentrated around the central business area (CBA) along Ahmadu Bello Way, Lagos Street, Mahmud Gumi Central Market, Mogadishu etc. Pockets of specialized markets and convenience shopping areas are located at the district and community levels. Some forms of shopping and commercial retailing activities are also carried out along major roads occupying the same

building or plot with residential accommodation which give rise to a phenomena known as mixed land use.

Most of these industries especially formerly organised and registered industries made up of large-scale manufacturing plants are located on the Southern part of Kaduna river along Kakuri - Makera axies, Nasarawa Kachia and Abuja road and light manufacturing in Hayin Banki. Small scale manufacturing like bakery, block –making , furniture works, welding etc are found within the mixed land use pattern.

Very limited space is devoted to recreational activities when compared with the size and function of Kaduna. In table 3.5, recreational land use accounts for only 2% existing land used comprising stadia, Murtala Square, Golf Course, parks and gardens.

In terms of land devoted to transport use comprising road, air, and water, road space dominate. The roads in the town are classified into three namely federal, state as local road. The road . and street system are made up of primary distributors, local distributors and access roads. These roads are patterned along radial and grid-iron networks.

3.60 URBAN TRANSPORT PLANNING AND PHYSICAL (LAND-USE) PLANNING IN KADUNA METROPOLIS.

The interactive relationship between transportation and development need not be over-emphasised. The linkage is so important that it is impossible to make an efficient transport plan in isolation with

the overall urban physical development plan. But this has been the case in Kaduna and most urban centres in Nigeria where transport planning and physical planning have not been properly co-ordinated.

Transport planning conceived as the whole process of identifying, designing and managing of transport projects and policies is carried out by the Kaduna State Ministry of Works, Housing and Transport. The Ministry oversees the implementation of national transport policies and programmes in addition to the provision and maintenance of road infrastructure investments particularly state roads. While, federal roads (trunks A &F) and local roads are maintained by the federal and local governments respectively. Rail and air transports are separately under Nigeria railway Corporation (NRC) in the Federal Ministry of Transport (FMOT) and Federal Aviation Authority of Nigeria (FAAN) in the Federal Ministry of Aviation (FMOA). Other transport projects and programmes are carried out by:

(i) Federal road safety commission- vehicle and road users safety.
(ii) vehicle inspection office- Vehicle road-worthiness.
(iii) Kaduna state transport office- transport service (Intra urban and inter urban).
(i) Nigeria police force – traffic control and road- user safety.
(ii) Local Government- Management of motor parks.

From the foregoing , it is evident that transport planning is presently uncoordinated and agencies and ministerial functions are overlapping. In Kaduna, Physical planning activities revolved around two major agencies

the Bureau of Lands, Survey, Town and Country Planning and Kaduna State Urban Planning and Development Authority (KASUPDA) . The former is the custodian of land in the state, while the latter controls and manages the uses of land for various purpose. The crucial factor observed is that greater concern has been given to managing the use of land, while transport planning is being neglected. Lay -outs, Planning schemes, etc have been carried out without establishing the transport

needs. This practice have led to very limited efforts aimed at an integrated approach to the solutions of urban transportation problems in Kaduna.

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CHAPTER FOUR
DATA GENERATION, ANALYSIS AND FINDINGS

4.10 Research Methodology

4.11 Method of Data Collection

The data required for the study consist of usage of various modes of transport, its determinants and problems. Other data include socioeconomic attributes of transport users and activity areas (land-uses). Various research methods employed in the collection of data - sets from both primary and secondary sources are:

A. Questionnaire and Observations

Primary data sets were collected using questionnaire administration and field observation. Questionnaires were administered to heads of households as trip-makers (see Appendix C). They are made up of high, medium and low-income groups. Given an estimated population of about 960,000 people in Kaduna, a random sample of 0.18 percent (1,600) was taken.

Table 4.1: Sample Distribution According to Districts

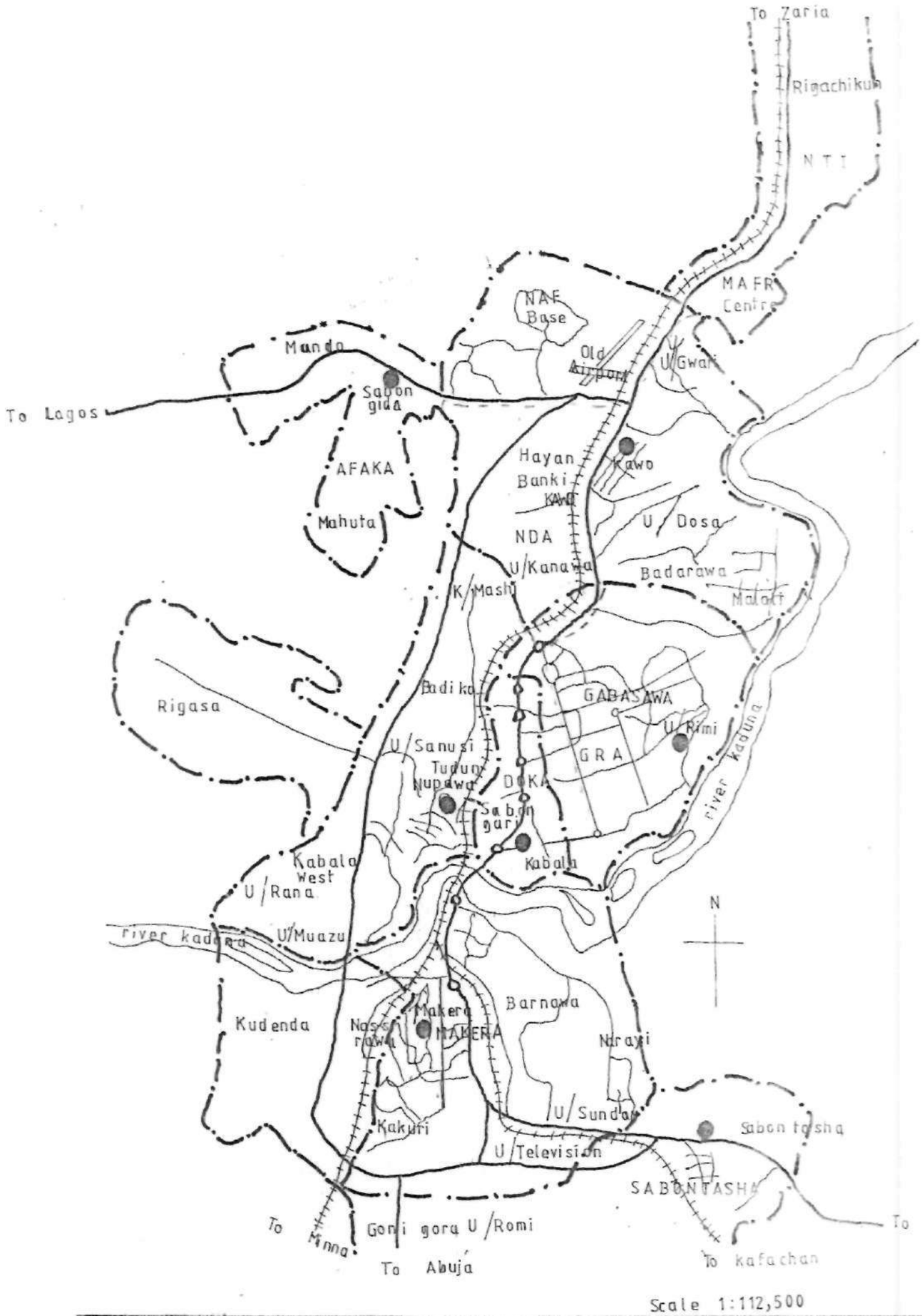
DISTRICTS	SAMPLE SIZE
Afaka	120
Gabasawa	210
Doka	320
Kawo	250
Sabon Tasha	190
Makera	230
Tudun-Wada	280
Total	1600

1,120 questionnaire were returned which gives a response rate of 70% after all the defective responded questionnaires have been removed, a total of questionnaires were analysed. The questionnaire solicited information on the socio-economic characteristics of transport users, journey purpose, car-ownership, mode of transport used for journeys, travel cost and travel time. Since all urban trips originate from the home (residential land use), this method of questionnaire administration serves a useful way of gathering information as to the destination of trips. Follow up interview was carried out to augment information on travel cost and travel time.

Volumetric traffic count was also carried out. Some major roads within The traffic zones were selected for traffic survey and interview (see table 4.3 fig. 4.1 and 4.2). The road side survey and interview was conducted during a weekday as from 7.OOam in the morning to 7.OOpm in the evening. Two enumerators were used in each of the incoming traffic and the other going traffic. The interview conducted introduced and explained the purpose of the survey. The original and destination of as well as trip purpose was also ascertained. Field observation was also carried out to up-date the general land - use developments in the town.

B. **Review of Records**

Secondary data were sourced from published materials and official records from the Kaduna State licensing office, Kaduna State Urban Planning and Development Authority, Statistics Departments, Governor's Office and Kaduna state statistical year books by ministry of finance and Economic planning. Other published materials include textbooks, journals



Scale 1:112,500

Fig 4.1 TRAFFIC ZONES IN KADUNA

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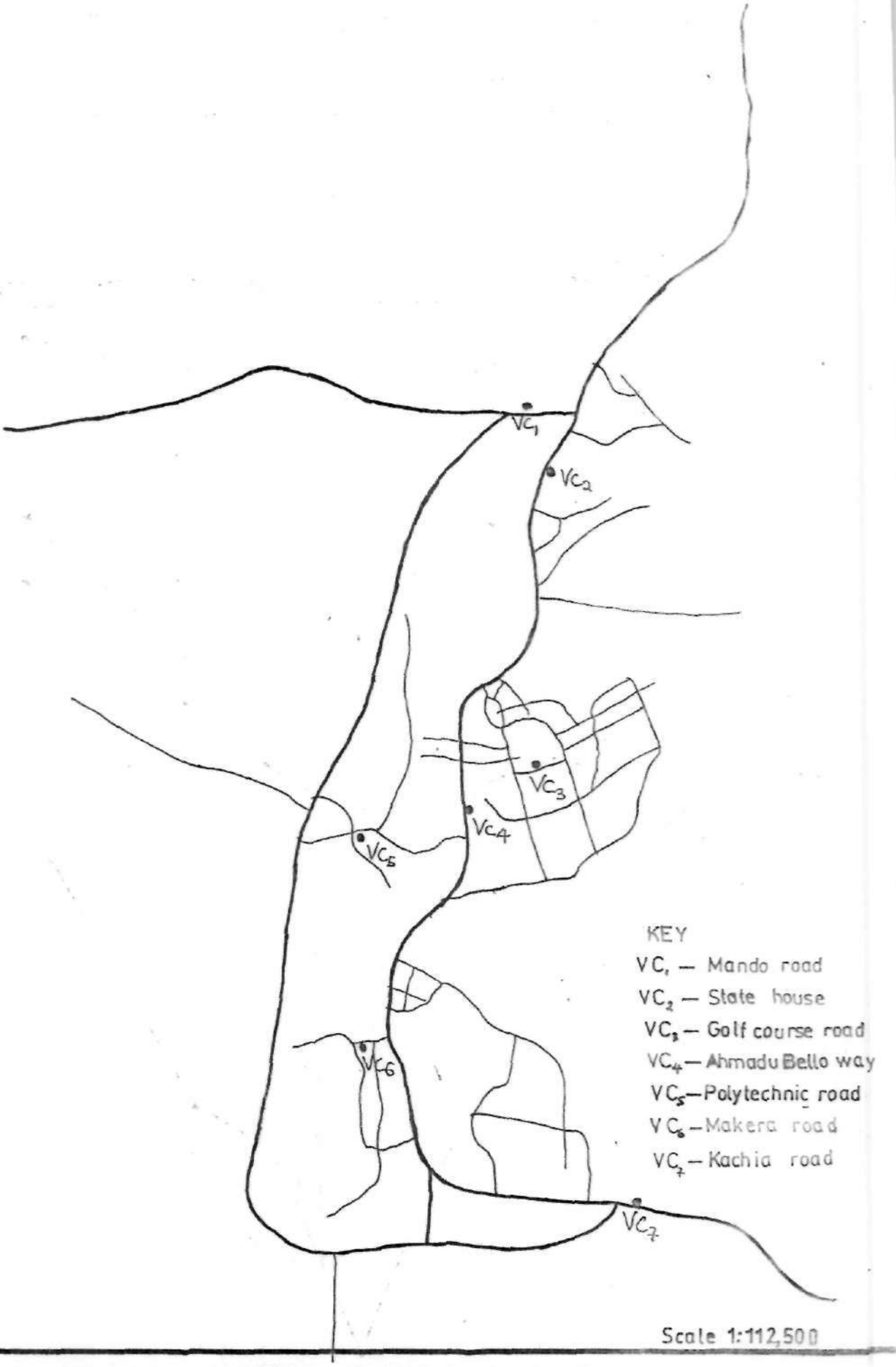


Fig 4.2 SELECTED MAJOR ROADS AND SURVEY STATIONS

Teku Y

and consultancy reports. Information gathered from these sources include, among others, vehicle registration statistics, demographic statistic and base map.

4.20 METHOD OF DATA ANALYSIS

The information collected in this study does not lend itself to rigorous statistical analysis such as multiple linear regression . probit analysis, logit analysis or discriminate analysis. Data generated were analysed using mean, ratio, and percentage. The data were presented through pie charts, graphs and tables.

4.30 DATA ANALYSIS

4.31 SOCIO - CULTURAL AND ECONOMIC CHARACTERISTICS

The questionnaire analysed shows that there were 800 males (80 percent) and 200 females (20 percent) respondents. The average household size varies between 3 and 10. The variation in household size is attributable to many factors amongst which are religion, kinship ties and ethnicity. In terms of employment, 57 percent are employed in the public service made up of civil servants from the federal, state and local government; and government parastals. Other forms of employment are private sector workers 22 percent, self employed 14 percent, others (i e those not covered by the above categories) 7 percent. Fig 4.3 shows the nature of employment. (See also Appendix A).

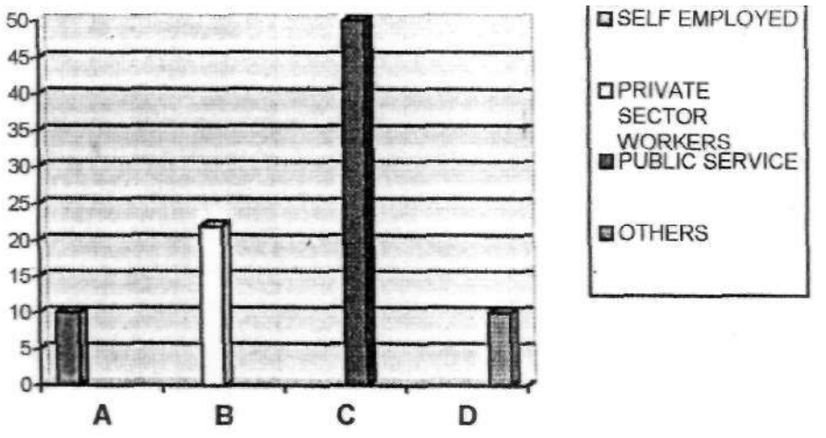


Fig 4.3: **Nature of Employment**

4.32 Journey Purpose

The outcome of the survey is similar to what is obtainable in most urban centres in Nigeria. The dominant trip purpose is for work.

This contributes about 70 percent of total journey purpose. Other non – work trips are distributed as business 18 percent, shopping – 6 percent, school – 5 percent, social visits (recreation, leisure etc) 1 percent. This information is depicted in fig 4.4 and appendix A.

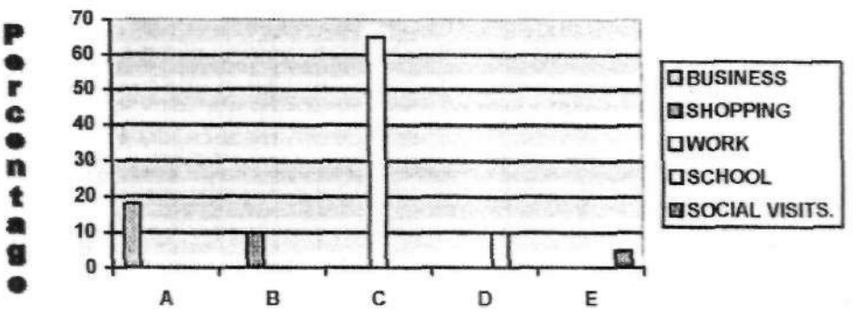


Fig 4.4: **Journey purpose**

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4.33 **Income**

Household income was observed to be generally low. From fig 4.5 70 percent of the respondents earn below N 1000 monthly ; while 21 percent earn between N1000 and N3000 and 7 percent above N 3000.

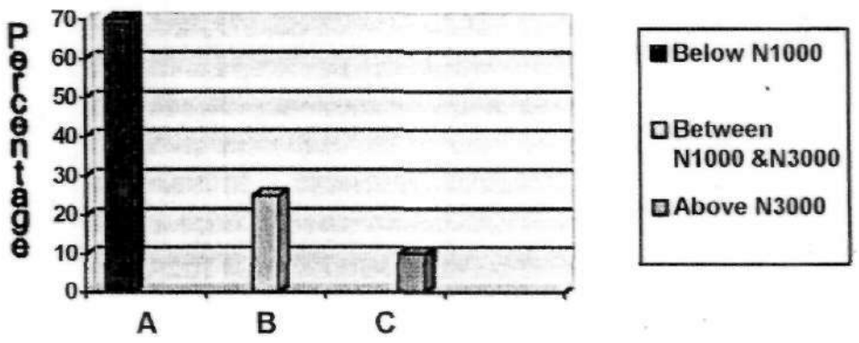


Fig. 4.5: **Income Level**

4.34 **Car Ownership**

In terms of car ownership, 28 percent of the respondent use private cars, while the percentage of those that use other modes of transport (taxi, bus, etc) stood at 72. Fig 4.6 shows the modal splits according to traffic zones. Some relationship between car ownership and residential development was also observed. The study noted that most car users belong to the middle and high income group (whose average income is around ₦3.000) and lived

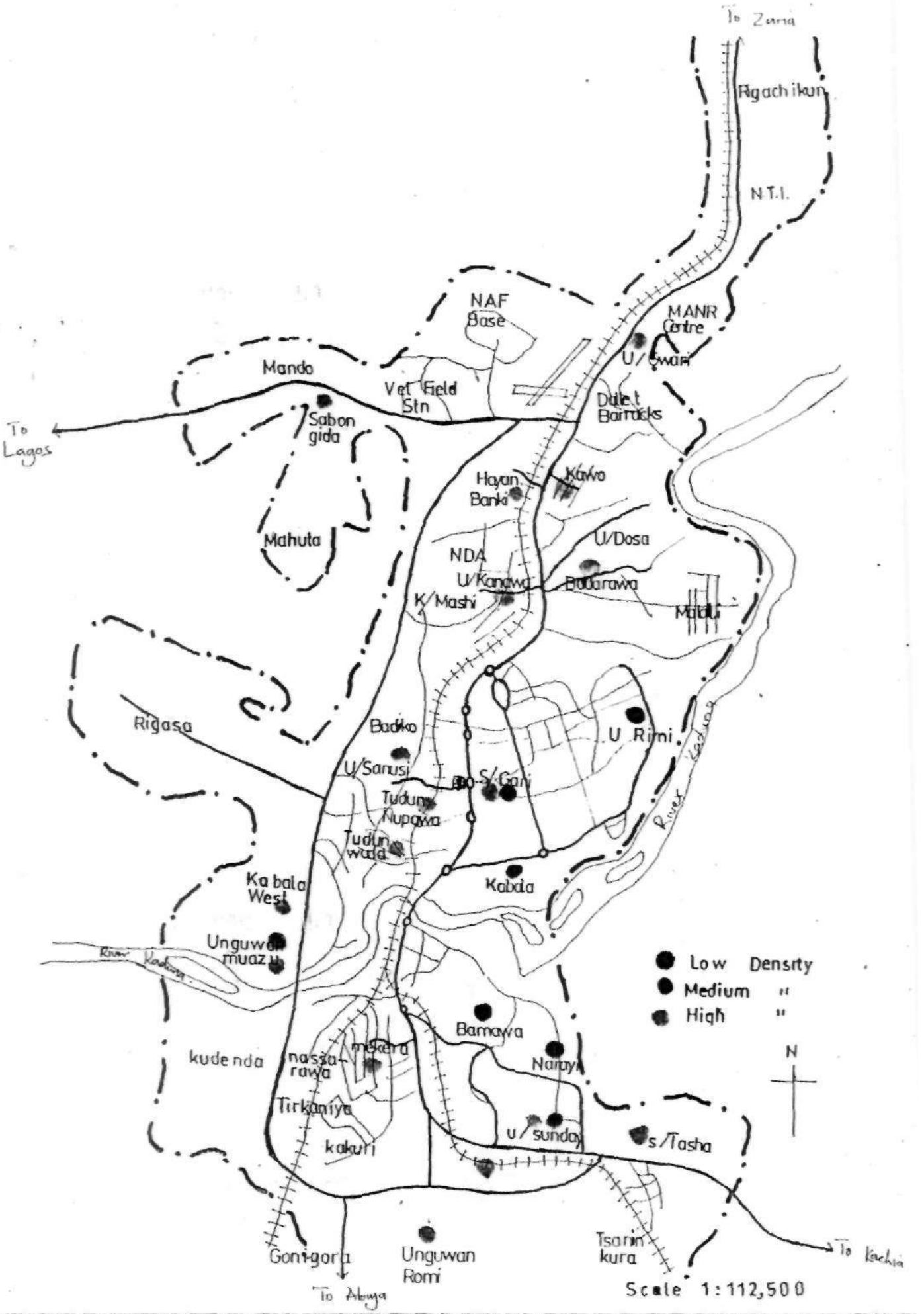


Fig 4.6 **MAJOR TRANSPORT ROUTE $ RESIDENTIAL AREAS**

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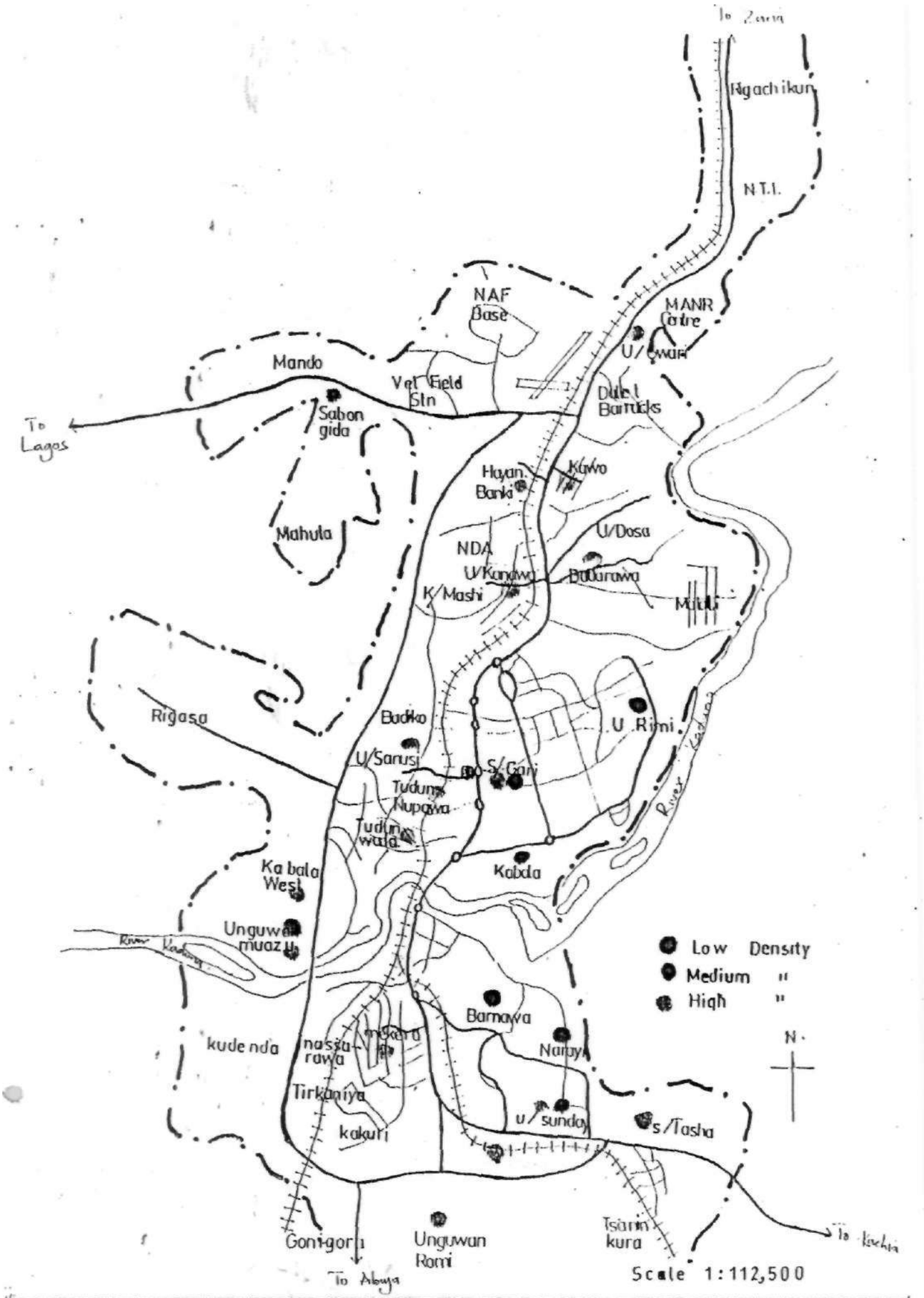


Fig 4-6 **MAJOR TRANSPORT ROUTE & RESIDENTIAL AREAS**

Teku Y
M Sc URP

around low residential density development. This corroborates with the notion that a direct proportional relationship exists between car ownership or use of transport mode, level of income and residential density. This has wide implication for planning for the provision of transport infrastructure for the various residential zone and urban growth.

4.35 Mode Choice Reasons

The questionnaire also sought to know, from the respondent reasons or problems identified with the choice of transport mode.

The following information was obtained:

A Car Users

Reasons For

(i) Speed I time saving	-	28.0
(ii) Comfort	-	24.0
(ii) Avoid travelling with stranger	-	8.0
(iv) Convenience	-	18.0
(v) Reliable	-	12.0
(vi) Safe	-	8.0
(vii) Prestige	-	7.0
(viii) Cheapness	-	3.0
Total		100

B Bus and Taxi Users

Problems Identified		%
(i) Overloading	-	16.7
(ii)Frequent stoppages	-	20.0
(iii)Unreliable Service	-	8.0
(iv) Careless driving	-	12.5
(v)Poor vehicle condition	-	15.4
(vi) Unstable transport fare	-	55
(vii) Impolite conductors/Union workers Union workers	-	2.6
(viii) Inadequate number of buses and taxi	-	12.1
(ix) Inadequate route coverage	-	2.0
(x)Lack of terminal facilities (e.g bus stop motor parks, etc)	-	4.5
Total		100

C Motorcycle Users

Reasons For	%
(i)Fast	60
(ii)Provide door to door service	15
(iii) Availability	25
Total	100

The respondent were asked to asses the public transportation about 90 percent were generally unsatisfied with the current state of the public transportation in the town (see Fig 4.7).

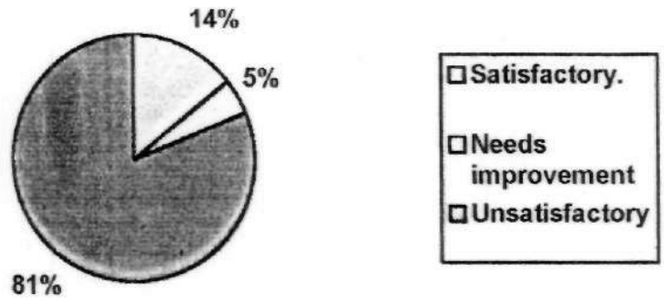


Fig 4.7: **State of public transportation**

4.36 **Travel Time & Travel Cost**

Attempts to asses the variables of time and cost during trip making was difficult. It was difficult to assess these variables because trip makers could not provide such information as required in the questionnaire.The vague non – numerical responses like 'don't know', 'not much', lack of knowledge of waiting time and walking time, and other components of travel cost and time made the analysis to be carried out even more difficult, and impossible to compute. These made it extremely difficult to establish accurately the time and cost differences and ratios between inter-zonal trips and the impact of such on modal choice. However, it can be

inferred from the responses in section 4.33 that income affects how trip-makers respond to factors such as inconveniences, delays, comfort, waiting time, walking time, etc. The tendency has been that high income earners choose alternative modes that involves spending more money to save time and increase comfort. The probability that they choose quicker and expensive mode of transport is likely to increase with income level. Hence, income also influences travel time and travel cost.

4.37 **Traffic Volume and Composition**

Analysis of the traffic survey carried out shows that the traffic peak periods extend between 7.OOam to 1O.OOam in the morning and 4.OOpm to 7.OOpm in the evening. This periods coincide with the time school children, workers, business premises and markets open and close for the day's work and activities.

In terms composition of traffic (modal split), bus mode of transportation dominates. This mode has the largest proportion of about 30% of the entire traffic surveyed at selected roads as can be seen in Table 4.2. This is followed by private car, taxi, motorcycle, pedestrian and heavy vehicles. The modal split at survey stations (or zones) is depicted in Fig. 4.8

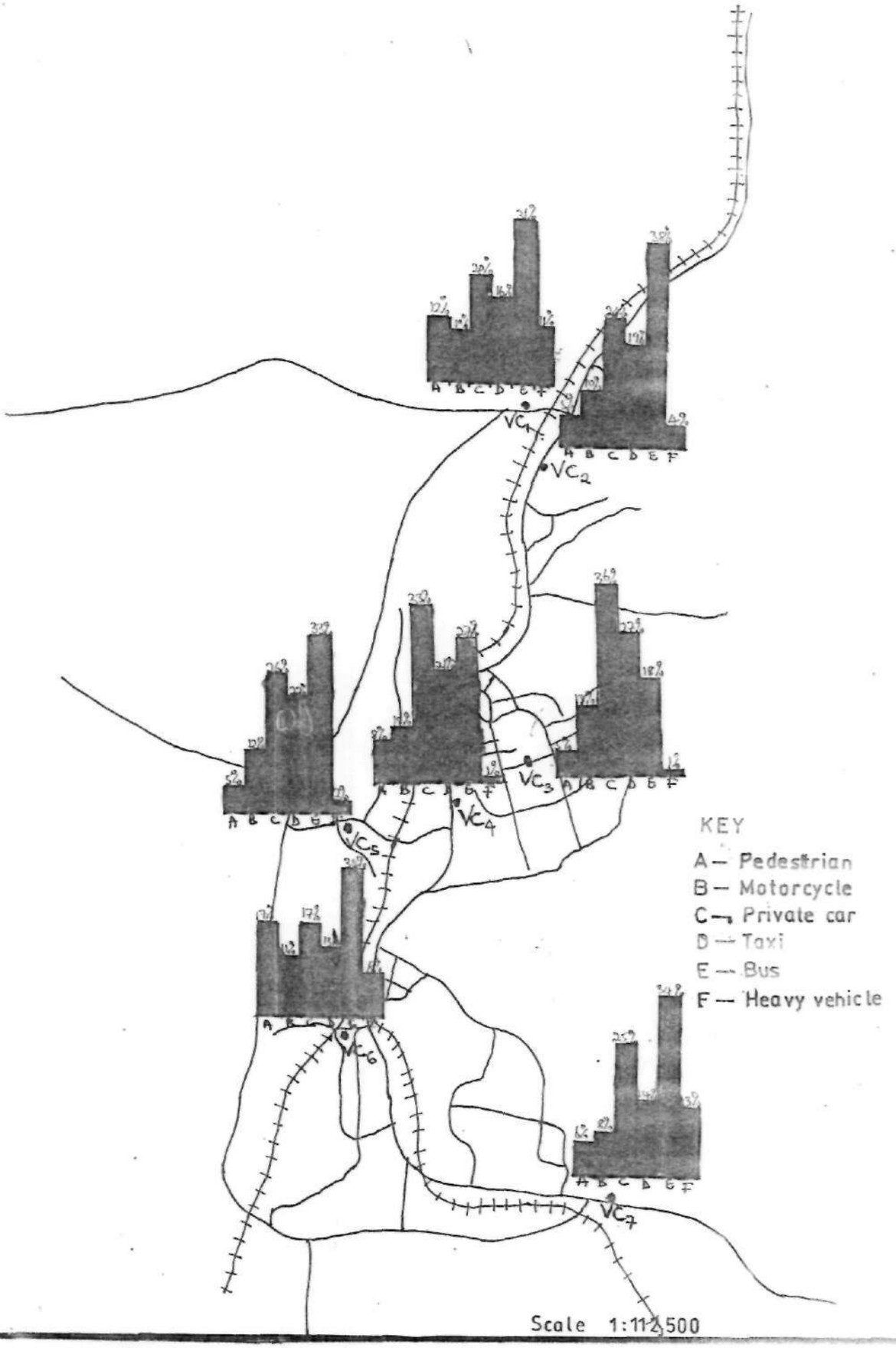


Fig 4.8 MODAL SPLITS AT SURVEY STATION

TABLE: 4. 2 Model Split at survey stations

		MODE OF TRANSPORTATION (IN PASSENGER CAR UNIT)						
TRAFFIC ZONE	DIRECTION	PEDESTRIAN	MOTOR-CYCLE	CAR	TAXI	BUS	HEAVY VEHICLE	TOTAL
VC1	IN	295	227	475	381	723	273	2374
	OUT	269	207	435	341	676	249	2171
	SUB-TOTAL	564	434	910	722	1393	522	4545
VC2	IN	130	247	605	495	963	110	2550
	OUT	156	342	836	684	1330	152	3500
	SUB-TOTAL	286	589	1441	1179	2293	262	6050
VC3	IN	141	522	1407	1085	723	40	3918
	OUT	166	360	969	747	498	27	2767
	SUB-TOTAL	307	882	2376	1832	1221	67	6685
VC4	IN	412	515	1670	1081	1390	52	5120
	OUT	324	405	1337	850	1093	41	4050
	SUB-TOTAL	736	920	3007	1931	2483	93	9170
VC5	IN	133	278	586	510	765	51	2323
	OUT	135	320	724	630	945	63	2817
	SUB-TOTAL	268	598	1310	1140	1710	114	5140
VC6	IN	440	376	564	451	1157	263	3251
	OUT	560	280	420	336	868	196	2660
	SUB-TOTAL	1008	656	984	787	2025	456	5911
VC7	IN	124	166	539	290	726	269	2114
	OUT	198	263	854	461	1153	426	3355
	SUB-TOTAL	322	429	1393	751	1879	695	5469
GRAND – TOTAL		3483	4508	11421	8342	13004	2212	42970

Source: field Observation 1999

Considering the total volume of traffic, traffic zone four has the heaviest traffic with about 9170 (see Table 4.3). This is followed by traffic zones three, two, six, seven and one respectively. The dominance of traffic in zone four has to do with the concentration of traffic generating activities especially commercial in the centre of the town. The dominance of the bus systems in traffic zones one, two five, six and seven (see Fig. 4.8 and Table 4.2) established the relationship between the types of residential development and use of transport mode as it fig 4.6 . This events hold strong implications for planning especially in the proposed Kaduna Eastern Sector Physical Development.

Table 4.3: **Total Traffic and Land uses**

Traffic Zone	Total Traffic (PCU)	Dominant Land Use
TZ1	**4545**	**Residential & Public**
TZ2	**6050**	**Residential & Public**
TZ3	**6685**	**Commercial & Res.**
TZ5	**5140**	**Residential**
TZ6	**5911**	**Industrial**
TZ7	**5459**	**Residential & Industrial**

Source: Table 4.8 and Fig. 3.4

A comparison of the results in Table 4.4 showed the availability and usage of the various transport modes. It was observed that the entire transport system has been un-organised. Transport modes have been introduced without planning. Given the limited road space, competition by road users have led to delays, conflicts, loss of lives, or permanent disability in some cases. Pedestrian needs such as walkways, street furniture, etc, have always been ignored. This has largely under-mind the optimal efficiency of the town.

Table 4.4 : **Comparison Between Road side survey & Household Survey**

Transport Mode	Road side Survey (%)	Household Survey (%)
Pedestrian	**8**	**2**
Cycle	**10**	**14**
Private Car	**27**	**28**
Taxi	**20**	**21**
Bus	**30**	**35**
Heavy Vehicle	**5**	**-**
Total	**100**	**100**

Source: Table 4.8 and Section 4.34

4.40 Findings

From the observations and analysis made, the following was inferred:

(a) Income strongly influence made choice decision behaviour. The strength of the effect of income is such that it affects car usage, residential location, travel time savings, etc, and therefore has a wider implication on urban growth.

(b) While it was difficult to estimate travel cost and time, it is common knowledge that it influence modal choice. Analysis in section 4.25 suggests that behaviorial factors such as walking time, waiting time, inconveniences, comfort, etc. add to the reasons in modal selection. Implied in this statement is the fact that different transport modes provide different levels of services. The balance of this gives rise to individual trip maker's selection of a particular mode. The understanding of the decision making process helps the planner to prescribe transport policies and restraint measures to promote or discourage the use of some modes.

(c) Income also affects road investment (improvement). In vestment in areas where average income levels are higher are favoured compared to investment in lower average come areas. Example of this is the PTF road intervention in Kaduna metropolis which favored the GRAs and high income residential area. In economic terms, the reason been that high income earners have the ability to pay for road improvement and also rate time savings much higher than low income earners.

(d) Traffic and land uses are interrelated. Connectivity between employment centres, commercial centres, and residential sectors shows the importance of transportation and some peculiarities in the use of some transport modes.

CHAPTER FIVE

TRANSPORT POLICY PROPOSALS

5.10 TRANSPORT POLICY PROPOSAL

Kaduna town has experienced and is still experiencing urban growth. The need to control its growth need not be stated. Since 1967 when the master plan for the physical development of the town was prepared by Max Lock and Partners, no genuine attempt has been made to either review the plan or make a new one by the government. By extension therefore, the town's physical growth has been uncontrolled and unplanned. Besides, the lack of a workable master plan also implied that transport planning, projects and policies have been uncoordinated since transport plans are supposed to be an off-shot of the physical development plan of a town. This neglect stem largely from the ignorance of the city as a system whose efficiency is conditional upon proper management of the urban area (urban growth) and transportation.

Several institutional responses have been made at both the federal and state government levels to address urban transportation problems. Some of the measures taken at the federal level include among others, construction and rehabilitation of existing highways by Petroleum Trust Fund (PTF) and Federal Ministry of Works and Housing, introduction of the federal urban mass transit propramme, rehabilitation of the railways, and the establishment of the Nigeria Institute of Transport Technology (NITT) for the training of skilled manpower in the transport industry or 'sector. At the state level, the Kaduna state government have established transport agency known Kaduna State. Transport Authority (KSTA) charged with the provision of transport services as well as implementing federal government mass transit programmes. Other

measures taken to check congestion and traffic problems include ascribing "no parking" in some portions of the street, traffic control signal/wardens, etc. while such efforts are commendable an assessment of these measures shows lack of co-ordination among agencies or ministries and inadequate integrated solution to urban transport problems.

The Modal split analysis carried out in chapter four of this report shows that the pressing issue is that what kind of transport policy or policies can the government and its people adopt for Kaduna town given itys present state and the future. The policies for the usage of these modes of transportation would depend on the policy thrust of the government. This could be motivate d by the principles of cost recovery, equity, efficient and environmental protections. However, two board strategies could be examined. The first strategy to is embark on massive investment in road construction programmes in order to provide adequate network of roads while allowing an unrestrained growth in the private ownership and use of cars. The second strategy is to make selective improvements of road infrastructures and facilities while introducing effective and comprehensive programmes of traffic management and control, restraining the use of cars (or low occupancy vehicles) and promoting efficient public transport system through the use of high occupancy vehicles or systems like rail and bus (mass transits). The fact is that the dwindling and limited financial resources will not allow investment in extensive new road construction and introducing expensive transport modes. Therefore, the second strategy is preferred because it attempts to reduce the dominance of private car use and its attendant consequences, and also making better use and operation of existing of public transport systems.

So, policy options that can be considered in this respect include:

A Disincentives to Private Car Use

One way of controlling congestion and use of car in the literature is to convince or persuade car users to driver their car less frequently and then promoting the use and providing attractive and efficient public transport systems especially mass transits where the rail and bus systems is believed to be a more viable option. Habits when formed are difficult to change. If persuasion cannot work, other vehicle restraint measures that can be used are:

(i) To ban car on some selected streets or roads as practiced in some Western
European Cities.

(ii) Restrict car entry and use in the city centre or central business district (CBD) through the use of area licensing as practiced in Singapore, Hong Kong, Greece, etc.

(iii) Fiscal measures like heavy import duties or taxes spare parts. This can be achieved through government budgetary fiscal policy.

(iv) Heavy fuel tax, toll tax (road) and vehicle registration fees and licenses, find parking fees on cars. For reasons of equity and rights of individuals the charges should reflect the cost cars (the motor users) impose on society as a result of the pollution or emission they generate. Or the charge should be the cost that the city incurs on behalf car use.

(v) Alternative day car use (for example add and even car numbers as was then practiced in Lagos) can be established for a defined area where congestion is highest in the city. Restrictions could be applied between the hours of 8.00 am to 6.00 PM from Monday through Friday .on cars and the federal.

The combination of measures listed above will aim at correct pricing and efficiency of road use, thereby reducing car ownership which in turn reduces the volume of private cars on the streets.

B Enhancing Public Transports

Policies that can promote the efficiency of public transport modes or systems include:

(i) Construction of bus ways. Bus ways are segregated by walls, kerbs or fences. They are quite different from bus lanes which are merely parts of

(ii) street designated for bus use only.

(ii) Bus priority schemes like exclusive or concession operated bus lanes, bus only turning movements, etc.

(iii) Providing credit facilities for purchase of recommended public transport vehicles.

(iv) Confessional fiscal measures for the recommended buses and (taxes) spare-parts.

(v) Providing terminal facilities for on and off street like bus-stops, motor parks etc.

(vi) Subsidizing public transport services.

C: MOTOR VEHICLE POLLUTION CONTROL AND ENERGY CONSERVATION

Pollution is generally worse in cities because it is the place where there are more vehicles (causing more traffic), more factories, chemical plants and more people cooking and heating. In fact, over 70 percent of the fuel consumption in Nigeria is used in the transport sector dominated by motor vehicles. (NTP, 1993). This is also true for Kaduna where road transport dominates.

Therefore, it can be deduced that motor vehicle pollution is a major problem. The problem is a serious because of adulteration of fuel (both locally refined and imported) and extensive use of diesel; importation of questionable fairly used vehicles and motor cycles which do not meet acceptable safety and emission standards; and the deteriorating condition of the few vehicles plying the urban roads. The pollutants of these vehicles such as carbon monoxide (Co), hydro carbon (Hc), leads, etc, are known (Urban Age, Fall 1993) and Urban Edge (1990) are found to have serious neurological impairments or behavioral disorders such as mental retardation or reduced intelligent (IQ) and inability to concentrate among children. Others are Cardio-vascular and chronic respiratory disorders such as cough, vomiting, sore throat, Asthma and cancer; and skin and eye irritation. This threatens the health of the urban population. It is lamentable that this fact been ignored largely government and partly by Planners. With increased environmental awareness and the need to reduce motor vehicle pollution, various policy options can be utilised.

(I) Promoting the use of mass transits especially rail and bus systems as a way of reducing the number of vehicles on the streets or roads. This will help in reducing the amount of pollution per passenger.

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In this sense, the use of private car should be discouraged using the aforementioned measures as more cars mean more pollution. The 'polluter' and user pays' principle should be introduced and sustained. Buses using diesel should be restrained as they pollute more.

(ii) The need to reformulate clearer transport fuels to reduce emissions of key pollutants should be instituted. Fuel whether refined locally or imported should be made to be free from Hc and Co by making sure that gasoline with lead pollutant is removed and diesel with sulfur is removed. This will require strict inspection and co-ordination between agencies such as NNPC, Ministry of Health, Ministry of Transport, Ministry, Ministry of Environment, etc.

(iii) In addition to (i) and (ii), all new vehicles (cars, buses motorcycle, etc) whether locally manufactured or imported must be equipped or fitted with catalytic converters to their exhausts which remove or reduce the Hc and Co from gasoline fueled engine. These new vehicles should also be made to be fuel efficient in that if they burn less fuel, they will emit fewer pollutants. This vehicle emission and safety control measure requires an effective and strict vehicle inspection and maintenance control programme which is however leaking in Nigeria in general and Kaduna state in particular.

(iv) Promotion of generous provision of bicycle and pedestrian tracks or lanes and facilities. This environment-friendly technology (otherwise known as non-motorised transport) is another viable option for the reduction of vehicle pollutants. In addition, it provides opportunities for improving the pleasant visual appeal or aesthetic quality of the urban environment. Though bicycles have been seen as a " backward" and unappealing mode of transport, its use and importance have been entrenched and popular in a number of countries (for example Cuba, Japan Peru, the Netherlands, India, Bangladesh, Nairobi and Mozambique) for diverse reasons. In the match towards a pollution-free environment, bicycle cannot be seen as a so called backward and unappealing mode. It is a way of providing transport at minimal cost and reduces fuel consumption. Its benefit to human health and the environment are quite tremendous. Obstacle to bicycle use are many. Chiefly among them is cyclist safety and drivers' attitude towards them. But, with proper planning, road education and strong legislation protecting bicycle users, these obstacles can be overcome. Tree planting along pedestrian foot-path as practiced in the past during colonial era should be reintroduced.

5.20 **Recommendations:**

A close look at transport planning in Kaduna shows nothing has been done to carry out thorough study on modal splits. Even where such attempts exist, the approach has been piece meal, short term and freestanding measures because they are not well coordinated. For instance, because of poverty and weak institutional measures, authorities concerned with the implementation of traffic standards and

regulations such as (the Vehicle Inspection Office (VIO), Federal Road Safety Commission (FRSC)$_1$ Police traffic department$_1$ etc, are in a disadvantaged position to dictate what kinds of motor vehicles to use or to enforce strict traffic standards (off4he-road, for example). Road construction and rehabilitation do not conform with reasonable humane and planning standards.

Kaduna cannot be said to have chaotic urban transportation problems like Lagos. But with its growth in spatial and car ownership, it is about entering the vicious cycle of more cars, reduced road space, more traffic and worsening public transport if left unchecked.

Table 5.1 Motor Vehicle Registration by Type of Ownership 1981

Year	Private	Commercial	Goods Van	Micycle	Total
1984	400	520	60	125	1230
1985	540	620	95	194	1449
1986	660	750	120	117	1647
1987	750	870	150	142	1857
1988	850	960	180	250	2240
1989	520	965	175	272	1932
1990	430	900	120	317	1767
1991	380	880	95	393	1748
1992	210	750	50	385	1395
1993	200	680	35	225	1140
1994	180	500	20	267	967

Source: MOF & EP (1997) Kaduna State Statistical Year Book

Analysis of the general motor vehicle registration in Table *5.1* shows that private vehicle registration is rising, while that of commercial is declining. Further investigation with the National Union of Road Transport Workers (NURTW) also

showed that bus and taxi have drastically reduced due to high cost of spare parts. The use of motor cycle as a mode for public transport services has been popular with attendant risks and accidents. The operations of these systems have been unchecked and uncoordinated. No conscious effort is made to determine the character or design of the environment the transport systems hope to shape. The resultant effect is urban sprawl with its attendant social and environmental problems.

The use of public transport and cars depends primarily on government policies. For instance, In Russia, 80 percent of trips are made by public transport. This is achieved by restraining the supply of private vehicles and subsidising public transports. In the United States of America (U.S.A), the converse is true where more than 80% of trips are made by private cars. The ownership and use of private cars have remained unrestrained. For cities in Nigeria including Kaduna neither the use of cars is discouraged nor public transports are encouraged including bicycles and pedestrians which are often neglected but important. A comprehensive and extensive transport research on the new concepts in public transportation and road usage is therefore required.

The broad spectrum of strategies already discussed in section, 5.10 can be used to assess the suitability and relevance of each mode of transportation with respect to the city's topography finances, and needs. The following principles could be applied:

(i) **Cost Recovery**

Charge to road users especially cars, should reflect the cost of road improvement (investment), congestion and pollution.

(ii) **Efficiency and Equitable Use of Road Space** Equitable rights of individual person (and not vehicle) to travel should be up-held. The goal should be a balance treatment between public and private vehicles.

(iii) **Environment Protection and Energy Conservation**

In conformity with environmental awareness the world over, environment-friendly technologies such as bicycles, and tree planting on road verges should be encouraged.

Without prejudice to what government has been doing there is the need for a deliberate, aggressive and leading role of government in the area of:

i) Providing finance for road, bicycle tracks, etc improvement.

ii) Making legislation and legal provisions for the implementation of policies.

iii) Involving the public in the decision making process through referendum and public awareness programmes through radio, television, newspapers, etc.

iv) Major air quality control and monitoring programmes through relevant agencies concerned.

5.30 CONCLUSION

Urban transport planning is a topical development issue in Nigeria and elsewhere. The continuing growth in population and vehicle fleet and the resulting congestion and pollution affecting the lives of urban dwellers have direct impact on the efficiency on the urban economy. A resolution to the problem is urgent, yet it demands a balanced and holistic approach because of the immediate and often highly political nature of the impact that the changes in transport are likely to have on the urban dwellers, firms and government.

Modal split analysis is a key ingredient in urban transportation planning process. Its study provides the basis for which efficient transport modes and policies are proposed for a town or urban area. The combination of persuasion and restraint backed by political will can help urban dwellers appreciate the use of alternative transport modes and reasons for government action.

Finally, lasting solutions to urban transportation problems would be achieved if long and short term coordination of urban planning and transport planning is done taking into consideration all factors such as physical, socio-cultural and economic peculiarities of Kaduna. A patch work of ad-hoc supply of mass transit buses for example, cannot solve intra-city passenger transport problems. A comprehensive and detailed study that covers all modes of transportation in the urban area is required. The making of appropriate policies requires that factors, which influence modal choice and changes in travel behaviour, be closely examined. It also requires a thorough understanding of the existing and potential roles of the governments (Federal, State and Local) in influencing travel behaviour and in guiding transportation investment, management and allocations.

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APPENDIX A

Nature of Employment

Nature of Employment	Total No of Respondents	%
A Self employed	140	14
B Private Sector Workers	220	22
C. Civil Servants	570	57
D. Others (specifics	70	7
Total	1000	100

ii. Income Level

Income	Total No. of Respondents	%
A. Below 1,000	699	69.9
B. Between 1,000 & 3,000	211	21.1
C. Above 3,000	90	9.0
Total	1000	100

iii Journey Purpose

Journey Purpose	Total No. of Respondents	%
A. Business	180	18
B. Shopping	60	6
C. Work	700	70
D. School	50	5
E. Social Visit	10	1
Total	1000	100

APPENDIX B

DATA SHEET FOR VOLUMETRIC COUNT

(mark in Column or each vehicle observed)

Location: ..... Name of Recorder: .....

Day/Date: ..... Direction (Incoming or outgoing): .....

Transportation Mode/Time	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7
Pedestrian												
Cycles												
Car												
Taxi												
Bus												
Heavy Vehicle												

APPENDIX C

Department of urban and Regional Planning, Faculty of Environmental Design, Ahmadu Bello University, Zaria.

QUESTIONIIARE FOR HOME-INTERVIEW SURVEY

INTRODUCTION

The aim of the study is to examine modal split characteristics in Kaduna metropolis as a basis for proposing efficient transport policy in the town. The research has no connection with tax collection or evaluation. Thus, information provided shall be treated in strict confidence and used for academic purposes only. Thank you.

Instruction: Please tick or fill in where applicable.

1. Sex:
(I) Male
(ii) Female

2. Size of Family household

3 Nature of Employment::

(I) Civil Servant
(ii) Private Sector worker
(iii) Self employment
(iv) Others (specify).

4. Household monthly Income:

(i) Below Nl_1OOO
(iii) Between NI ,000 and N3,00O
(iii) Above N3,00O

5 Where do you:

(i) Work: .....
(ii) Shop: .....
(iii) School: .....
(iv) Business: .....
(v) Social Visit:.....

6. What mode of transportation do you use:- (5)
(i) Private Car
(ii) Bus
(iii) Taxi
(iv) Motor cycle
(v) Walk

7. How much do you estimate it cost (in N) to use year Car for a trip

(i) Cost of Petrol: .....

(ii) Cost of Engine Oil: .....

(iii) Package Charge: .....

(iv) Average Car Occupancy: .....

Total: .....

8 What is your daily expenditure on public transports (on bus, taxi, motorcycle):.....

9. How much time does it take before you get to your destination
A. Using Car:

(i) Time spent driving car .....

(ii) Time spent parking at destination .....

(iii) Time spent walking from parked vehicle

at destination .....

B Using Public Transport:

(i) Time spent in public transport vehicle .....

(ii) Time spent in changing from one public transport to another .....

(iii) Time spent making for public transport vehicle.....

(iv) Time spent walking to public transport vehicle at origin ...

(v) Time spent walking from public transport Vehicle at destination.....

10 Reason for the choice of transport mode

.....

.....

.....

.....

11. Comment on the current state of public transport

(I) Satisfactory : .....

(ii) Required Improvement: .....

(iii) Unsatisfactory : .....

12. Suggest ways transport problems encountered can be minimized.

.....

.....

.....