# A FUNCTIONAL TRANSPORTATION PLAN

# FOR EFFECTIVE WORKTRIP IN KADUNA METROPOLIS

BY

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DECLARATION

This thesis has not, in part or whole been previously submitted by the Author for any other degree or qualification at this or any other university.

D. ALHASSAN

APPROVAL

This thesis entitled "A Functional Transportation Plan for Effective Worktrip in Kaduna Metropolis" by Danjuma Alhassan meets the regulation governing the award of the degree of Master of Science of Ahmadu Bello University and is approved for its contribution to knowledge and literary presentation

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*DEDICATION*

This work is dedicated to my late Father, Malam Alhassan Achemu Adejo, the Madaki of Odu-Ogodanya.

## ABSTRACT

This study entails an evaluation of the characteristics of worktrips of a model Nigerian municipality, Kaduna metropolis.

It was found that, on the average, 20% of the monthly income of low income earners is expended on worktrips and the average length of travel is more among this group than for high income earners. Comparatively, the mean monthly expenditure of all groups on rent exceeds the average proportion of income spent on worktrips.

Vehicle ownership among the sampled group of workers is 26%. This includes cars, motorcycles and bicycles. About 70% of the workers live in rented houses, 19% own houses and 2% live as secondary tenants.

The worker's most popular mode of travel to work is the public transport Tminibusl. Unfortunately, there is no well organised mass transit system. The only form of public transport system is run by private operators and it inefficient overcrowded and offers a limited access. These problems evolved out of urban sprawl and uncontrolled developments in both the core and periphery, lack of adequate maintenance of the road network and the current global economic recession.

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# CHAPTER ONE

## 1. INTRODUCTION

### 1.1 BACKGROUND TO THE STUDY

Worktrips are the most important category of journeys emanating from home. Horton et. al [1969] indicated that among all the traffic generated from the home in urban areas, journeys to work normally dominate, both in importance and relative numbers. Hutchinson [1974] also indicated that home based trips constitute 80-90% of total travels in urban areas and 30-45% of these are work trips.

Worktrips tend to be distributed unevenly throughout the day and are mostly concentrated into a few peak hours. There is steep gradient of traffic flows between residential areas and workplaces during the morning and evening hours. These daily movements in large urban areas involve thousands of pedestrians, bicyclists, motorcyclists, public transport and private car owners.

In recent times a hybrid of problems is associated with urban travels for residents of most developing cities. These problems include high costs of travel, long travel times, inconveniences and strains. These problems have been aggravated by the prevailing economic predicament. The astronomical rise in prices of vehicles and spare parts has made urban travels costly, time consuming and frustrating. In the particular case of Nigeria the substantial quantum increases of fuel prices in April, 1988 and October, 1994

brought about astronomical increases in fares. The crucial role of transport in economic activities has made the upward review in transport fares to automatically translate into a general price hike in the entire economy.

Journeys to work which accounts for a large part of Urban traffic problem is a product of comparatively free choices of residences and places of work [Dyckman 1971] by residents. In the past, residences were located within walking distance from workplaces because of the low level of traffic technology. Improvements in living standards have contributed almost as much as the growth of cities to contemporary comfort and conveniences as well as the ability to sustain higher costs which in turn affects the choice of residence and mode of travel. The transportation plight of city dwellers is a condition that they themselves have brought about by taking advantage of individual opportunities.

The problem of Urban transportation is one of city layout and planning as well as one of transportation technology. Different types of land uses generate different traffic flows. The basic city planning proposition is that traffic can be controlled by rearranging the land use that represent the end points of trips as well as generate the purposes of transportation. There is a need to study land use pattern within our cities in order to relate these uses to transportation demand.

This work, therefore has its aim, the study of the characteristics of Journey to work within Kaduna metropolis with a view to identifying the associated problems and proffer solutions that would alleviate the problems encountered by worktrip makers in Kaduna Metropolis.

1.2 PROBLEM DEFINITION

Kaduna has been growing very rapidly in size and population as a result of influx of Civil Servants, industrial workers and businessmen to the town since it became the headquarters of Northern Nigeria in 1912. The rapid growth coupled with physical constraints [drainage, topography, soil etc] to Urban development has led to hapharzard development of land uses. The lack of balance between employment and housing in different quarters of the metropolis has led to the location of workplace far away from the main residential areas. The low income groups seem to be more affected by this long distance travel than the high income groups since high residential distances are generally far away from the work areas than low residential areas.

The present economic recession has made it difficult for the low and middle income groups to commute to work. Unfortunately, too, the existing public transport system [motorcycles, minibuses, and taxis] are inadequate in their coverage and levels of service. They charge very high fares and their services do not permit long routes. This makes it

necessary for workers to transfer several times before reaching their workplace. These multiple transfers translate to high cost and long travel times.

The problem has been compounded by inadequate transportation infrastructures like the poorly developed road network, lack of horizontal separation of vehicular traffic and lack of adequate bus-stops, parking spaces, etc., which cause traffic delays on the roads.

The problems associated with the land use, road network, the mode of movement and socio-economic characteristics of workers have led to unaffordably high cost of travel, long travel times, inconveniences and strains to workers in Kaduna Metropolis.

There is, therefore a need for detailed studies on worktrips in Kaduna Metropolis which will lead to curative and preventive physical planning measures to solve the problem of Journey to work in Kaduna. This, indeed, is the focus of this work.

## 1.3 AIM AND OBJECTIVES

The aim of this study is to examine the characteristics of Journey to work within Kaduna Metropolis with a view to identifying the associated problems and proffer solutions. The overall consideration in the work is to seek means of removing all inconveniences and difficulties presently associated with worktrip in Kaduna Metropolis.

In achieving this broad goal, the specific objectives of the study are:-

[a] To review concepts,models, approaches and strategies used in planning for smooth worktrips in Urban areas, globally.

[b] To determine the patterns of locations of residences and workplace in Kaduna Metropolis.

[c] To examine the characteristics of worktrip in Kaduna Metropolis and identify the extent to which socio-economic characteristics feature.

[d] To identify and characterise the problems associated with worktrips in Kaduna Metropolis.

[e] To formulate appropriate planning proposals for alleviating the problems associated with worktrips in Kaduna Metropolis.

[f] To design suitable traffic engineering measures capable of achieving immediate relief to problems connected with effective Journeys to work in Kaduna Metropolis.

## 1.4 SCOPE OF STUDY

The scope of this study is limited to major workplaces in Kaduna Metropolis. The activities of informal sectors [Hawkers and service oriented] which provide moving employment and whose work location covers a large area are not considered. This is because their Journey to work is erratic and can not be determined easily.

## 1.5 THE STUDY AREA

The study area is Kaduna Metropolis. Kaduna is located between latitude $10.3^0$ and $10.50^0$ North of the equator and Longitude $7.1^0$ and $7.45^0$ East of the Greenwhich Meridian. It is the capital of Kaduna State of Nigeria which is bounded on the North by Katsina and Kano States, on the South by Plateau State and the Federal Capital Territory, on the east by Bauchi State and on the West by Niger State and Abuja. Thus, it is located in the North central part of Nigeria.

Kaduna is one of the oldest major cities in Nigeria and was designed and laid out under the personal direction of Lord Lugard. He chose the city in 1912 to be the headquarters of Northern Nigeria because it was situated in the sparsely populated countryside near a good water supply source [Kaduna river] and far from any major emirate. [The nearest was Zazau emirate]. It was because of the administrative and commercial importance of the city then, that it became an attractive centre for migrant workers and modern factories whilst its expansion and urbanisation became inevitable. It became easily accessible by rail to Zaria and Kano in the North and Yoruba land and Lagos in the South. It later became a major rail road Junction of north where rail tracks were extended to Jos, then to Maiduguri and PortHarcourt.

The city became more and more important with its linkage to major communication and administrative centres in Northern Nigeria such that in 1910, the Borno - Kano rail line reached Kaduna, while the military headquarters, of the West African Frontier Force [WAFF] were moved from Zaria to Kaduna in 1912 and 1913. In 1917 the Northern Nigeria administrative and political staff were moved from Zungeru to Kaduna. And on 27th May 1967, when Nigeria was divided into 12 states, it became the headquarters of the then North central state. Today, Kaduna is the headquarters of Kaduna State, Kaduna North and Kaduna South Local Government Councils.

### 1.5.1 URBAN ACTIVITY SYSTEM WITHIN THE STUDY AREA

Prior to the advent of the colonialists, the activities of Kaduna dwellers were mostly related to agricultural and traditional crafts. Under the colonial administration, the city performed mainly administrative and commercial functions with the substantial part of the inhabitants as government workers and traders. The post colonial government introduced a new dimension to the economic and Urban activities of the city through investment in import substitution industries such as textile mills, asbestos factories, assembly plants and infrastructural services. Thus, Kaduna emerged as a modern industrial centre attracting more migrant workers than could immediately be

coped with in terms of employment, housing and Urban services [Sada, 1984]. Most of these class of workers are underemployed and constitute the bulk of the Urban working poor who could not afford any automobiles of their own. The military is also highly visible although their major office activities are restricted to their barracks.

The poor residents now occupy the inner traditional part of the city which is characterised by high density development and is seriously congested in contrast with the new and better developed areas such as Ungwan Rimi, G.R.A. and all other G.R.A.s within the metropolis.

The two main markets in Kaduna Metropolis are Kawo and Abubakar Gumi Central Markets. These markets are particularly relevant. Although there are some other secondary markets which serve as neighbourhood shopping centres, their standards and the services they provide are not comparable to the ones mentioned. These secondary markets include Kasuwan Besi, Sabo, Nasarawa, Ungwan Rimi, and Kakuri markets.

Most of the economic activities in Kaduna metropolis are carried out in the central part of the city. This creates the daily high human and vehicular traffic dilemma along Ahmadu Bello Way area of the city.

### 1.5.2 DEMOGRAPHIC CHARACTERISTICS

The population of Kaduna was estimated to be 149,910 by 1963 population census. The projected population released by the ministry of Finance and Economic Planning Statistics Division, Kaduna State for 1993 was 1,141, 154. This was calculated based on an annual growth rate of 7%. On the same bases, the population for 1994 and 2004 would be 1,221, 035 and 2, 400,000 respectively.

The population estimate has been based on the 1963 population figure because it has been the only officially accepted population estimate for Nigeria since independence.

### 1.5.3 LAND USE CHARACTERISTICS IN KADUNA METROPOLIS

Any land use,whether at national, regional or local level must contain residential; concentrations from where different types of transport requirement emanate.

The land use characteristics of Kaduna city is summarised in Table 1.1. The breakdown appears to indicate adequate provision for residential, educational, commercial, industrial and military activities in and around the city. These activities are facilitated by assorted transport infrastructures.

TABLE 1.1: LANDUSE ALLOCATION IN KADUNA, 1994

| LANDUSE TYPE | HECTARES | PERCENTAGE |
|---|---|---|
| High density housing | 3023 | 25.5 |
| Low density housing | 2019 | 17.0 |
| Armed services | 1943 | 16.4 |
| Institutional uses | 1700 | 14.3 |
| Industrial | 826 | 7.0 |
| Commercial-Distributive | 631 | 5.3 |
| Health & Educational Training | 611 | 5.2 |
| Open space, cemetrics | 550 | 4.6 |
| Railway, water & electricity | 374 | 3.2 |
| Government Offices | 182 | 1.50 |
| TOTAL | 11859 | 100% |

SOURCE: FIELD WORK, 1994

Fig. 1.1 shows the map of Kaduna state in the Nigerian context while fig. 1.2 indicates the map of Kaduna metropolis (the study area) depicting some major streets, River Kaduna and Railway lines.




SCALE 1:8000000

FIG.1.1: KADUNA STATE IN THE NIGERIAN CONTEXT.

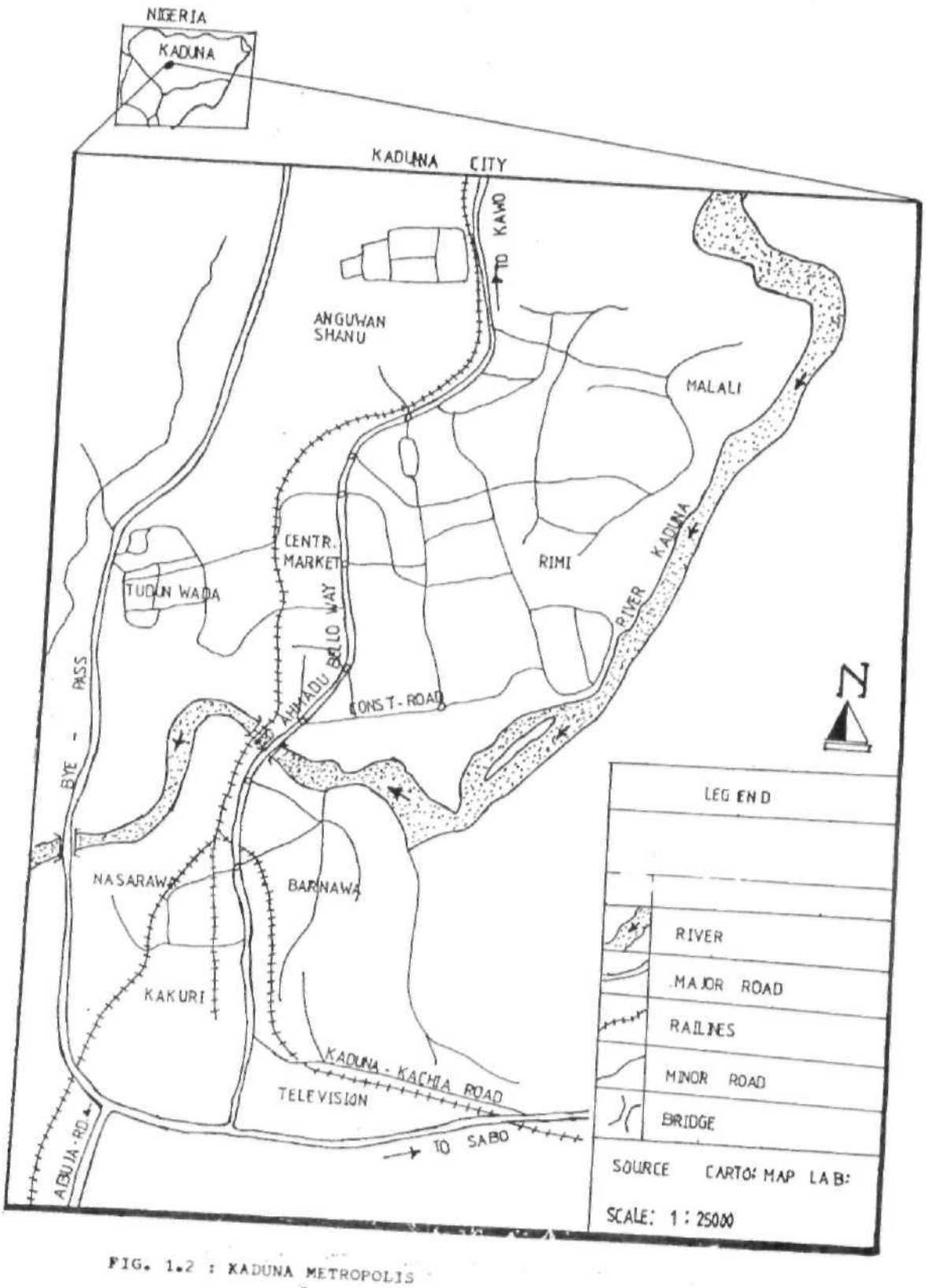



FIG. 1.2 : KADUNA METROPOLIS

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 MODELS OF JOURNEY TO WORK

A model is simply a means of expressing significant casual or structural relationship stripped of the irrelevances and complexities of the real world so that they may be more readily understood [Wingo, 1961]. Models are of different types: Physical models like globe, conceptual model and Mathematical models. A Mathematical model is a set of quantitative relationships expressed in the language of Mathematics and describing the inter-reaction of phenomena.

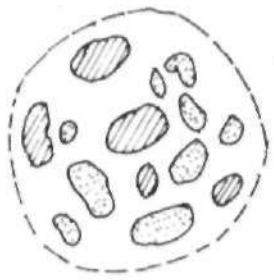
### 2.1.1 EVOLUTIONARY CITY GROWTH MODEL OF JOURNEY TO WORK

Vance [1960] postulated a sequential model of the changing pattern of employment catchment areas through changes in transportation technology. The relationship between workplace and residences, according to him, may be explained only in terms of historical development. He postulated an original zone which is an initial site of Urban area. An increase in economic activity at this stage will lead to increase in the labour force employed until it can no longer be accommodated by the site itself. The community at this stage divides into two distinct zones, a zone in which work is performed or the zone of conflux and another one in which those who perform the work reside or the zone of dispersion. This model is illustrated in fig. 2.1 [A].

The increasing population itself attracts heightened industry and commerce which are unable to be located at the periphery. This later increases the total employment of the area and provides for secondary zone of conflux at the outer perimeter of the growing Urban area [fig 2.1[B]. Vance [1960] also stated that the changing locations and dimensions of the zones of conflux and dispersion are a function of changing transportation technology [fig.2.1c]. While in the early stages, workers travelled to work mostly on foot, the introduction of automobile and railway results in expansion of labour catchment areas located beyond walking distances.

The simple evolutionary model of Journey to work seems to explain the situation in most Nigeria's precocial Urban centres like Ibadan, Kano, Ilorin Zaria, Enugu etc [Fig. 2.2]. These cities are characterised by the dual city concept. It is the tendency for the development of "cities" side by side, usually one had existed long before the other. The dual city concepts is a form of multinuclei model whereby the two centres result from the inter-reaction between two histories of Urbanization.

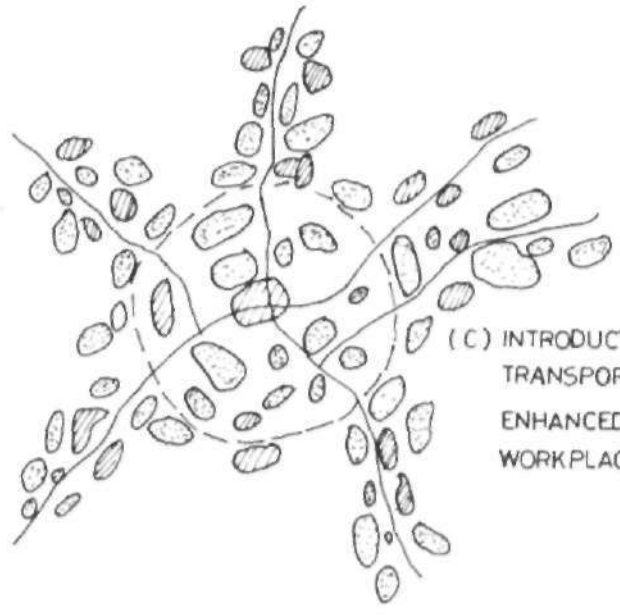
For example, Zaria city grew up around a walled city [Birin] about the 11th century. The growth was due to the transahara trade route through caravan roads from Kano and Katsina to Tripoli. It has an Emir who is an administrative leader.



(A) RESIDENTIAL AREAS AND WORKPLACES CONTAINED WITHIN THE INITIAL BOUNDARY.



(B) THERE IS EXPANSION BEYOND INITIAL BOUNDARY.



(C) INTRODUCTION OF TRANSPORTATION NETWORK ENHANCED RESIDENCE WORKPLACE DISTANCE.

RESIDENTIAL AREA (ZONE OF DISPERSION)

INITIAL BOUNDARY

ROADS

WORKPLACES (ZONE OF CONVERGENCE)

FIG. 2.1 EVOLUTIONARY MODEL OF JOURNEY TO WORK.
SOURCE : VANCE (1960)

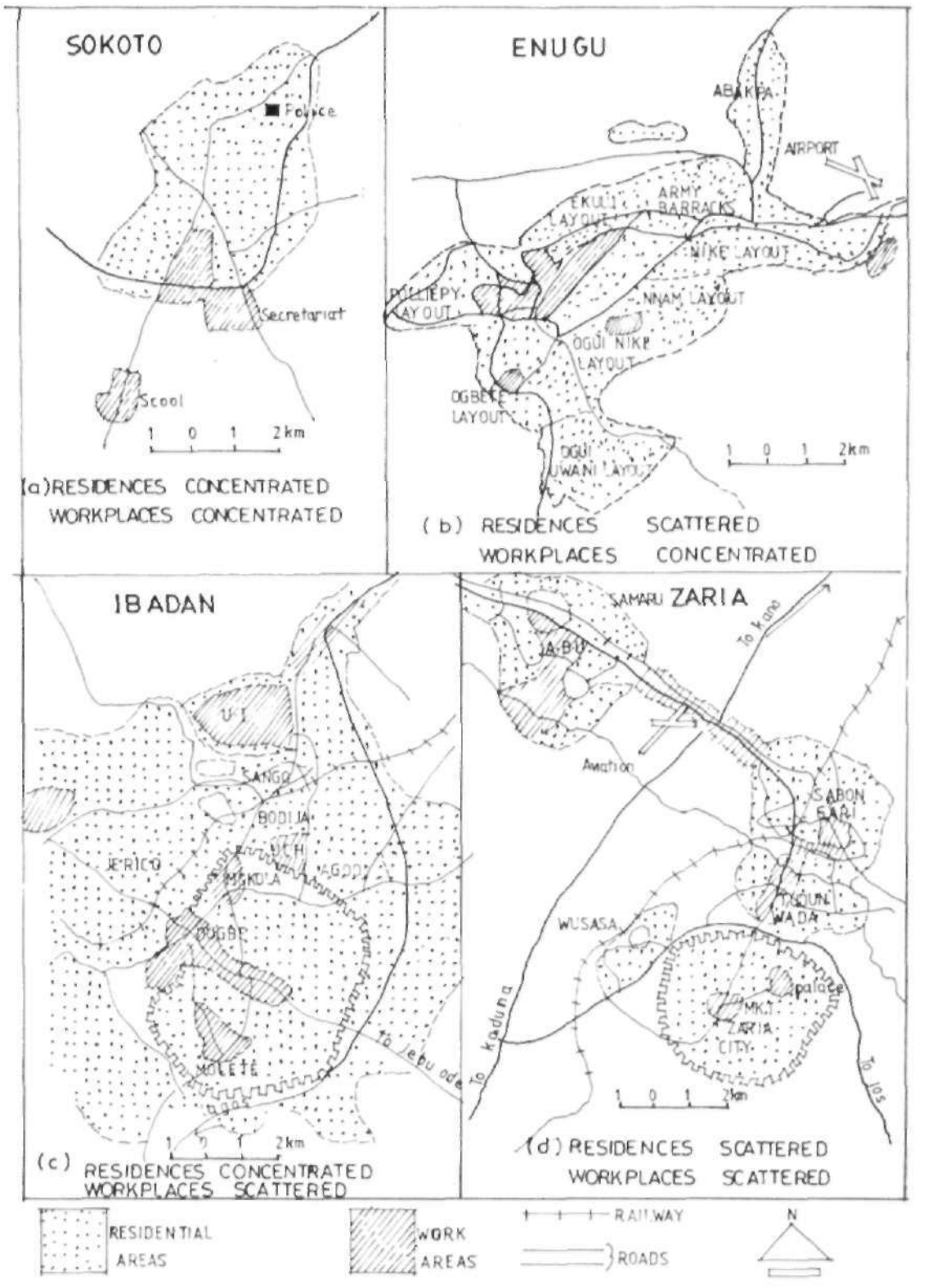



FIG. 2.2 DISTRIBUTIONAL PATTERNS OF RESIDENCES AND WORKPLACES IN SOME NIGERIAN URBAN CENTRES (SOURCE: KHANAN (1988)

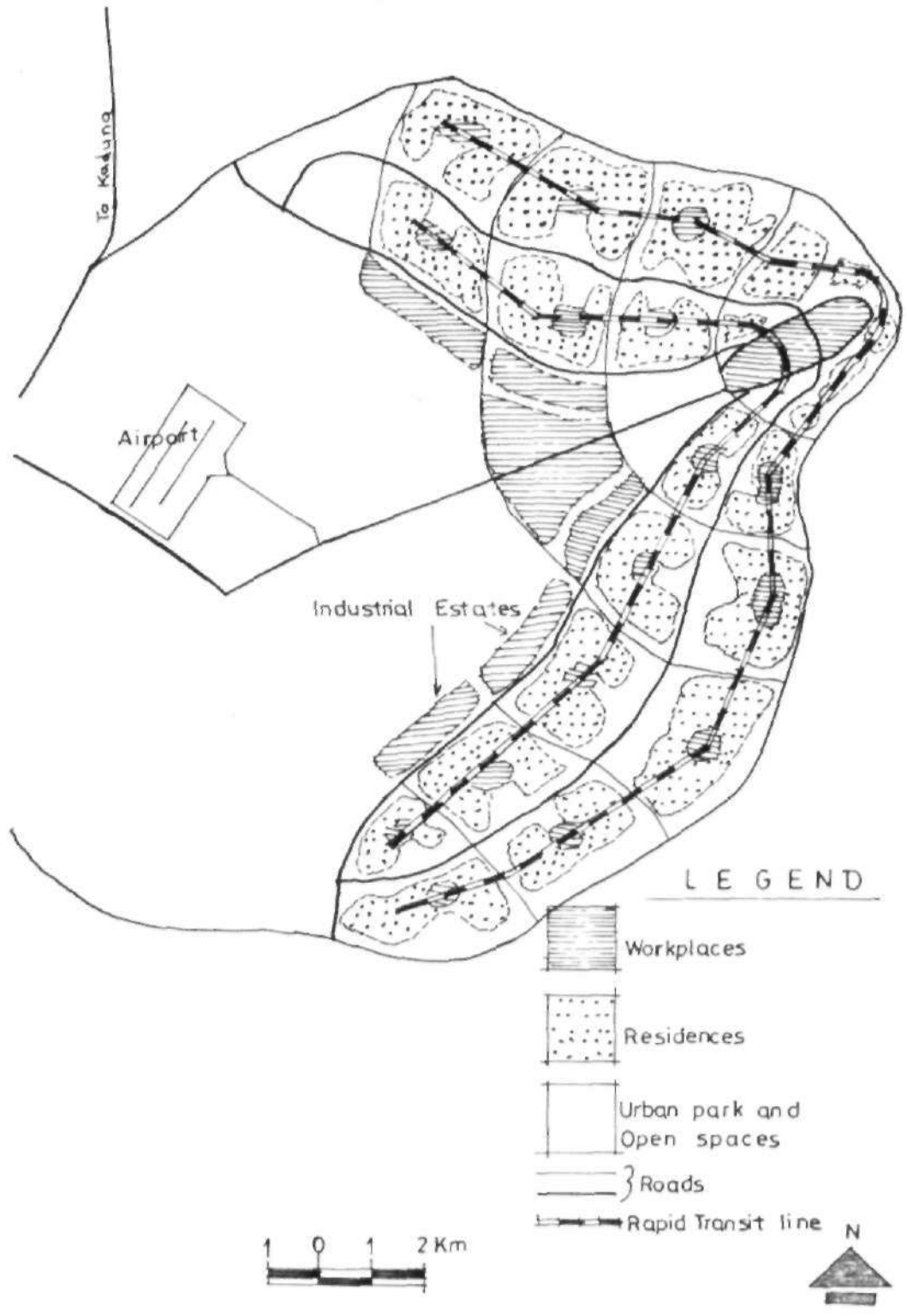



FIG 2·2e; DISTRIBUTIONAL PATTERNS OF RESIDENCES AND WORKPLACES IN ABUJA.
(SOURCE: ABUJA MASTER PLAN 1979)

A motor way cuts through the city to the market area, the Emirs palace and friday mosque which form the focal points of the city. When the walled city could no longer contain more people, Tudun Wada, Sabon Gari, Government reserve areas and Samaru grew up outside the city wall later as workplace for non- indegenes, strangers from other parts of Nigeria, colonial masters, etc.

2.2 FRAME-WORK FOR CATEGORIZATION OF WORK - LIVING AREAS

A simple framework for categorizing the spacial distribution of homes and workplaces has been put forward by Welforth [1965].

These include:-

[a] Residences concentrated, workplace concentrated in central, intermediate or periphery of the city [fig 2.2a]. The settlements with this pattern have, in most cases, worktrips originating and terminating at a very few points. An example of a Nigerian city having this pattern is Sokoto.

[b] Residences scattered workplace concentrated in central, intermediate and peripheral locations [fig.2.3b]. This is a situation where most worktrips originate at several points and terminate at very few points. The average distance between residences and workplace is always minimum [Khanna 1988]. Examples are Universities, airports or heavy industries which have peripheral work site location in one zone drawn from widely scattered residences. To use

Leipman's [1944] terminology, "it could be said that these represent the strong conflux in a zone of workplace from a region wide zone of distribution". Examples of Nigerian cities with this pattern are Enugu, Kaduna etc. [fig. 2.2b]

[c] Residence concentrated, workplace scattered [fig.2.2c]. Where professional classes are residentially concentrated for instance, their workplace are fairly scattered. This is characterised by most worktrips originating from very few points and terminating at several points. The average distance between workplace and residences is always medium [Khanna 1988]. An example of a Nigerian town having this pattern is Ibadan [fig.2.2c].

[d] Residences scattered and workplaces scattered [fig.2.3d] In this case, most worktrips originate and terminate at several points. The average distance between residences and workplaces is always the shortest. An example of this type is Zaria [fig. 2.2d].

The proposals in Abuja Master Plan was structured to have residences and work places scattered in several locations (fig.2.2e). In the plan, public service employment was divided between the central area, the sector, the district centres and industrial estates

on the southern edge of the city(Abuja Master Plan,1979). The basic strategy employed was to concentrate these public service activities in the central area which require regular and close communication and to decentralise the remainder so as to maximize the ease of accessibility to job from residental sectors and minimize central area congestion. The decentralization of the parastatals provide employment opportunities in dispersed locations convinient to employee residences (Abuja master plan, 1979). The plan also has dual transit spines forming the core of each development corridor permitting the majority of residents to be within walking distance of public tranportation.

As Eliot [1970] puts it, "mean work-place and residence separation will be least when residence and employment are both evenly distributed with workers seeking employment at the place of work closest home. On the other hand, mean length of the Journey to work is at a maximum when employment is concentrated and residence of workers dispersed, of course it would also be at a maximum if the reverse pattern were found"

Studies carried out in Ilorin by Amudu [1986] revealed that residences and workplace were concentrated. In order to solve the problem, he proposed the scattering of residences in the "new area" where workplace were concentrated and scattering of workplace in the "old area" where residences were concentrated.

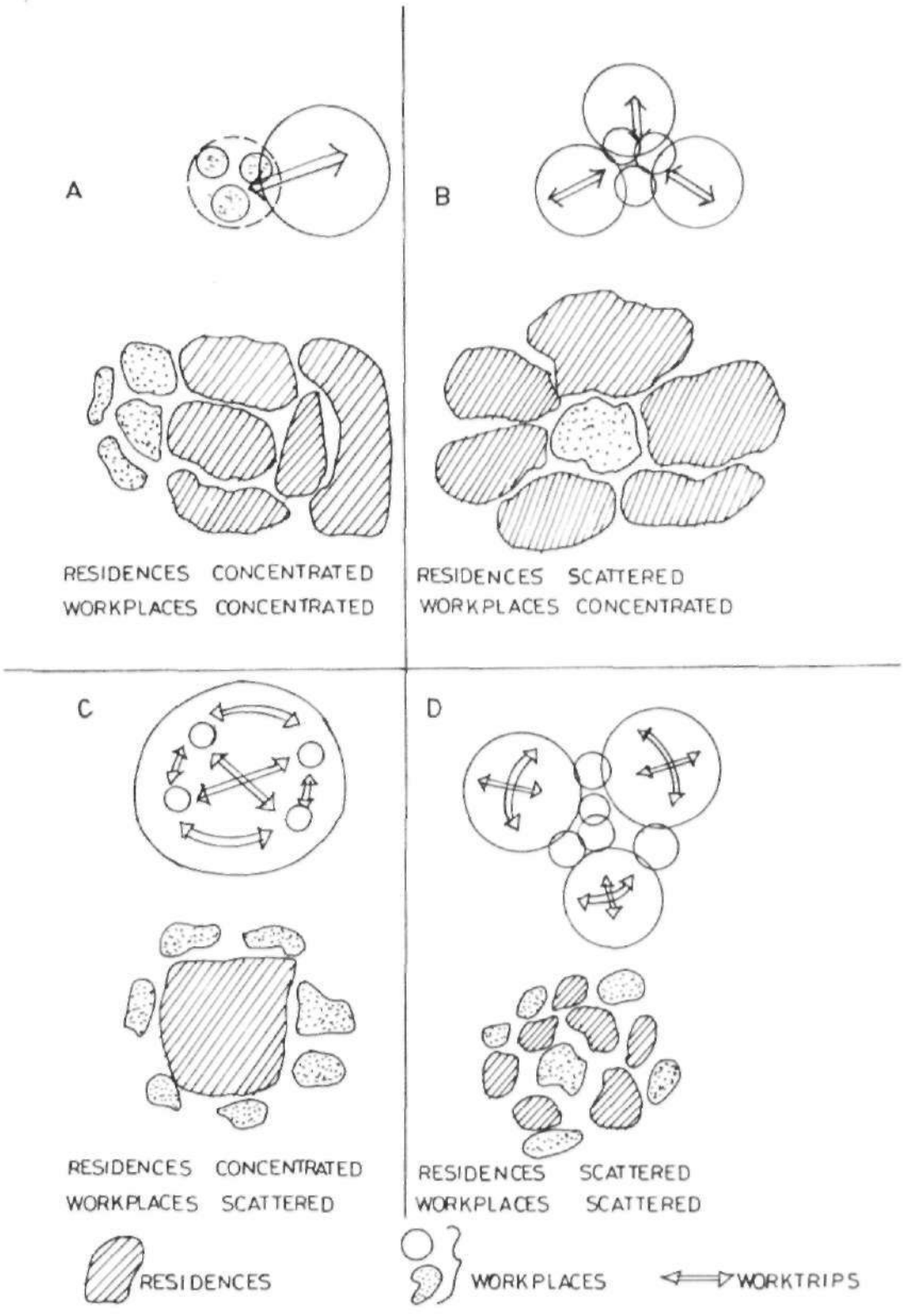



FIG. 2·3: A FRAME WORK FOR CATEGORIZATION OF THE DISTRIBUTION OF HOMES AND WORKPLACES.
SOURCE WOLFORT (1965)

Table 2.1. shows the suggested solutions for the problem of distributional pattern of residences and workplace in some Nigerian Urban centres.

Table 2.1. Suggested solutions to the problem arising from the distributional patterns of residences and workplace in some Nigerian Cities.

| Pattern | Examples | Average travelling distance | Solution |
|---|---|---|---|
| Residences Concentrated workplace concentrated | Sokoto, Oyo Ilorin, Maiduguri, Badagry,etc | Longest | Scattering Residences and Workplace in New development |
| Residences Scattered, workplace concentrated | Enugu, Aba, Benin & Porthacourt | Close to Medium | Scattering workplace in new developments |
| Residences concentrated , workplace scattered | Ibadan and Kaduna | Medium | scattering residences in new developments |
| Residences scattered, workplace scattered | Zaria and Abuja | Shortest | Maintain the pattern |

SOURCE: KHANNA [1988]

## 2.3 URBAN TRAVEL PATTERNS

Urban travel demand patterns were classified by Hutchinsion [1974], into the broad categories shown in fig.2.4 and described as follows:

TYPE 1 is travel along corridors focused on the central business district [CBD]. It is characterised by high intensity

along definite corridors with concentrated peak movements. This needs high capacity system to provide the service [Khanna, 1988].

TYPE 2 is the circumferential travel between activities located in the suburbs of cities. This highlights the increasing trends due to the shift of work and residential areas away from traditional centre areas and it needs low capacity systems to provide the service [Khanna 1988].

TYPE 3 is travel within residential areas. This type of travel might be between local activities or longer trips within an Urban area. This calls for careful attention to safety and environmental quality [Khanna, 1988].

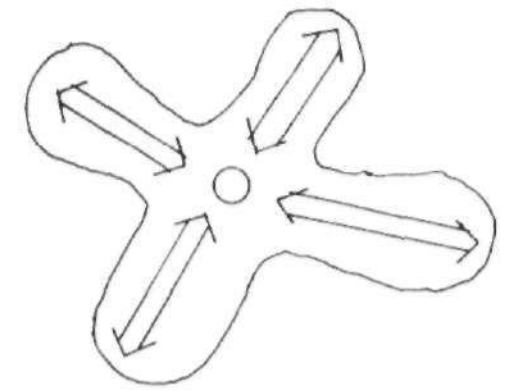
TYPE 4 is travel within the central business district [C.B.D]. This travel might be between activities within the central area. It is characterised by high intensity, all day duration for all purposes and of short trip lengths.

TYPE 5 is travel to and from major activity concentrations not located within the central areas such as airports, Universities and residential areas.

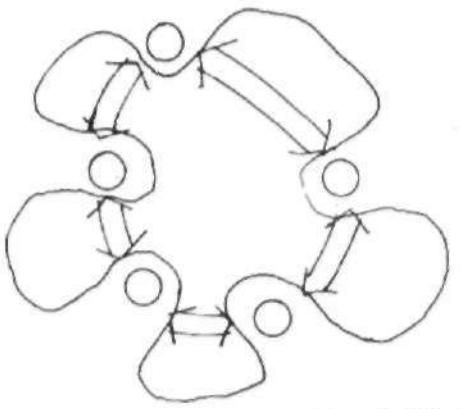
This classification of travel enables better understanding of the needs and appropriate matching of modal system [Khanna, 1988].

## 2.4 APPROACHES AND STRATEGIES USED IN PLANNING FOR JOURNEY TO WORK

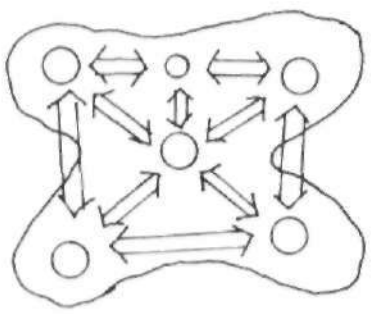
The problems of Journey to work is derived largely from the distributions of the residences and workplaces or



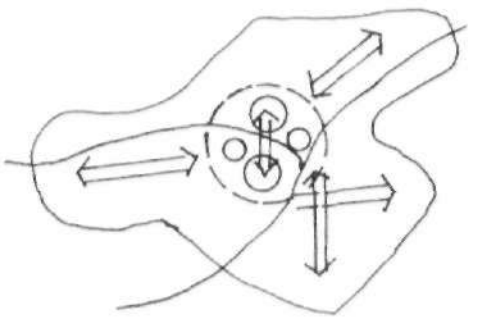
TYPE 1: RADIAL TRAVEL



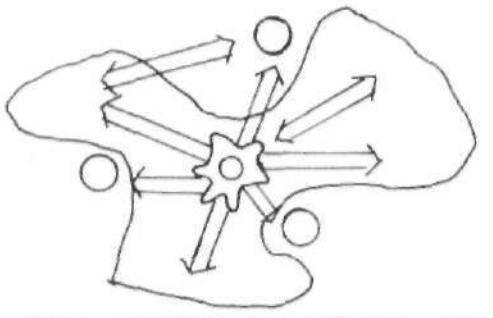
TYPE 2: CIRCUMFERENTIAL TRAVEL



TYPE 3: WITHIN RESIDENTIAL AREAS TRAVEL



TYPE 4: C·B·D·AREA TRAVEL



TYPE 5: TRAVEL TO OUTSIDE AREA ACTIVITY CONC·




FIG. 2·4 URBAN TRAVEL DEMAND PATTERNS
SOURCE: KHANA (1988)

employment centres. Studies in Karachi [Pakistan] indicated on a smaller scale, how planned community growth can minimise local transportation problems. There, a growth, plan financed through the United Nations Development Programme [UNDP] recommended the creation of a series of "metrovilles" or compact communities of 40,000 to 50,000 people focusing on self help housing and public housing programmes and of street systems, close by Schools, Clinics, markets and bus depots and light industry capable of employing large volumes of local labour [Owen, 1978]. The growth strategy creates an orderly growth process designed to conserve resources, avoiding unnecessary transportation and reduce the distance between homes and workplaces.

Joint landuse and transportation planning approach could be used to great advantage since different landuses generate and attract different and variable traffic flow. The fundamental aim of planning should be to provide most people with the opportunity to live reasonably close to their places of work in the interest of personal convenience and economy and in order to relieve Urban congestion [Keeble, 1969]. There will always be cases of people living in one zone and working in another zone. Nevertheless, it is essential that sufficient information be available to ensure that development proposals shall not inevitably bring about crazy, general post, cross-town Journeys to work for substantial number of people.

Another approach which has been proposed is to study and plan the transportation modes of the town. Attention would be paid to the types of mass transit systems to include a family of modes of different characteristics and compatibility. Such modes would offer a spectrum of transport services ranging from the highly flexible taxis and motorcycles service to a rigid fixed route, fixed schedule service of rail and rapid transit system.

Among strategies so far proposed for minimising traffic congestions during the Journey to work in Urban Centres include the following.

[a] Decentralization of offices. The disadvantage of this is that at the lowest level of physical planning, the impacts are negative. This is because, apart from the increased demand for housing, education and shopping facilities, additional traffic is generated [Daniels, 1973].

[b] The application of constraints to the use of private cars by imposing charges [parking, tolls etc] on the use of car rather than on "Ownership". The proceed may be used to build up mass transit fund with which to subsidise mass transit users.

[c] Banning of automobile traffic in limited areas of the city and the dedication of the streets to pedestrians and transit vehicles. There is also the avoidance system, such as designing Urban activity systems that reduce the need for vehicle movement [Thompson, 1972].

[d] The use of Urban freeways as in Lagos, Nigeria to provide rapid flow of traffic and reduce congestion.

[e] To legislate for the use of even and odd number plate cars on alternate days in order to curtail traffic congestion as also in Lagos, Nigeria.

[f] Catering for public transport vehicles, the needs of pedestrians and cyclist.

[g] Diverting motorists making "through" journeys" to ring roads to avoid city centres. Traffic patterns at central business districts should be radial. Some streets could be designated one way streets.

[h] Staggering of working hours or shifting system, used in developed countries, reduces the peak hour volume of traffic by redistributing it over a longer period of the day.

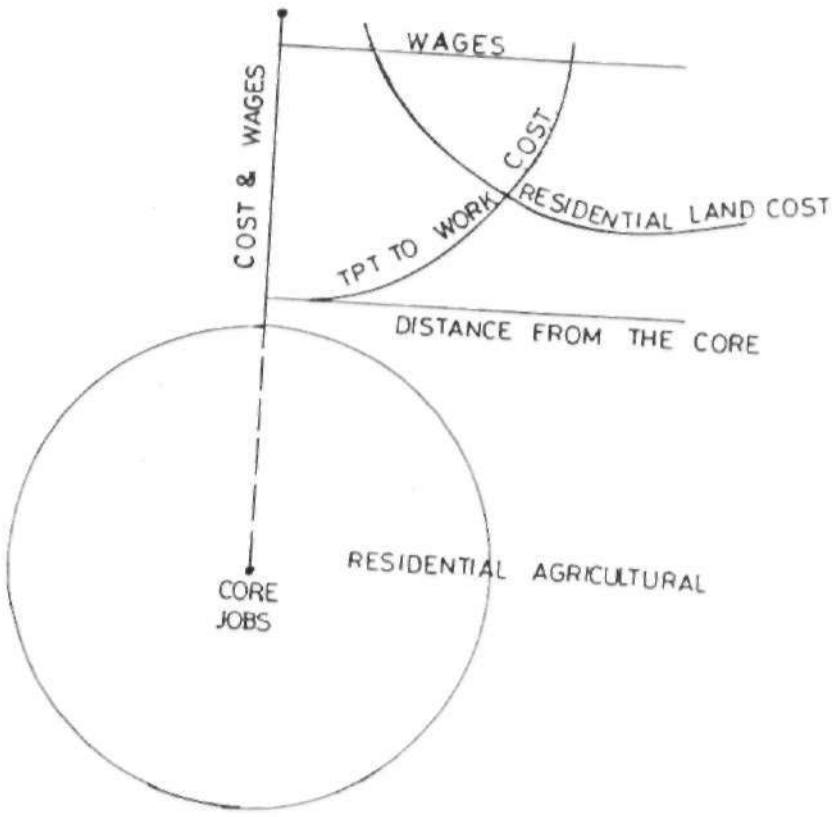
[i] By introducing modern traffic management schemes.

## 2.5 FACTORS AFFECTING JOURNEY TO WORK

Characteristics of worktrips have been the subject of many studies. Several models ranging from purely theoretical to wholly empirical have been derived to explain the effects of factors such as landuse pattern, technology, socio-economic status of the worktrip makers, level of service, choice of travel mode etc., on the choice behaviour of trip makers. Some of these are briefly reviewed in the following subsections.

### 2.5.1 TRANSPORT COST AND RESIDENTIAL LOCATION.

It is generally believed that worktrips characteristics




FIG·2·5: DISTANCE & COST IN A CORE DOMINATED CITY (SOURCE: SCHREIBER '76·)

are determined by residential choice among workers. Carol1 [1952] Suggested that the costs incurred in Journey to work are major determinants of residential location and therefore, most workers attempt to minimise the length of their journey to work. In his study of some factory workers, he concluded that most of the workers live close to work and that beyond 2 or 3 kilometres, the population of workers decreases as the distance from the factory increases. He attributed this pattern to tendency to reduce travel time and costs and the location of residential houses.

This relationship between transport cost and residential location has been illustrated by Shreiber [1976] to fit the pattern drawn in fig. 2.5. The wage curve is horizontal [wage do not vary with distance]. The cost of transportation to work is upwards sloping as distance from the core increases. The compensating savings in cost residing further from the core [otherwise the houses of workers would have been clustered near the core] is that the price of land decreases with distance from the core. Workers would pay more for housing if closer to the core, so they trade off reduced housing cost with increased transport cost in their choice of residence.

This model is based on the character of the united states housing market. The model assumes a mono-centric city where workplaces are concentrated at the centre. The situation is likely to be more complicated where there are multiple

workplaces. Nevertheless, the model gives an idea that residential choice of workers is influenced by journey to work.

More recent studies indicate that residential location choice is infact an oversimplified explanation and that many factors including sociological and economic influence worktrip decision. The most important factor is that workers seek to minimise the distance between their residences and workplaces.

In other related studies, Beesly etal [1974] analysed the 1951 and 1961 Commuter census data for central London and found that socio-economic status strongly influences the residential distributions relative to workplace and that this influence does not decline much with time. One shortcoming of the study was that they failed to account for the influence of availability and non-availability of vacant residence.

In his study, Guest [1976b] investigated the influence of metropolitan population, size and age on worktrip patterns. He found that metropolitan population, size and age do not exert strong effects on worktrip patterns of metropolitan areas but that workplace exerts a strong, though not profound effect on the location of residence. He further found that worktrips from sub Urban areas to central city were increasing whereas those within the central city were decreasing.

2.5.2 MODAL CHOICE

The cost of the workers final choice of mode in time, comfort, convenience and money will depend on how much residential space he consumes and the level as well as types of transit services available. [Meyer, 1965]. The mode of travel used by employees for daily journey to work affects the characteristics of trip time and trip length [Daniel, 1973]. Trips by private transport, with the exception of trips on foot, are generally faster per unit of distance than public transport because of waiting and stopping times at loading points.

2.5.3. SOCIO-ECONOMIC STATUS OF WORKERS.

Higher income groups normally have longer trip lengths than lower income groups. The higher status occupation groups command high incomes and this permits a wider choice of residential location as well as the ability to accommodate higher commutting cost.

Several authors have tested the hypothesis that commuting distance increases as occupational status rises but the results of these studies range from acceptance through no meaningful relationship to inverse relationship [Wheeler, 1967]. These mixed findings have led more than one investigator to conclude that worktrips behaviour is individualistic and varies with the time and place [Peterson, 1961].

The effects of travel costs and level of service on mode

choice patterns were investigated by Ben-Akiva etal [1976]. They found that out of pocket travel costs have no significant influence on mode choice. This is contrary to general beliefs. The authors concluded that the probability of any one choosing a given mode is determined largely by factors other than level of service effect offered by the mode.

# CHAPTER THREE

## 3.0 METHODOLOGY

The framework of this study has been grouped into stages. These are conceptual framework, data collection, data analysis, discussion of the results, recommendations and conclusions.

## 3.1 CONCEPTUAL FRAMEWORK

The first aspect of the conceptual framework is concerned with problem identification in which study goals and objective were formulated. The existing strategies for improving worktrips are first reviewed and analysed for their adoptability to the study area.

The third stage involves the analysis of characteristics of Journey to work in Kaduna metropolis with a view to isolating the major areas requiring attention. The stage of planning proposals follows. This has been categorised into curative planning measures for short term planning and preventive planning. All of these proposals were then evaluated and the selection of preferred alternatives followed.

## 3.2 METHODS OF DATA COLLECTION

The data used were collected from primary and secondary sources. Data from primary sources were based on the components of journey to work which include the distribution of residence and workplace, the road network, the modes of transport and the socio-economic characteristics of workers.

The secondary data include literature review, landuse maps, Kaduna Master plan, vehicle registration data, Government Statistical records and interview of National Union of Road Transport workers [NURTW] Offices.

3.2.1. COLLECTION OF DATA FROM PRIMARY SOURCES.

Information on residence/employment, Journey to work and socio-economic characteristics of workers were obtained through, the use of structured questionnaires. [a copy is given in appendix iii]. Road inventory and traffic surveys were also undertaken to obtain information on road network and traffic volumes on the major roads.

3.2.1.1 WORKPLACE INTERVIEW SURVEY

A list of major workplaces was compiled and workers selected by random sampling using random numbers [appendix 1]. A 5% sampling was employed to select workers from the studied workplace. What constitutes the studied workplace in this study is an establishment employing up to 1000 workers. Although the Federal Government of Nigeria's guideline stipulates that an establishment employing up to 10 workers should provide housing for her workers and be regarded as a major workplace, 1000, workers was taken as the lower limit in this study to considerably reduce the extent of data collection to a feasible limit for the work and also for assumption of uniformity and homogeneity.

A total of 1000 questionnaires were administered in all out of which a total of 948 were collected, given a response rate of 94.8%

3.2.1.2 SAMPLING METHOD USED

The purpose of sampling is generally to save effort and money by dealing with a subgroup instead of the whole population. To be useful, a sample must be representative of the population from which it was selected. But even with the best form of sampling, some degree of accuracy is usually lost. Thus, sampling is largely a matter of economics in which cost implication of possible sample errors are weighed against the cost of full data collection and analysis.

For the purpose of this study the quota sampling method was employed. This was achieved by dividing Kaduna into the present 8 main functional zones shown in fig.3.1. The advantage of the quota sampling method is that it is easy in administration as there is no problem of non-response.

To ensure even coverage of the population, systematic sampling technique was used in each of the zones. The names of all the workers in the zone were randomly arranged according to income group. Although the list was stratified by income, the arrangements of the names in each stratum was done at random. Selection of names was made systematically by selecting the first of each 20 consecutive names.

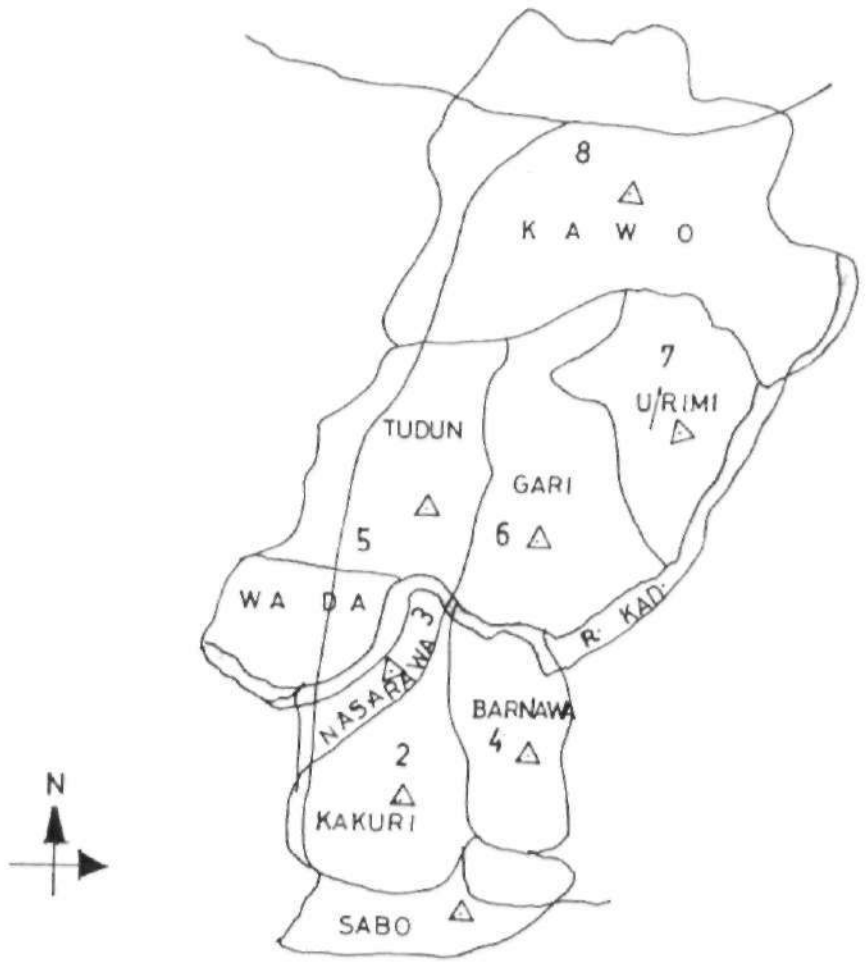



FIG 3:1 MAIN FUCTIONAL ZONES IN KADUNA 1994.

The advantage of stratified sampling is that every income group is selected in the right proportion. Income group was used because incomes were the easiest to get from records readily available. The number of workers in each salary level was obtained from the chief Accountants of the various ministries and companies [workplace] and a sample of size 1 in 40 was used to determine the number of workers to interview to minimise cost. The questionnaires were administered according to the 8 main functional zones in fig.3.1.

3.3 FIELD SURVEY

The field survey was subdivided into two:- Road inventory and traffic survey

[a] ROAD INVENTORY

Road inventory was carried out on some of the major roads. Information on the conditions of carriageways, traffic control devices, width of roads, availability of bus stops and parking facilities and road junctions were obtained and recorded on prepared forms.

[b] TRAFFIC SURVEY

Manual traffic count was carried out on some selected major roads within Kaduna metropolis in order to establish the volume of traffic passing a road at peak periods for *comparison with other variables and standards. The peak* hours were 7.00am to 8.00am [when workers go to work and traders go to market], 3.15pm to 4.15pm [when workers return

from work] and 6.00pm to 7.00pm [when markets close and traders and some factory workers return home], morning, afternoon and evening respectively. Besides monitoring the traffic volumes the following parameters were also evaluated.

(i) JOURNEY SPEED

Journey speed is the distance travelled by a vehicle divided by the total time taken to complete the distance. Here, the total time includes both the running time [when the vehicle is in motion) and the stopping time enroute. Information on Journey speed is a useful determinant of level of service. It is among the criteria on which traffic assignment is based.

(ii) RUNNING SPEED

Running speed is the distance travelled by a vehicle divided by the total time that the vehicle is in motion.

The running and Journey speeds were estimated by the vehicle plate registration number method. A few heavily travelled roads were selected as "test roads" observers with synchronised watches were stationed at both ends of each test road section while collecting data. As vehicle passed an observer, its registration number and time of passage were recorded. At a later time, the registration number was matched and individual vehicle's travel time determined. Knowing the distance over which the vehicle has travelled, the mean running speed of traffic was determined.

[iii] DELAY STUDIES

Delay data enable one to pin point locations where conditions are unsatisfactory and the reasons for the delay are to be investigated. Such information is used to justify road improvement. There are two types of delay: One is fixed delays which is the result of fixed roadway conditions and can occur irrespective of the traffic congestion. These include railway crossing, road intersections, roundabouts, stop signs, etc. The second is operational delays which are caused by parking and unpacking vehicles, pedestrian crossing, turning of vehicles and internal friction within traffic streams.

The moving observer method was used for measuring the delays. A survey log was prepared. A car was started along a test section with the aid of stop watch, all locations and times of stopping and starting were noted as well as ancillary data.

3.4 METHODS OF DATA ANALYSIS

The workplace survey data was analyzed and results presented in terms of percentages, bar graphs, and pie charts. The traffic counts were expressed in qualitative terms in passenger car unit [pcu]. The pcu was derived from standard text shown in Table 3.1: A car is assigned a value of one and other types of vehicle are equivalent to "X" passenger car units.

TABLE 3.1: PASSENGER CAR UNITS EQUIVALENTS [P.C.U]

| TYPE OF VEHICLE | P.C.U FACTOR |
|---|---|
| Bicycle | 0.33 |
| Motorcycle | 0.75 |
| Private Car/Taxi | 1.00 |
| Minibus/Pick up Van | 2.00 |
| Bus/Trailer/Truck | 3.00 |

SOURCE: FEDERAL MINISTRY OF WORKS

HIGHWAY DESIGN MANUAL

# CHAPTER FOUR

# ANALYSIS OF DATA

## 4.1 WORKTRIP PATTERNS

The main worktrip production zones are Sabo, Television, Kakuri, Tudun Wada and Kawo. These are areas with high residential density but have work places that cannot provide work for all the workers within the zones. The main worktrip attraction zones are Kakuri, Gari [Gabasawa] Sabo New extension, Nasarawa new extension and Ungwan Rimi [State Secretariat, College of Administrative and Business Studies] and all the industries within the Kaduna metropolis. Some of these zones have few residences and many work places. In most cases, all of the zones considered in this study could be said to be areas of trip production and attraction zones because virtually all of them have work places and residences.

Results of the analysis of the mean distance separation between worker's residences and work places in the different zones are presented graphically in fig.4.1. It shows that most workers in Sabo, Kawo, Ungwan Rimi and Tudun Wada Zones travel for up to 8.5km to work because they are major residential zones. Workers in Gari zone travel shorter distances [5km] to work while workers in Kakuri, Barnawa and Nasarawa travel for the shortest distances [0.4km]. This is because these zones are attraction and production zones.

The presentation of the percentage of workers that travel at various distance to work shown in fig. 4.2 indicates that most workers travel for between 3km and 10km to work.

The results presented in figures 4.1 and 4.2 show a generally medium to long. This is probably because in Kaduna worker's residences are concentrated and the work places are scattered. Some of the work areas in zones like Kakuri, Barnawa, Nasarawa and Gari do not have enough residential areas to cater for workers housing problem.

## 4.2 TRAVEL MODES

The results of the analysis of travel modes shown graphically in Fig. 4.3 indicates that the main modes of journey to work are minibus [55%], motorcycle [15%], private car [10%], while foot [8%], taxi [7%], bicycle [2%] and large bus [3%] constitute the least used modes. Taxis cannot compete with the minibus on the major roads because they charge higher fares and have less overall carrying capacity. This makes the taxi services not to be well patronised.

Results of the analysis of the effect of distance on choice of modes in fig.4.4 shows that at 0 - 2km worktrips, foot is the predominant mode, closely followed by bicycle. Within 2km to about 5km, motorcycle and

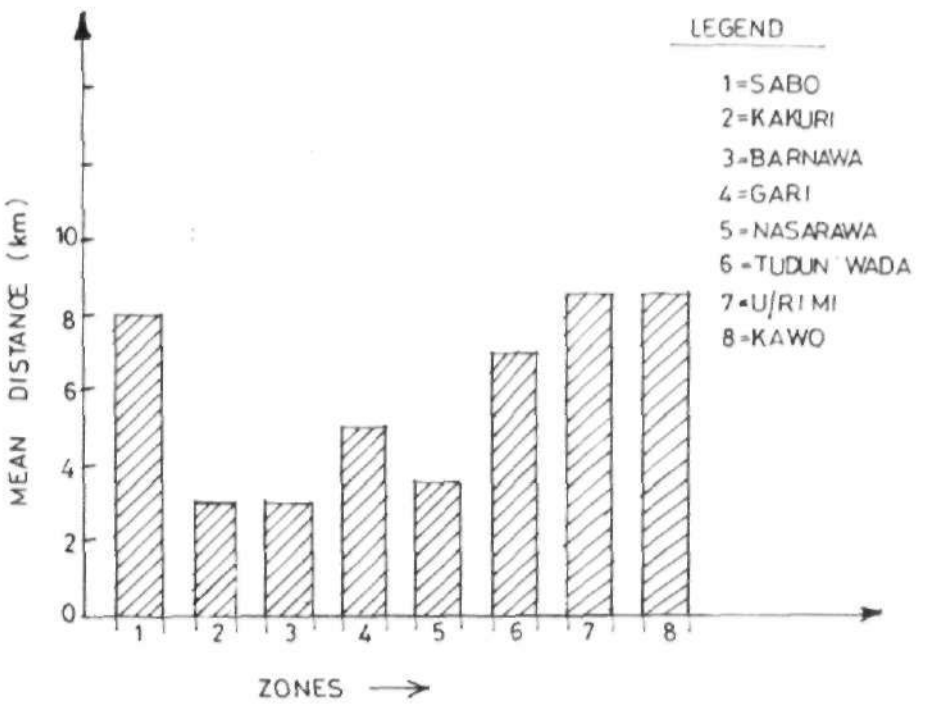



FIG-4-1: MEAN DISTANCE SEPARATION BETWEEN RESIDENCES AND WORKPLACES AMONG WORKERS IN ZONES.

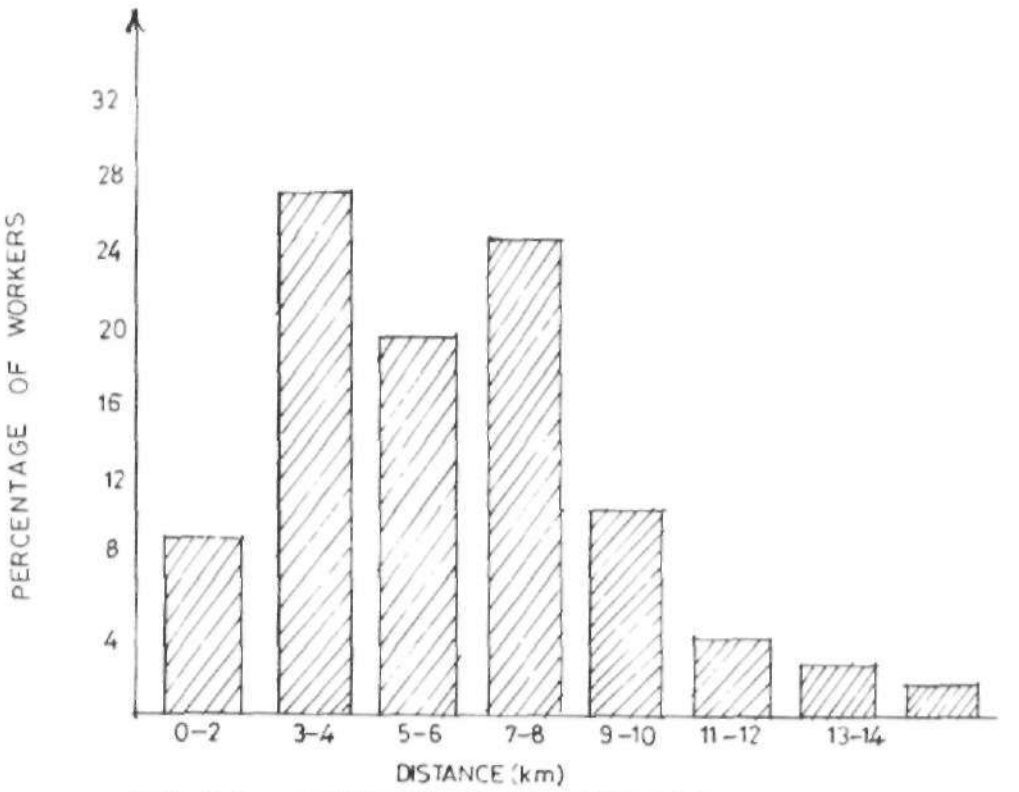



FIG. 4.2: PERCENTAGE OF WORKERS THAT TRAVEL AT VARIOUS DISTANCES TO WORK KADUNA 1994.

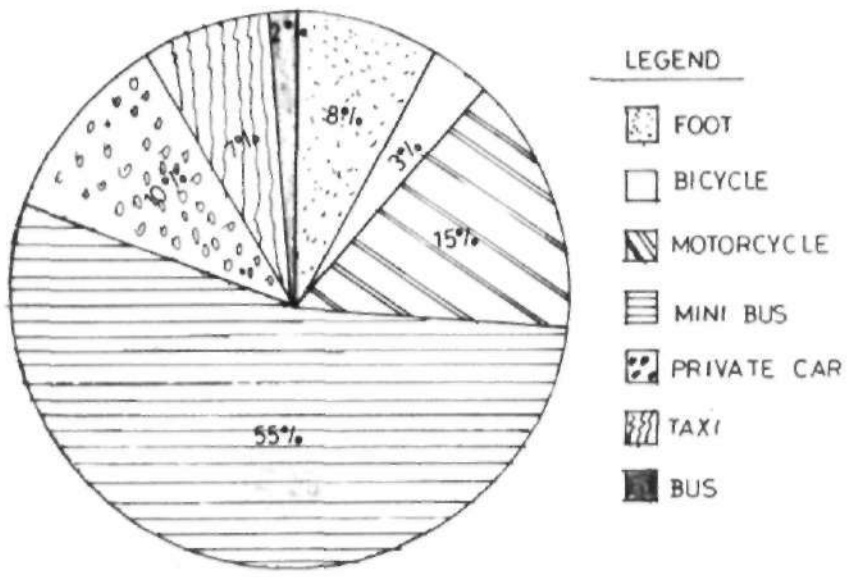



FIG. 4·3: WORKERS' POPULAR MODE TO WORK, KADUNA, 1994

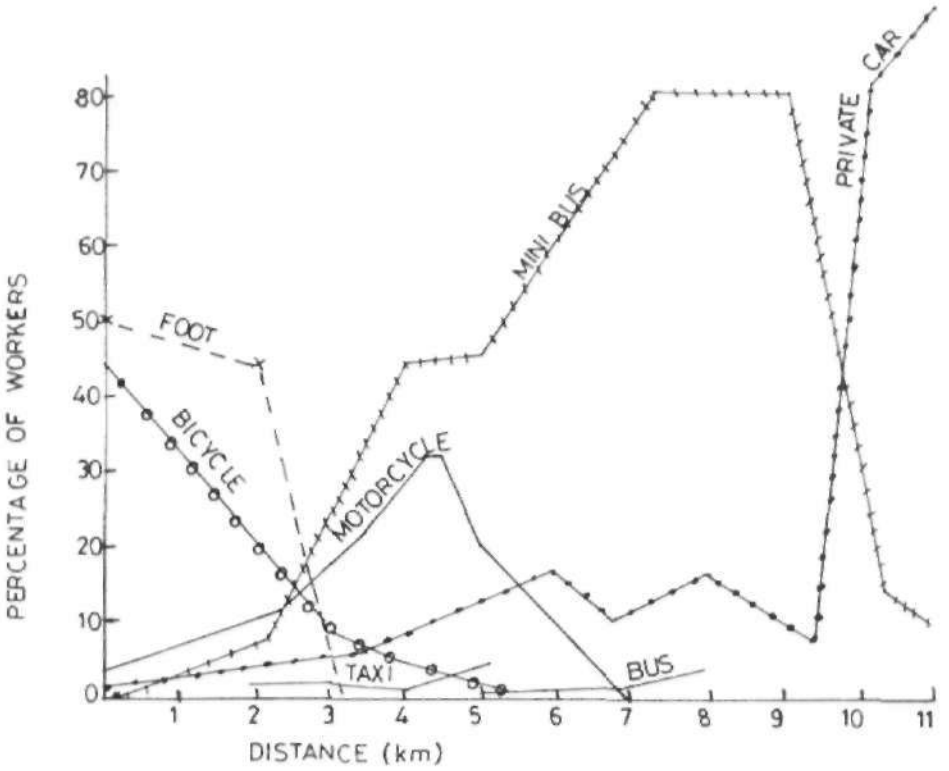



FIG. 4·4: PERCENTAGE DISTRIBUTION OF WORKERS AMONG MODES BY DISTANCE BANDS FOR JOURNEY TO WORK, KADUNA, 1994.

minibus modes assume prominence, and from 9km and above, private car is the dominant mode.

Vehicle ownership pattern is shown in fig.4.5. Given the low vehicle ownership ratio among workers, it is obviously beneficial to reduce commuting distance to work so as to facilitate a situation whereby a large population of workers go to work by foot thereby saving money for other purposes.

Another implication is that majority of the sampled workers depend on the public transport system for their journey to work because very few of them own vehicles. Only 26% of workers interviewed own private vehicles, out of this 26%, 4% own bicycles, 44% own private cars and 26% own motorcycles as shown in fig 4.6. Unfortunately, the public transport has several limitations as it is characterised by inadequate route density, its vehicles are overcrowded, uncomfortable, unreliable and slow.

The choice of mode during worktrips is normally influenced by factors like speed, journey length, comfort, convenience, cost, reliability of alternative mode, town size and socio-economic status of persons making the journey.

4.2.1 ADEQUACY OF THE MODES

A large proportion of the population of workers depend on public transport to go to work. Unfortunately,

the public transport system in Kaduna is inadequate. Table 4.1 gives an inventory of vehicle fleets of all public transport vehicles in Kaduna in 1994. When related to vehicles per capita based on the 1994 estimated population of 1221035, we have per capita value of about 345 persons per vehicle and for worktrip makers, this is about 65 per vehicle.

TABLE 4.1: INVENTORY OF PUBLIC TRANSPORT VEHICLES IN KADUNA, 1994

| MODE | NUMBER REGISTERED TO SERVE IN KADUNA ** | NUMBER WORKING IN KADUNA |
|---|---|---|
| MINIBUS | 1090 | 877 |
| TAXI | 1487 | 1053 |
| BUS | 25 | 10 |
| MOTORCYCLE | 2405 | 1597 |

Sources *NURTW [Town Service Division].

The fleet available, therefore, cannot meet the increasing demand of workers especially at peak periods. Workers will inevitably have to wait for a long time to have access to public transport vehicles. This aspect was captured in the data collected. Results obtained, which is shown in fig, 4.7 indicates that although the waiting time range of 6 - 10 mins contains the highest percentage of workers but there are those who wait longer than 35 mins for public transport vehicles.

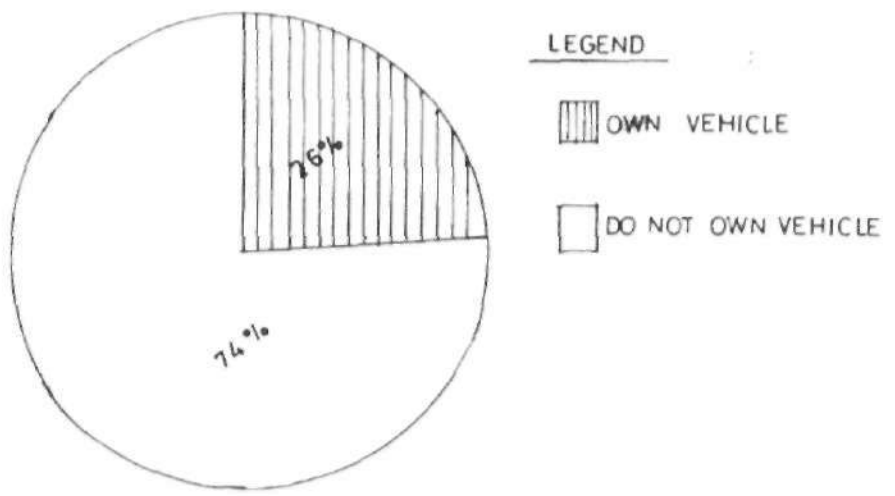



FIG. 4.5: VEHICLE OWNERSHIP AMONG WORKERS IN KADUNA, 1994.

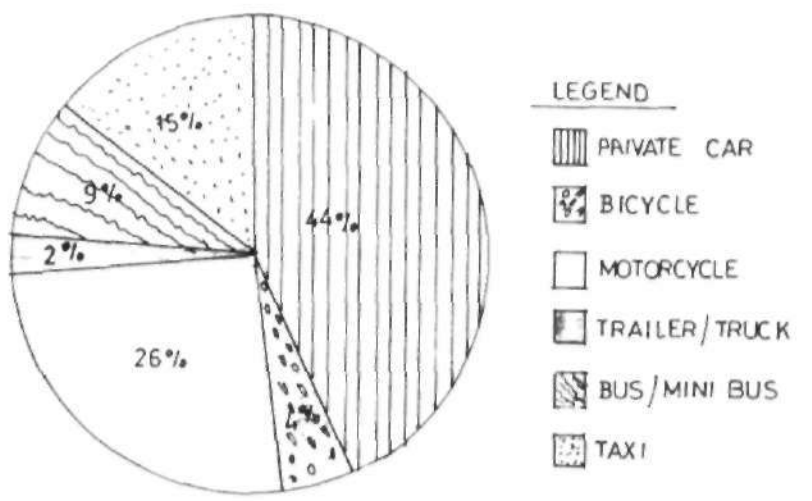
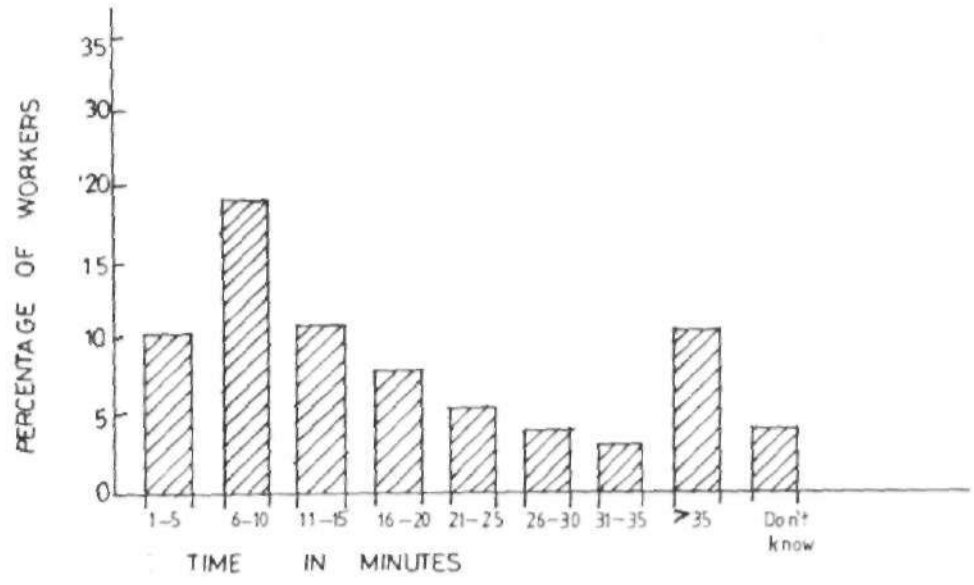



FIG. 4.6: TYPES OF VEHICLES OWNED BY WORKERS IN KADUNA, 1994.




FIG·4.7: WORKERS MEAN WAITING TIME ·

4.2.2 ROUTEING STRUCTURE

Public transportation in Kaduna is characterized by inadequate route densities. Their services do not sufficiently cover the township areas. As a result they are not easily accessible to many Urban residents. Infact, routes are fixed and confined to corridors of high densities. Some areas in the new extensions like the Government Reservation Areas [GRA] and the newly built up areas are not served by public transport systems as indicated in fig.4.8. However, the effect of this problem is lessened by the presence of motorcycle transport system. Unfortunately, they charge very high fares [N10 per drop] compared to minibuses that charge N5 per drop. Besides, motorcycles are prone to risks of accidents. These motorcycles are not even enough at peak periods to adequately cover the gaps in supply of public transport vehicles.

It has been established that minibus is the main mode of journey to work in Kaduna [fig. 4.3]. But it is characterized by numerous problems. Fig.4.8 shows that the services of minibus do not cover the town's areas. For instance, from the results of interviews minibus service does not extend to Kawo new extension because the operators want to maximize projects.

Results shown in fig. 4.9 also highlight some aspects of service, indicating that services of the minibuses are mainly restricted to high density streets where they are assured of high "turnover" of passengers all the time. Also, they are so used to their present routes that they follow them religiously. Most workers therefore, have to walk for 6 - 10 minutes or more to the nearest public transport route. Another effect of the poor routeing structure which brings about the increased importance of motorcycle transportation has been summed up by Sheikh [1993] as follows, "people's use of motorcycles in the town is based not on preference because it is more expensive than a bus or taxi cab ride to one's destination within the town".

The problem of public transportation of commuters in Kaduna revolves round this central fact that operators refuse to convey passengers to their various distinctions except along the regular routes. Their refusal may be due to the bad state of roads in the residential areas.

Another problem relates to the operational routing pattern whereby a route is segmented and users need to change vehicle many times before getting to and from their work places. This situation is clearly illustrated by the results summarized in fig. 4.10. It shows that 73% of the workers change vehicles at least once during their

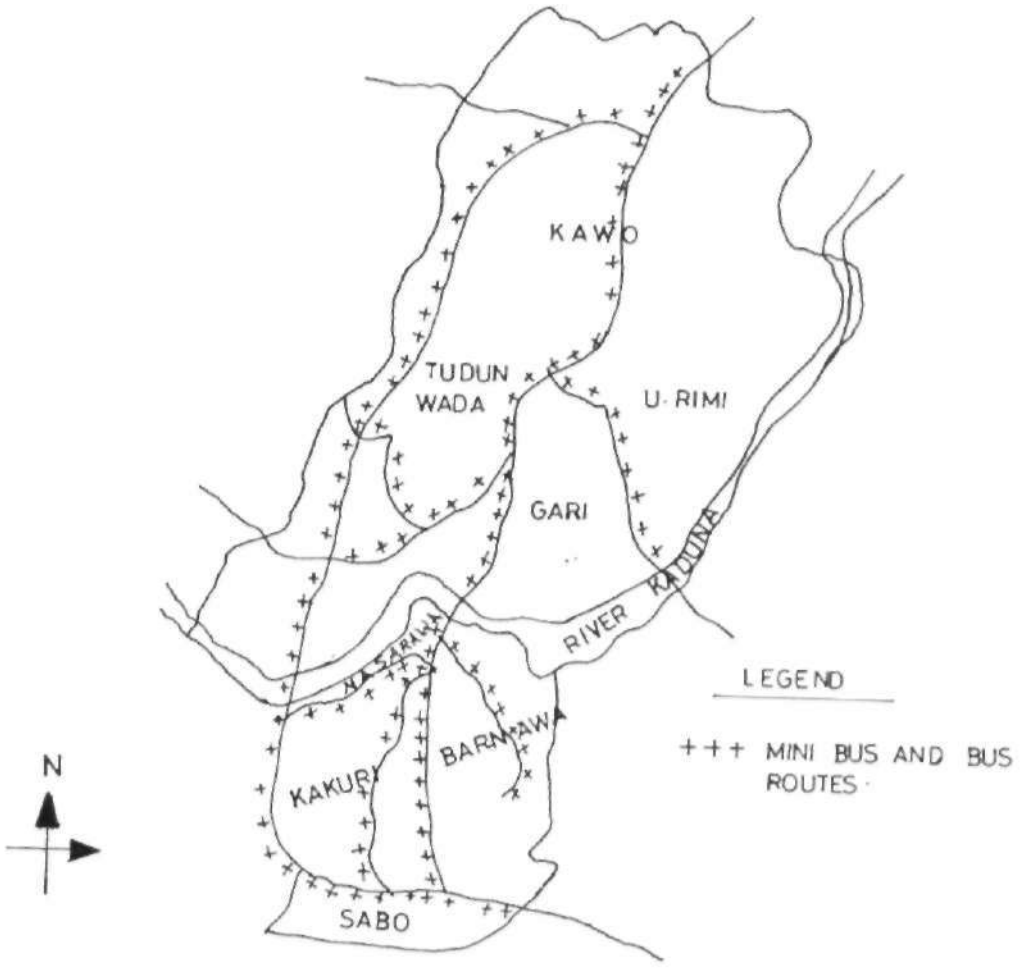



FIG. 4.8 BUS AND MINI BUS ROUTES KADUNA, 1994.

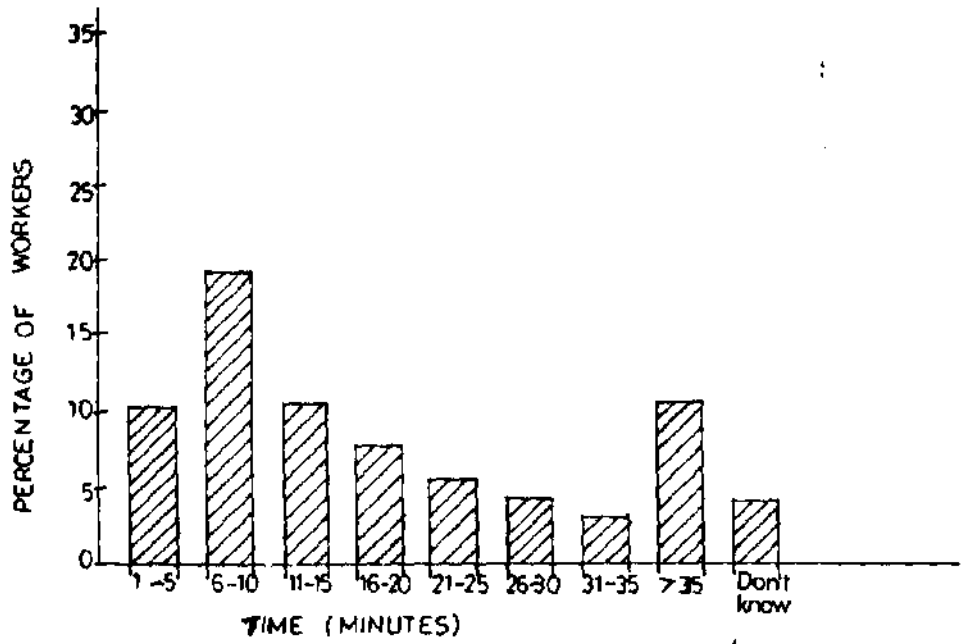



FIG 4-9 MEAN WALKING TIME TO THE NEAREST PUBLIC TRANSPORT ROUTE BY WORKERS, KADUNA 1994.

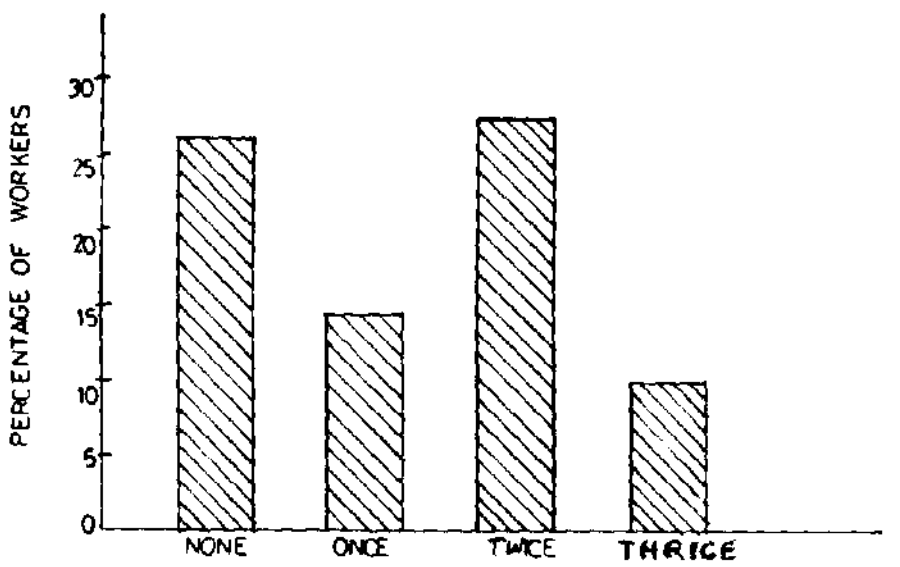



FIG 4-10 PERCENTAGE CHANGE OF MODE BY WORKERS TO AND FROM WORK.

worktrip. These frequent changes in vehicle, elongate travel time and increase travel costs. From the foregoing, there is therefore the need to restructure the routes to ensure direct journeys to work without change of modes by workers.

4.2.3 USER'S ASSESSMENT OF SERVICE QUALITY

Most of the minibuses are old, worn-out and dirty. Some emit thick smoke because they lack regular maintenance. Also, the standard of comfort and convenience particularly in respect of comfortable seating spaces available is very low. The minibus carries many passengers [12-14 passengers] which is in excess of the normal capacity of eight passengers . They pick up and drop off passengers anywhere, having no definite or designated stops. With this mode of operation, they often endanger pedestrians and motorists alike and disrupt smooth traffic flow.

It is instructive to consider the workers perception of the problems associated with minibuses. This is presented in fig. 4.11 and they include long distance to bus routes, 10%, lack of buses during peak hours, 12%, frequent stops to carry passengers, 33%, poor vehicle condition, 6%, overcrowding of buses during peak hour, 3%, high fare, 29%, and inadequate routing, 7%.

The worker's proposed solutions to these problems are shown in fig.4.12. Most workers would prefer vehicle

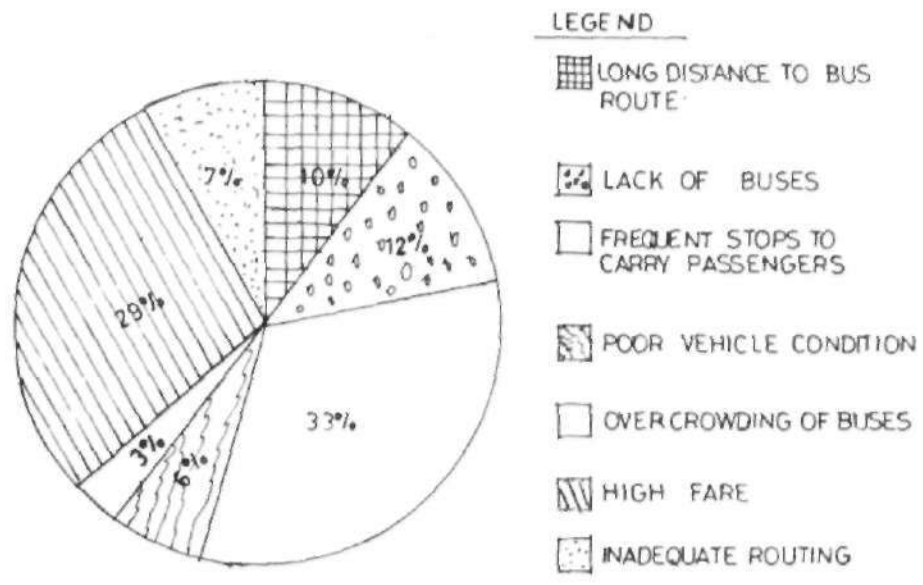
loans [33%.] In the present state of urban transportation in Kaduna, minibus and motorcycle have been invaluable in bridging the gap created by the inadequacies in the transit system. The motorcycle mode, unfortunately, has its own shortcomings. There is therefore the need to improve these modes of transport.

4.3 SOCIO-ECONOMIC CHARACTERISTICS OF WORKERS AND THE ACCOMPANYING PROBLEMS;

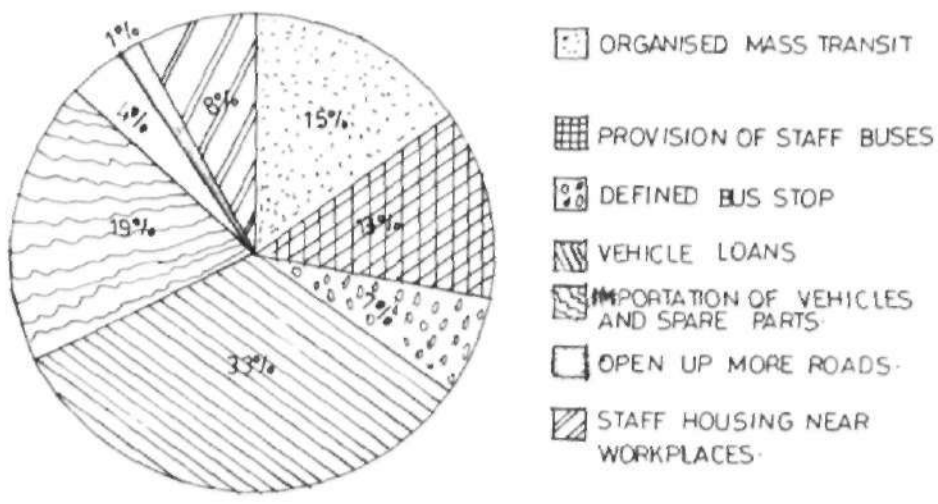
Socio-economic characteristics of workers generally influence their choice of mode, and residential location. Here, results obtained on socio-economic characteristics of workers under their expenditure pattern, income level, modal choice and distance are presented and discussed.

4.3.1 INCOME LEVEL

The workers monthly earnings are shown in fig.4.13 and the worker are classified into income groups [fig. 4.14] 48% of the workers are low income earners 32% middle income earners and about 20% high income earners. The threshold salary used for this grouping is less than N1500 per month for low income earners, N1501 - N3000 for middle income group [per moth] and more than N3000 per month for high income group. Most workers in Kaduna are Civil Servants and Industrial workers because the functional base of Kaduna is a mixture of administrative,




FIG·4·11: PROBLEMS ASSOCIATED WITH MINI BUSES AS IDENTIFIED BY WORKERS·




FIG·4·12: TENTATIVE SOLUTIONS TO PROBLEMS OF JOURNEY TO WORK BY WORKERS·

commercial to a lesser degree and industrial to a higher degree.

4.3.2. RESIDENTIAL LOCATION

Results of data on reasons for workers choice of residence in fig. 4.16 shows that the main reasons are nearness to workplace, [27%], affordable rent [25%] and live with husband/relative/family [22%]. But from the analysis of workers choice of residence under normal circumstances shown in fig. 4.17, workers would prefer to live close to their workplaces [53%] while low rent plays secondary importance [24%].

4.3.3 EXPENDITURE PATTERN

Results of data on monthly expenditure on journey to work and rent among workers in different zones is presented in fig.4.18. It shows that workers in Kakuri, Barnawa, and Kawo spend more money on journey to work than rent. It is not surprising that workers in Kaduna metropolis pay more on rent per month than on journey to work because of the generally high rent.

When the income groups were compared with each other on the basis of expenditure on journey to work and rent [fig. 4.19], it was found that all the income groups spend more money on rent than on journey to work. This is of course against the factors of income influencing the amount of money a worker expends on rent.

From fig. 4.20 the low income groups spend more of their monthly income (20%) on journey to work than the middle and the high income groups.

4.3.4 MODAL CHOICE

Worker's socio-economic characteristics affect their modal choice. The data on the choice of mode amongst the income groups presented in fig. 4.21 shows that the low income groups travel more by foot, bicycle, minibus and bus while the middle income groups travel more by motorcycle, bus, taxi and minibus. The high income groups travel more on cars to work. This is expected since income determines choice of mode in a mode captive market. The low income group cannot afford cars for themselves, and so do not travel by private car unless given a lift or is a driver to someone.

4.4 SOCIAL CHARACTERISTICS OF WORKERS

The main ethnic groups of workers in Kaduna are Hausa, Yoruba, Ibo, Igala, Tiv, Idoma, Kanuri, Fulani and others. From the results presented in fig. 4.22, 34% of the workers have lived at their present residences for up to 3 years while only 21% of the workers have been able to live in their present residences for more than 10 years. This indicates that alot of workers in Kaduna change their residence frequently for reasons which could be attributed to Urban rapid growth and changes in tenantship agreements.

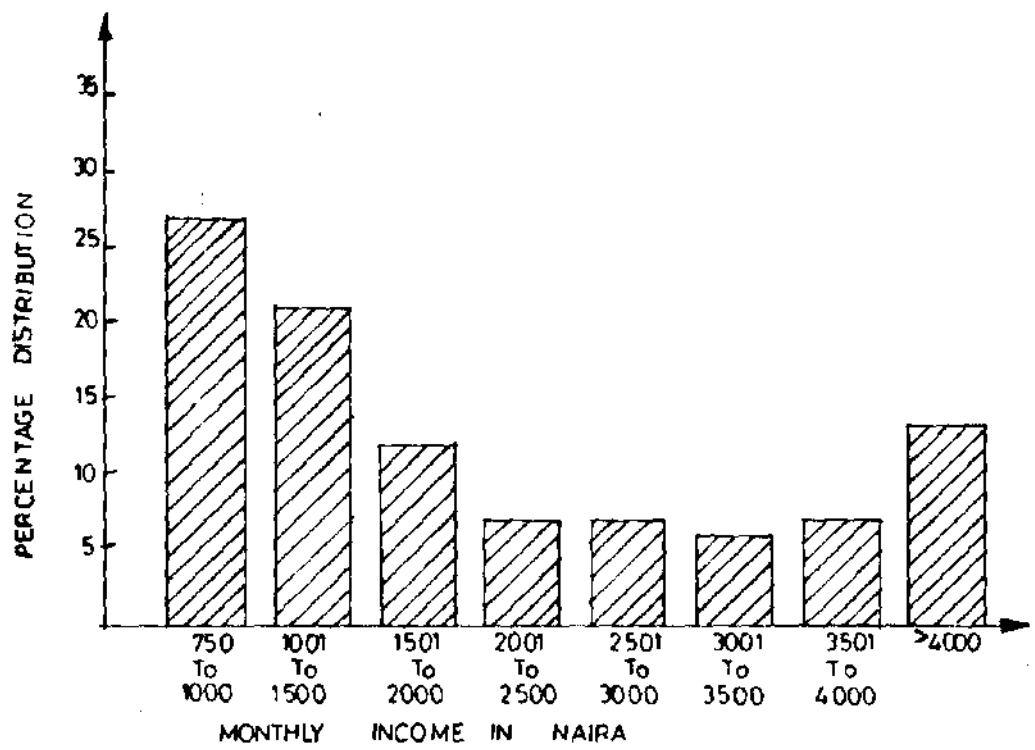



FIG. 4.13: MONTHLY INCOME DISTRIBUTION AMONGST WORKERS, KADUNA, 1994.

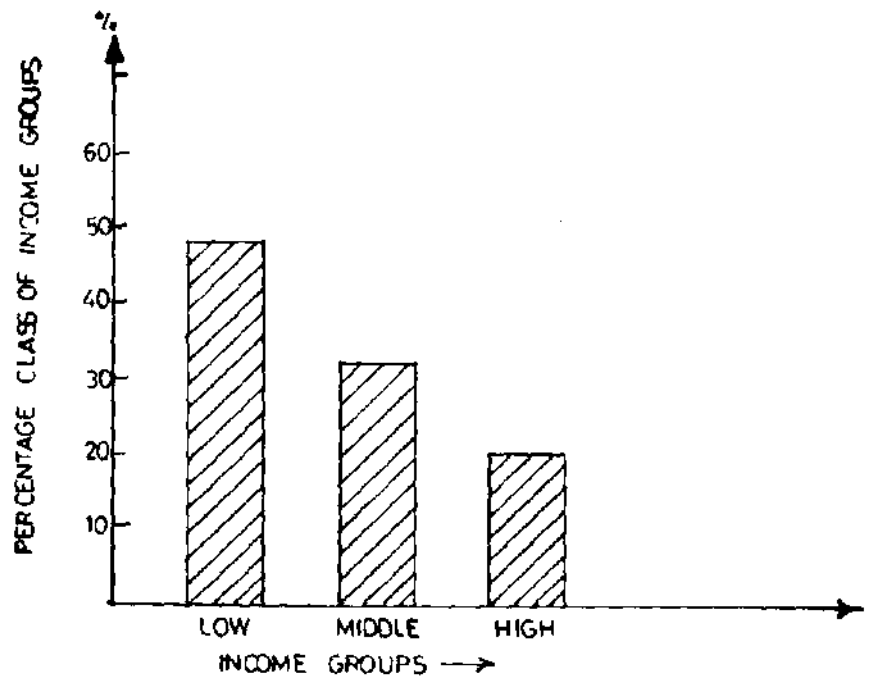
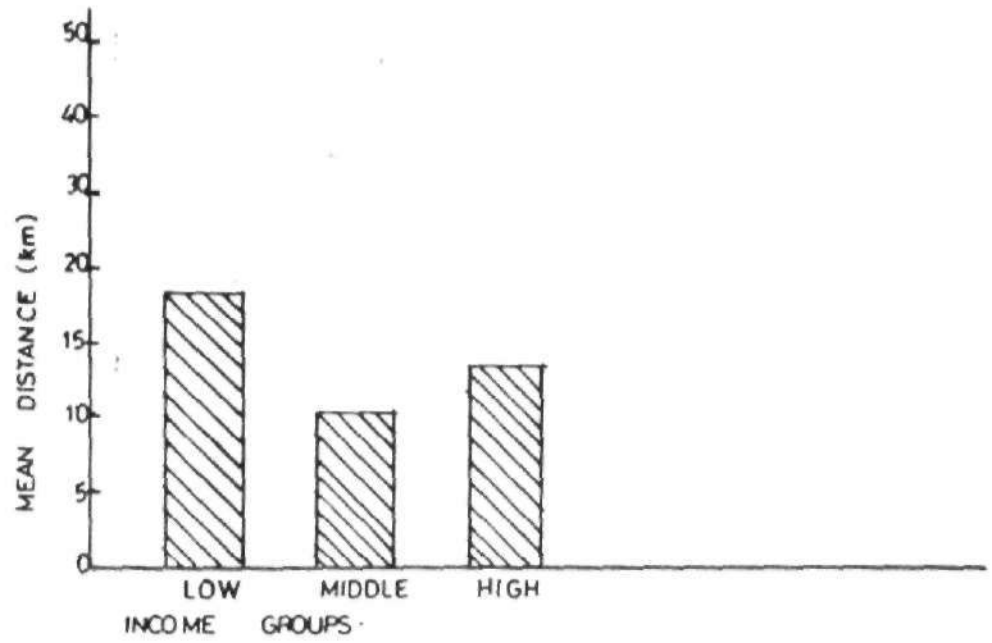
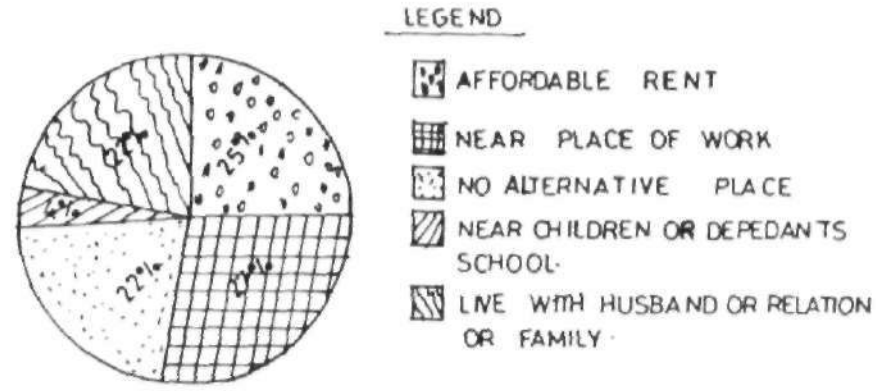


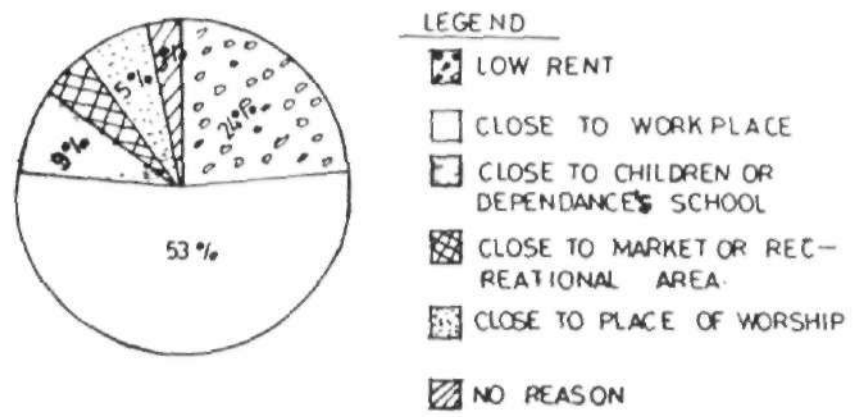

FIG. 4.14: CLASSES OF INCOME GROUP AMONGST WORKERS, KADUNA, 1994.



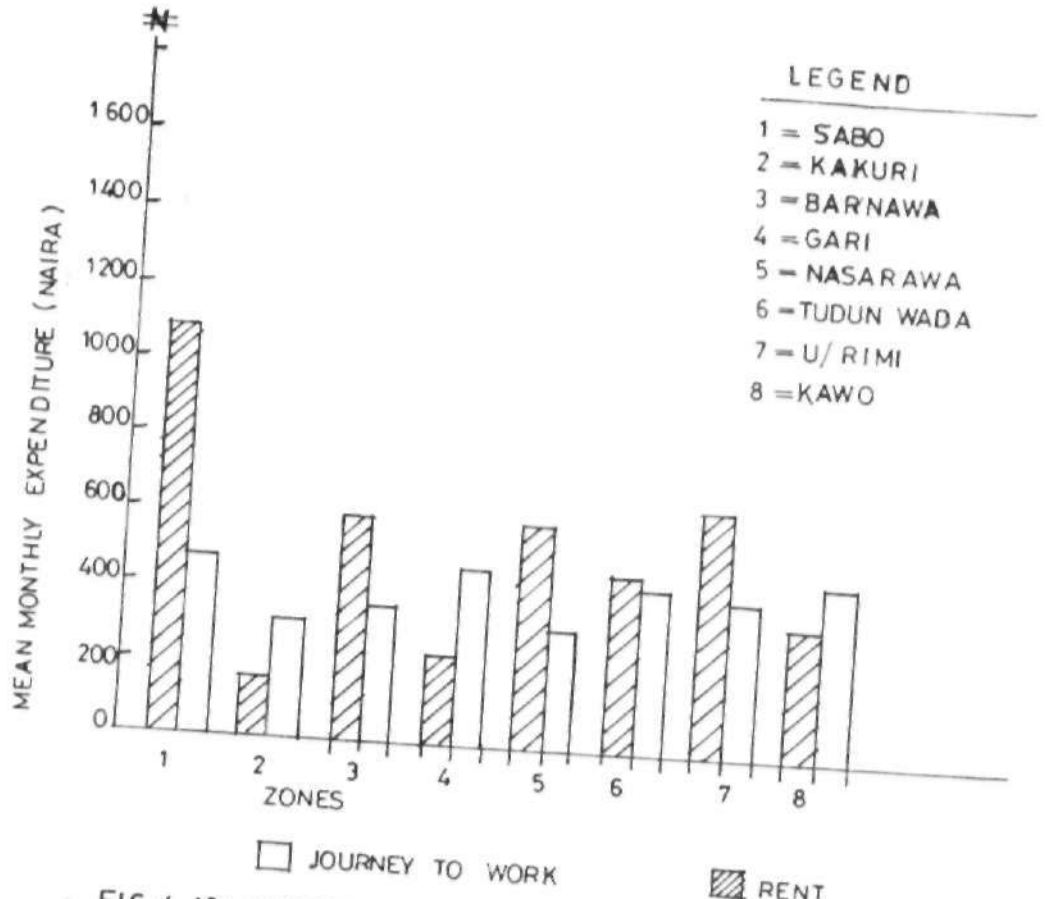

FIG·4·15: MEAN WORKTRIP DISTANCE AMONG WORKERS ACCORDING TO INCOME GROUPS, KADUNA, 1994



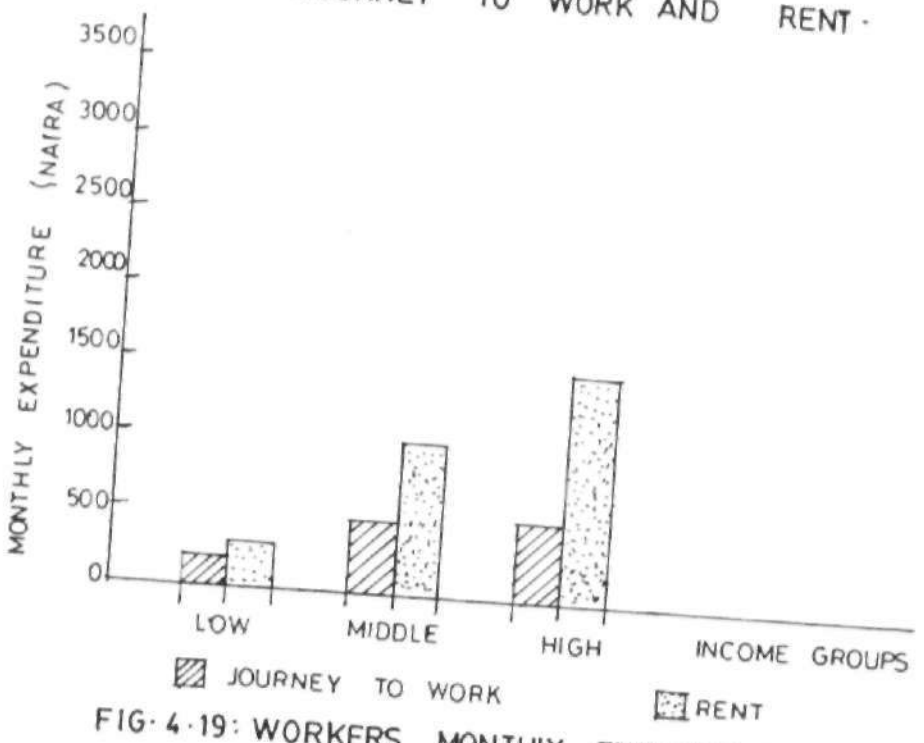

FIG·4·16: REASONS FOR WORKERS CHOICE OF RESIDENCE



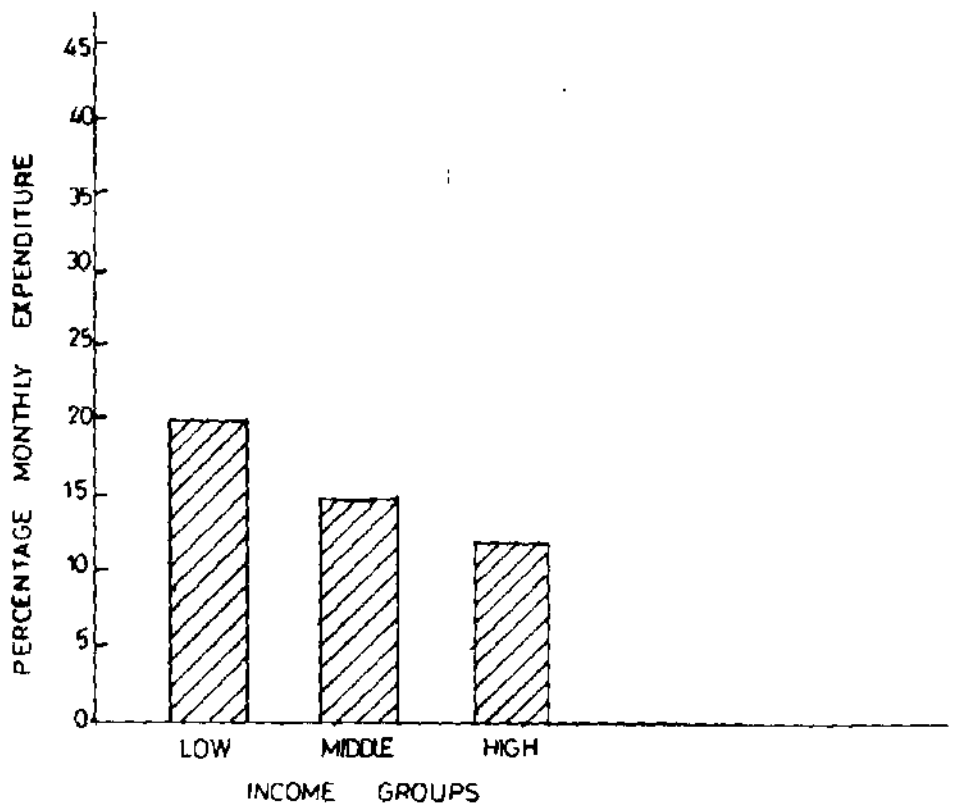

FIG·4·17: WORKERS CHOICE OF RESIDENCE UNDER NORMAL CIRCUMSTANCES·



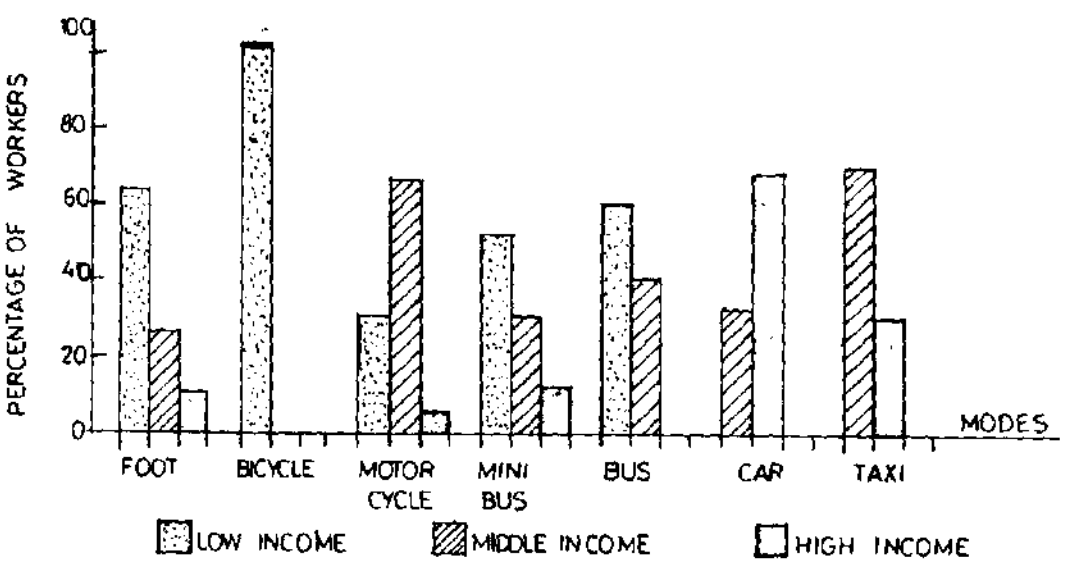

FIG·4·18: WORKERS MONTHLY EXPENDITURE ON JOURNEY TO WORK AND RENT.




FIG·4·19: WORKERS MONTHLY EXPENDITURE ON JOURNEY TO WORK AND RENT AMONG INCOME GROUPS.




FIG· 4·20: PERCENTAGE OF WORKERS MONTHLY INCOME SPENT ON JOURNEY TO WORK·




FIG· 4·21: MODAL CHOICE AMONG INCOME GROUPS·
(SOURCE; FIELD WORK KADUNA (1994)

The home ownership rates among workers according to zones is high in Sabo/Television and Kakuri zones [fig.4.23], while most workers in Kawo, Tudun Wada and Gari stay in rented residences.

The results of the analysis of data on home ownership presented in fig. 4.24 shows that only 19% of the sampled workers in Kaduna own houses, while the percentage that rent houses is 79% and squatters constitute 2%. The low percentage home ownership among workers is as a result of the economic recession, and it reinforces the likelihood of frequent changes of residences.

From the results shown in fig.4.25, most of the sampled workers in Kaduna are Civil Servants [64%] while others constitute the remaining 36%. The analysis of the percentage type of houses occupied by workers presented in fig.4.26 shows that rooming accommodation is dominant [54%], flat [41%], thatched houses 3% and duplex 1.6%].

## 4.5 ASSESSMENT OF THE NETWORK OF ROADS

Kaduna has a reasonably well developed arterial but lacks maintenance and facilities such as approved bus stops, parking facilities and vehicular segregation. There is also the problem of constrained flow in the East-West direction. This has led to serious traffic delays on the major roads like the Ahmadu Bello way, especially at the peak periods.

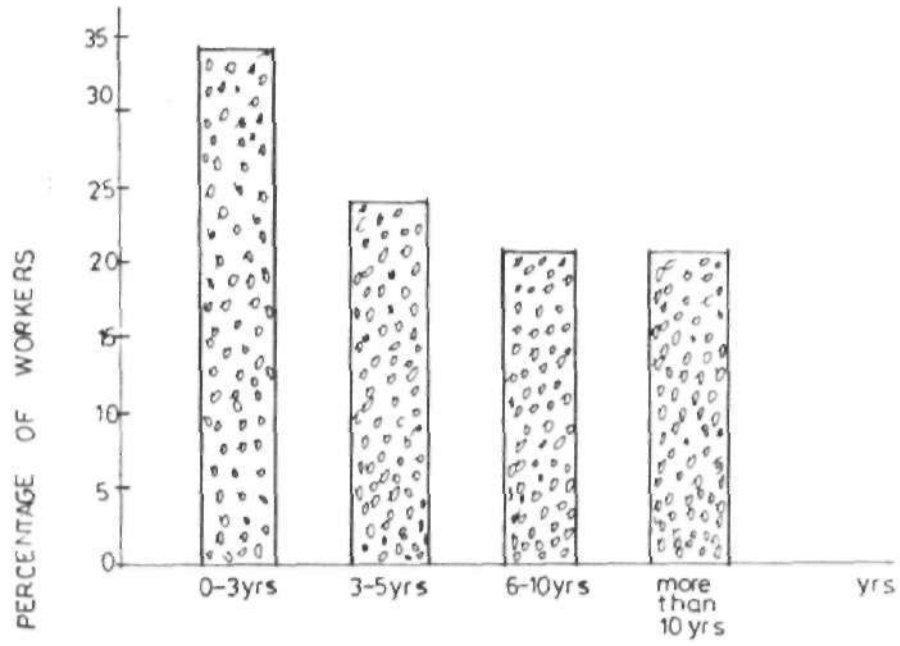
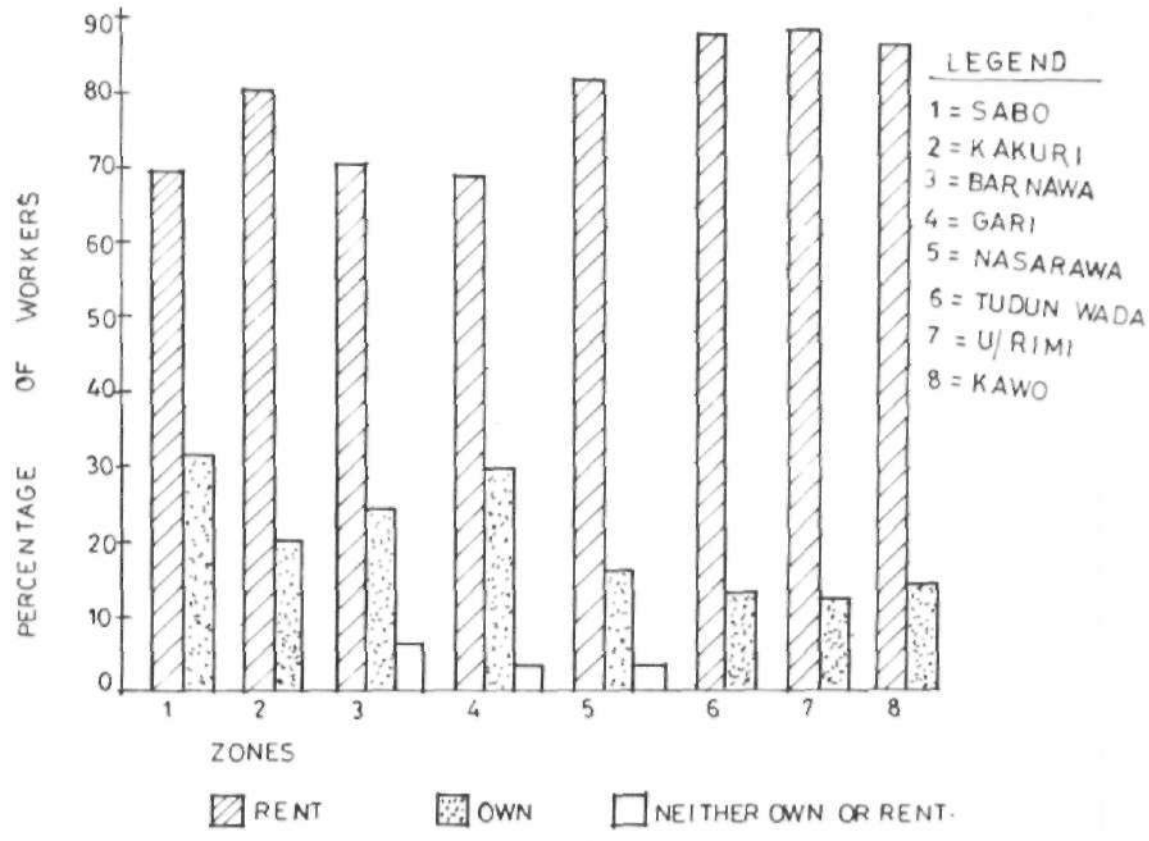
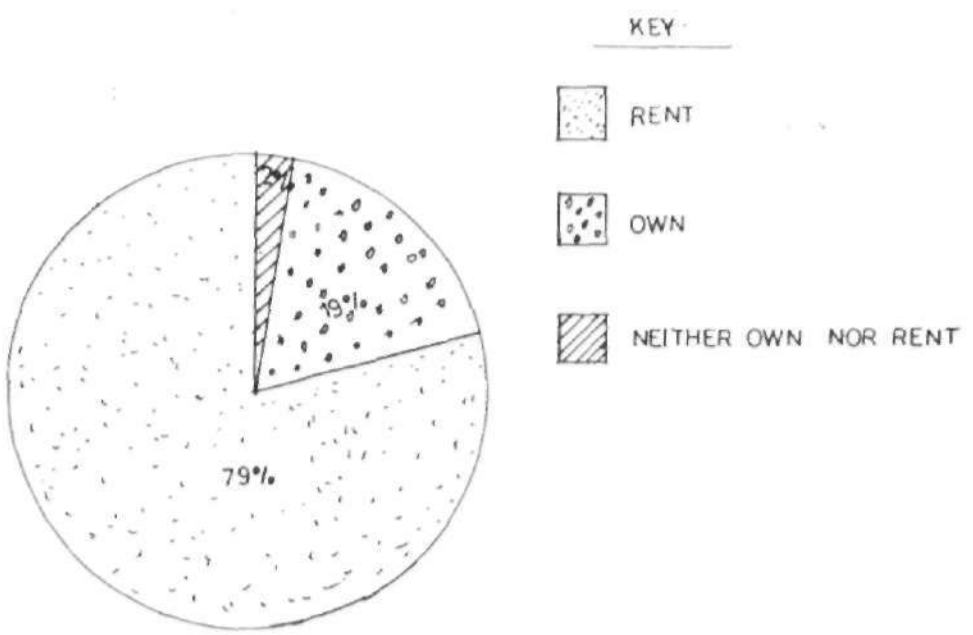


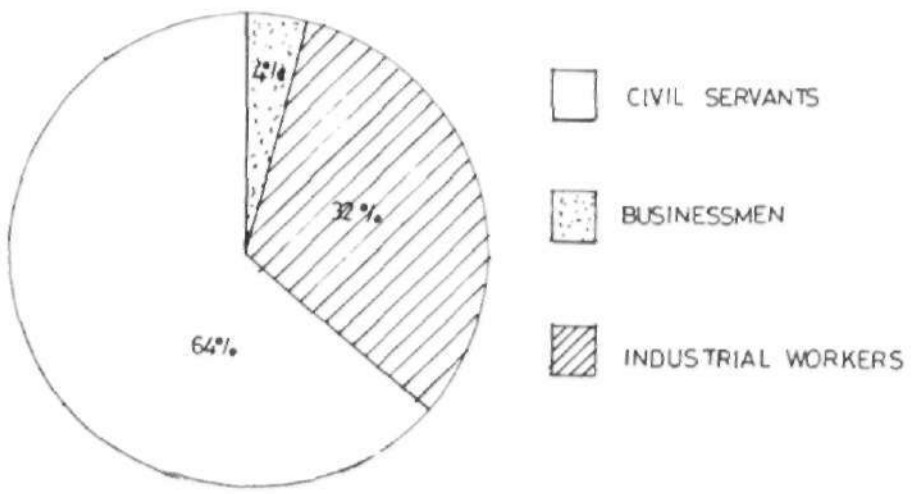

FIG-4·22 PERCENTAGE OF WORKERS THAT LIVE AT THEIR PRESENT HOME FOR VARIOUS DURATIONS KADUNA, 1994·




FIG·4·23 PERCENTAGE OF WORKERS THAT OWN OR RENT OR NEITHER OWN OR RENT HOUSES IN ZONES, KADUNA, 1994·




FIG·4·24: PERCENTAGE OF WORKERS THAT OWN OR RENT OR NEITHER OWN NOR RENT HOUSES IN KADUNA 1994·




FIG·4·25: PERCENTAGE OF WORKERS BY OCCUPATION KADUNA, 1994

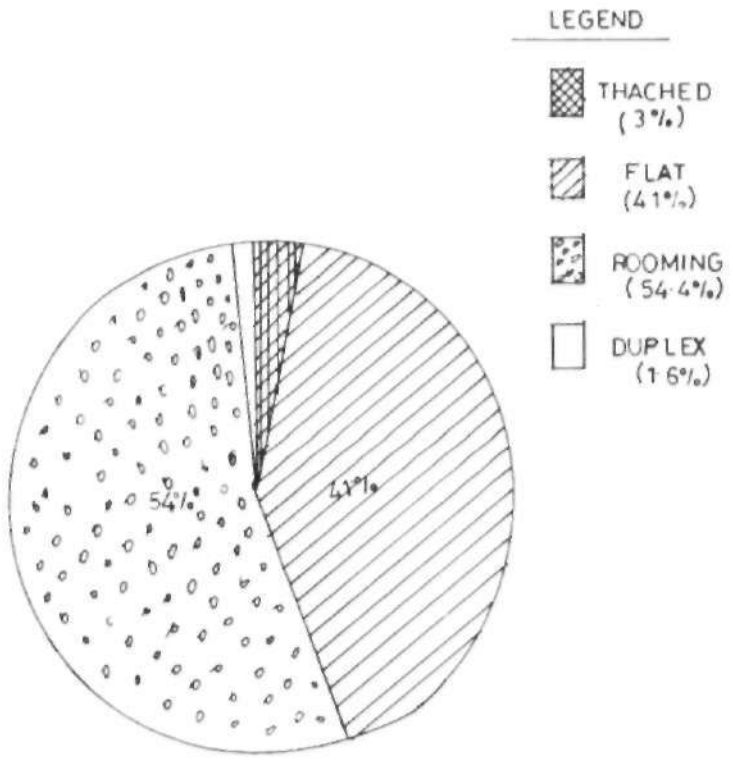



FIG 4·26: PERCENTAGE OF HOUSE TYPE OCCUPIED BY WORKERS, KADUNA 1994

The condition of the roads and streets linking residences and workplaces is important since it influences the type of mode to be used by workers, speed of movement and time cost.

4.5.1. ROAD PATTERN

The road network in Kaduna is inadequately developed but has well developed arteries. Some workers can travel through direct routes to their workplaces [for example, workers travelling from Kawo to Gari] but some workers can not travel through direct route to their workplaces [for example workers travelling from Sabo to Tudun Wada, Sabo to Ungwan Rimi etc]. This has been worsened by the many rough streets which have hindered the operation of smooth services in Kaduna. Some houses in residential areas of Tudun Wada, Kakuri, Kawo, Nasarawa, etc, are inaccessible by commercial vehicles.

From field observations, it was concluded that most of the worktrips are concentrated on roads like College road, Ahmadu Bello Way, Ali Akilu Road, Polytechnic Road, Mallam Madori Road, Brewery Road, Textile Road, Aliyu Makama Road, Constitution Road, Independence Way and Broadcasting Road. Traffic surveys aimed at establishing the peak demand levels were therefore undertaken on these roads. The results are summarized in Table 4.2 and appendix II.

TABLE 8.2: MEAN TRAFFIC VOLUMES IN Pcu/h DURING PEAK PERIODS ON SOME SELECTED ROADS IN KADUNA 1994

| S/NO. | ROAD | TYPE | PEAK TRAFFIC VOLUMES | | |
|---|---|---|---|---|---|
| | | | Moring Peak (7 - 8am) | Afternoon Peak (3.15 - 4.15pm) | Evening Peak (6-7pm) |
| 1. | Golf course | Major arterial | 1953 | 1756 | 1690 |
| 2. | Mallam Madori | Major arterical | 1331 | 715 | 986 |
| 3. | Western bye- | Dual carriageway | 2765 | 1719 | 2807 |
| 4. | pass. | | | | |
| 4. | Kachia | Dual carriageway | 3140 | 2142 | 2035 |
| 5. | Ahmadu Bello | Dual carriageway | 2887 | 1998 | 2080 |
| 6. | Ali Ailu | Dual carriageway | 2188 | 1966 | 1837 |
| 7. | Breweries | Major arterial | 1536 | 1458 | 1503 |
| 8. | Textile | Major arterial | 1185 | 924 | 868 |
| 9. | Polytechnic | Major arterial | 2859 | 2251 | 2228 |
| 10. | Gamagira | Minor arterial | 1295 | 1130 | 1124 |
| 11. | New Bida | Minor arterial | 962 | 829 | 894 |
| 12. | Aliyu Makama | Minor arterial | 1785 | 1378 | 1247 |
| 13. | Constitution | Minor arterial | 896 | 895 | 727 |
| 14. | Independence | Minor arterial | 1106 | 1034 | 1113 |
| 15. | Yakubu Gowon | Minor arterial | 1494 | 1402 | 1471 |
| 16. | Broadcasting | Minor arterial | 1555 | 1003 | 827 |

SOURCE: FIELD WORK, MARCH, 1994.

TABLE 4.3 STANDARD VOLUMES OF TRAFFIC IN PCU/H

| ROAD TYPE | PCU/H |
|---|---|
| Dual carriageway | 1200 - 3600 |
| Major arterial | 1200 - 3600 |
| Minor arterial | 500 - 1200 |
| Collectors | 500 - 1200 |

SOURCE: FEDERAL MINISTRY OF WORKS, HIGHWAY DESIGN MANUAL:

4.4.2 ROAD TRAFFIC VOLUME

The traffic volumes in P.C.U. values for morning, afternoon and evening peak periods for some selected Urban links are shown in Table 4.2 Morning peaks are generally higher than afternoon and evening peaks. Also, traffic flows on the roads tend to be highest towards the directions of work areas mostly in the morning and the reverse in the afternoon and evening peak periods. The data gives a strong indication that there is a high concentration of vehicular traffic on a few roads.

By comparing the volumes of traffic at the peak periods with the standard given in table 4.3, it is noted that the volume of traffic on the busy roads are all within the average expected on the roads. Given the erratic traffic flows observed on all the roads generally, it looks like factors other than volume are to

TABLE 4.4: KADUNA URBAN ROAD INVENTORY, 1994

| ROAD | SURFACE OF CARRIAGEWAY | CONDITION OF CARRIAGE WAY | EFFECTIVE WIDTH OF CARRIAGEWAY | CONDITION OF DRAINS | TYPES OF SIDE WALK | TRAFFIC CONTROL DEVICES | BUS STOPS | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CONSTITUTION | ASPHALT | GOOD | 7.5m | NM | UNPAVED | TW | NO | APPROV D | BUS | STOP |
| INDEPENDENCE | ASPHALT | GOOD | 7.3m | NM | UNPAVED | TW | " | " | " | " |
| NEW BIDA | ASPHALT | POOR | 7.3m | NM | UNPAVED | NONE | " | " | " | " |
| ALIYU AKILU | ASPHALT | GOOD | 9.6m | NM | UNPAVED | RA & TW | " | " | " | " |
| POLYTECHNIC | ASPHALT | FAIR | 7.6m | NM | UNPAVED | TW | " | " | " | " |
| GAMAGIRA | ASPHALT | FAIR | 7.3m | NM | UNPAVED | TW | " | " | " | " |
| BREWERIES | ASPHALT | POOR | 7.3m | NM | UNPAVED | NONE | " | " | " | " |
| TEXTILE | ASPHALT | FAIR | 7.3m | NM | UNPAVED | TW & RA | " | " | " | " |
| AHMADU BELLO | ASPHALT | GOOD | 9.6m | NM | PAVED | TW & RA | " | " | " | " |
| ALIYU MAKAMA | ASPHALT | FAIR | 9.6m | NM | UNPAVED | TW | " | " | " | " |
| WESTERN BYE-PASS | ASPHALT | FAIR | 11.4m | NM | UNPAVED | RA & TW | " | " | " | " |
| KACHIA | ASPHALT | FAIR | 9.6m | NM | UNPAVED | TL & TW | " | " | " | " |
| GOLF COURSE | ASPHALT | GOOD | 7.5m | NM | UNPAVED | TW | " | " | " | " |
| MALLAM MADORI | ASPHALT | POOR | 7.3m | NM | UNPAVED | TW | " | " | " | " |
| BROADCASTING | ASPHALT | GOOD | 7.5m | NM | UNPAVED | TW | " | " | " | " |
| YAKUBU GOWON | ASPHALT | GOOD | 7.5m | NM | UNPAVED | TW | " | " | " | " |

KEY:

NM = Not maintained, TW = Traffic Wardens, RA = Rounabout, TL = Traffic light.

facilities on Kaduna roads are generally poor while there are also no approved bus stops within the metropolis.

### 4.4.4 DELAY FACTORS ON KADUNA ROADS

Traffic delays on Kaduna roads are caused by a multiplicity of factors. Such factors include lack of bus stops and parking facilities, non-catering for pedestrian traffic, inefficiently operated road intersections and poor road surface conditions. This had contributed to indiscriminate picking up and dropping off of passengers by minibuses and taxis thereby obstructing the free flow of traffic. Also, double parking of vehicles is a common phenomenon on some of the roads like Mallam Madori road, polytechnic road, broadcasting road, etc. that are major worktrip routes, especially during peak hours.

There are no properly constructed side walks for pedestrians on the roads. This has led to the use of available road space by pedestrians in competition with vehicles. The resulting pedestrian vehicle conflict is not safe for pedestrians. Besides, it effectively reduces the available road space. The absence of pedestrian crossing like "zebra crossing" fly overs and pedestrian signals also contribute to traffic delays.

Again, observations on traffic delays were made along strategic arteries and the results are summarized in table 4.5. Other possible contributing factors are

level crossing turning maneuvre at junctions and several others. The railway level crossings on Kachia and Mallam Madori roads for example, have been the major causes of delays due to oncoming train.

TABLE 4.5: MEAN PEAK HOUR DELAY TIMES [SEC.] ON SOME SELECTED ROADS, KADUNA, 1994

CAUSES OF DELAY

| ROAD | APPROXIMATE LENGTH [KM] | ROAD INTER-SECTION | PARKING & FREQUENT STOPS | PEDESTRIAN CROSSING | TOTAL |
|---|---|---|---|---|---|
| AHMADU BELLO | 5 | 30 | 305 | 30 | 365 |
| WESTERN BYEPASS | 24 | 85 | 92 | 50 | 227 |
| INDESPENDENCE | 2 | 20 | 10 | 25 | 55 |
| MALLAM MADORI | 1 | 15 | 165 | 20 | 200 |
| BROAD CASTING | 1 | 30 | 35 | 20 | 85 |
| YAKUBU GOWON | 1 | 20 | 45 | 35 | 100 |
| POLYTECHNIC | 2 | 108 | 157 | 35 | 300 |
| GOLF COURSE | 1.5 | 28 | 20 | 25 | 73 |
| CONSTITUTIONS | 2 | 16 | 24 | 26 | 66 |
| ALI AKILU | 6 | 21 | 65 | 20 | 106 |

TABLE 4.6: COMPARISM BETWEEN THE AVERAGE VEHICLE OPERATING SPEEDS ON SOME SELECTED ROADS IN KADUNA AND THEIR DESIGN SPEEDS.

| S/NO. | ROAD | AVERAGE WIDTH(M)* | AVERAGE SPEED(KM)* | DESIGN SPEED($\frac{KM}{n}$)** | REMARKS |
|---|---|---|---|---|---|
| 1. | YAKUBU GOWON | 7.5 | 25 | 50 - 70 | OPERATING SPEEDS OF VEHICLES ARE LESS THAN DESIGN SPEEDS IN ALL THE ROADS. |
| 2. | BROADCASTING | 7.5 | 25 | 50 - 70 | |
| 3. | GOLF COURSE | 7.5 | 25 | 50 - 70 | |
| 4. | MALLAM MADORI | 7.3 | 19 | 50 - 70 | |
| 5. | WESTERN BYEPASS | 11.4 | 30 | 50 - 70 | |
| 6. | KACHIA | 9.6 | 25 | 50 - 70 | |
| 7. | AHMADU BELLO | 9.6 | 12 | 50 - 70 | |
| 8. | ALI AKILU | 9.6 | 15 | 50 - 70 | |
| 9. | BREWERIES | 7.3 | 25 | 50 - 70 | |
| 10. | TEXTILE | 7.3 | 27 | 50 - 70 | |
| 11. | POLYTECHNIC | 7.5 | 26 | 50 - 70 | |
| 12. | GAMAGIRA | 7.5 | 27 | 50 - 70 | |
| 13. | NEW BIDA | 7.5 | 27 | 50 - 70 | |
| 14. | ALIYU MAKAMA | 7.5 | 34 | 50 - 70 | |
| 15. | CONSTITUTION | 7.5 | 23 | 50 - 70 | |
| 16. | INDEPENDENCE | 7.5 | 28 | 50 - 70 | |

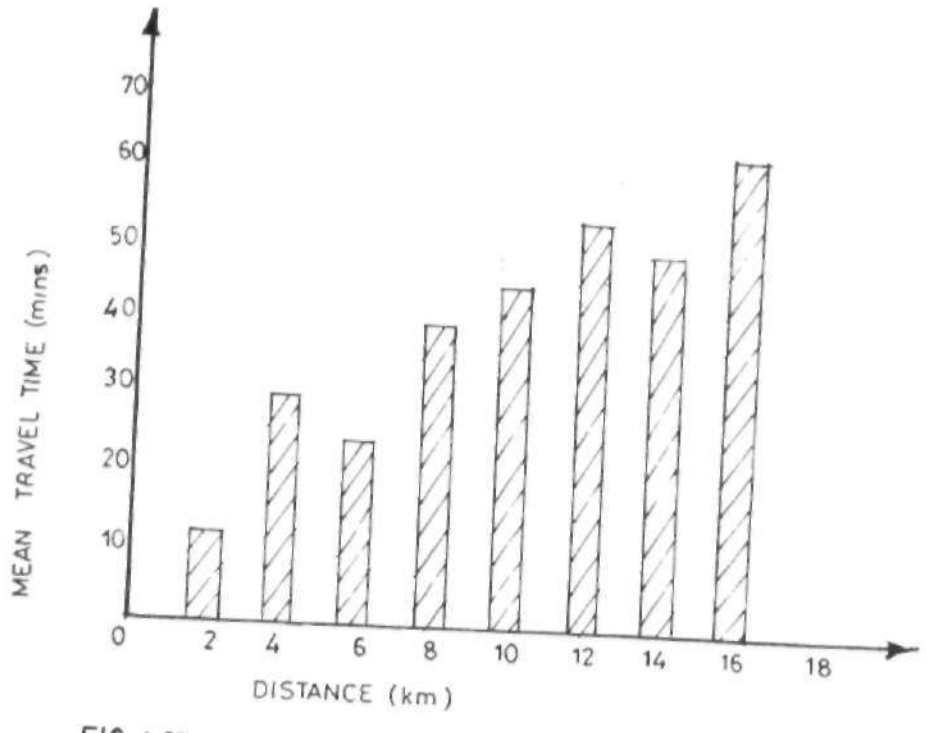
SOURCES: Field work, 1994, ** F.M.W & H, Highway Design Manual.

## 4.6 PROBLEMS ASSOCIATED WITH JOURNEY TO WORK.

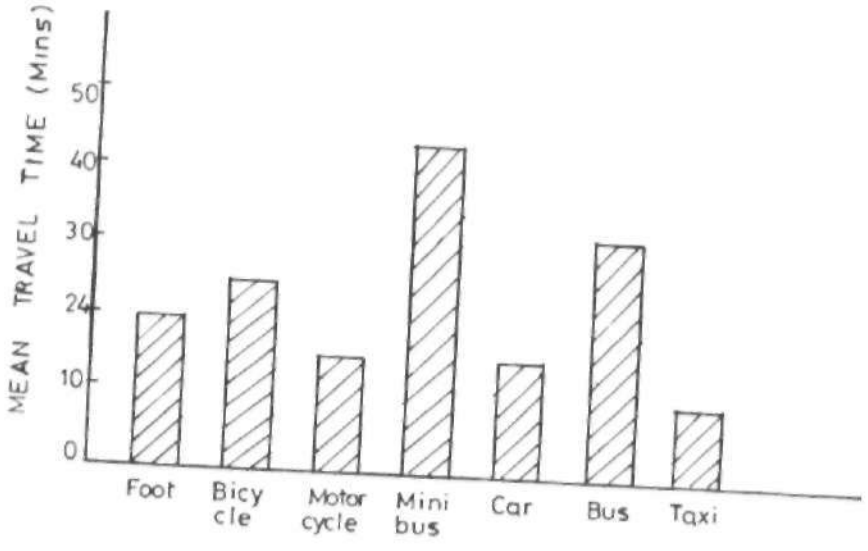
The main problems of journey to work in Kaduna include long travel time, high cost inconveniences and stains. These vary depending on the socio economic status of the worker. High income earners who can own private Cars value the time factor more while for the low income earners who use public transport, money is more important.

Travel time, according to world Bank standard, can be considered excessive when a door to door trip of 6km consistently takes 40 minutes, 10km trip take 60 minutes (Ayeni, 1986). The travel time is assumed to include walking and waiting time as well as time spent on board vehicle. Based on studies of a similar nature by Ayeni [1979] in Jos, Amuda [1986 in Ilorin, Ojumu [197S in Lagos, We could conclude that the World Bank Standards are achievable. Analysis of time spent on Journey to work at various distances by workers in fig.4. 27 shows that workers spend less time in travelling to work . When the mean travel time of workers among various modes was computed [fig.4.28], the workers that go by minibus, in their worktrip all spend about 45 minutes. The major causes of long travel time are overcrowding [when more than two buses or 15 minutes pass before boarding is possible], traffic delays [as a result of inadequate road net-work and traffic management facilities] and unplanned residential, locations or development.

The high travel cost, according to World Bank's criteria, is a fare structure that discriminates against low income workers when cost makes it impracticable for them to use bus. A reasonable




FIG·4·27 RELATIONSHIP BETWEEN DISTANCE AND TRAVEL TIME OF WORKERS, KADUNA 1994.




FIG·4·28 REPORTED TRAVEL TIME OF WORKERS BY MODES, KADUNA, 1994.

criterion is the cost of a week's transit fares for trips to work as a percentage of the total weekly household income. Costs exceeding 10% of income for more than 15% of the population can be considered discriminatory service. Lack of service to low income neighborhood is another obvious form of discrimination. [Urban, Edge, 1986]. These are reasonable criteria and since they were derived from studies in Urban centers in many developing countries, they are adopted in this study. From our earlier results [fig.4.14], the low and middle income groups form about 48% and 32% respectively. Also, in fig.4.20, the low income group spend about 20% while the middle income group spend about 15% and the high income group spend about 10% of their monthly income on Journey to work. Considering the World Bank's criteria, we conclude that the fare structure discriminates highly against low income group in Kaduna. This finding underlies the strong need for some form of subsidy targeted at the low income earners.

The main factors responsible for the high cost of worktrips are distance of the work places from the residences of low income earners and change of modes several times before getting to work places.

Inconveniences and strains are other problems associated with Journey to work in Kaduna. Worktrips by

public transport involve walking to bus stops/routes, waiting at bus stops/route, struggling to board a bus, changing vehicle and walking from the bus stop to workplaces which constitute inconveniences and strains to workers and affect their productivity. Also, smoke emitted by unserviced minibuses causes stress and discomfort to the bus users. Overcrowding of the buses can again cause stress to workers.

# CHAPTER FIVE

## 5.0 PROPOSALS FOR MAKING WORKTRIPS MORE CONDUCIVE

Proposals for making work trip more conducive should involve both curative and preventive measures. Curative proposals are short term solutions to problems of worktrips in Kaduna metropolis, while the preventive proposals are planning oriented and involve long term solutions for landuse planning.

## 5.1 CURATIVE PLANNING PROPOSALS

The curative planning proposals involve the improvement of the road network, organising the present mass transit program and the use of school and staff buses.

### 5.1.1. IMPROVEMENT OF ROAD NETWORK QUALITY

The poor maintenance of the road network in Kaduna metropolis has been shown to be a major cause of problems. There is therefore, the need to improve the road network. All the streets in the metropolis require overlay and constant maintenance. If this is done uniformly, there would be a better spread of traffic as opposed to the present situation where traffic is concentrated on the major

roads such as Ahmadu Bello Way, Kachia road, Ali Akilu road, Independence way, Breweries road, new Bida road etc. The new road which requires urgent attention is the eastern byepass which should start at Sabo [Kachia road] and burst at Zaria road [Kawo]. This will enable much of the worktrip from Sabo (Television), and Kawo to be assigned to this route. Improvements are expected to be made on the poorly designed intersections, construction of side walk and improved paving.

5.1.2 ORGANIZATION AND BETTER CO-ORDINATION OF MASS TRANSIT OPERATION

In view of the heavy reliance on the public transport by worktrip makers in Kaduna, the modes require attention. The strategy proposed here is to improve the mass transit system through ensuring adequate supply of mass transit vehicles [minibuses and big buses] ensuring more appropriate frequency and improved reliability of their services, making the
buses clean decent and fairly comfortable. The proposal also entails ensuring a wider coverage of the city areas in their operation.It will further involve integrating of the bus, minibus, taxi and motorcycle services so that their services will compliment one another in an efficient manner. it is hoped that the series of actions proposed will help in inducing car owners from the use of private cars during peak hours.

cause minimal disruption to flow of traffic on major streets.

[b] CONCEPT II

The second concept calls for the operation of the bus services in the form of a cross as shown in fig.5.1[b]. Bus services will cover North-South and East-West of the town. In that case, workplaces in the Western bye-pass and those in the center of the town will be served.

The minibuses, taxi and motorcycle services will then converge on the bus routes to serve the workplaces. The parallel and cross shaped bus services, supported by the minibus services will ensure that workers are adequately served and workplaces are easily reached in good time at low cost and under comfortable conditions.

[c] CONCEPT III

The third concept is a synthesis of the first two concepts [I & II] and is shown in fig.5.1[c]. It has a peripheral city bus service and a North-South and East-West routes. Minibuses will then "feed" these bus routes. This concept combines the best features of the other two concepts.The three concepts described above all have their strengths and weaknesses. Under normal situation, detailed simulations of the operations are needed to be able to fully design and evaluate the performances of each concept. In the present situation, the needed data

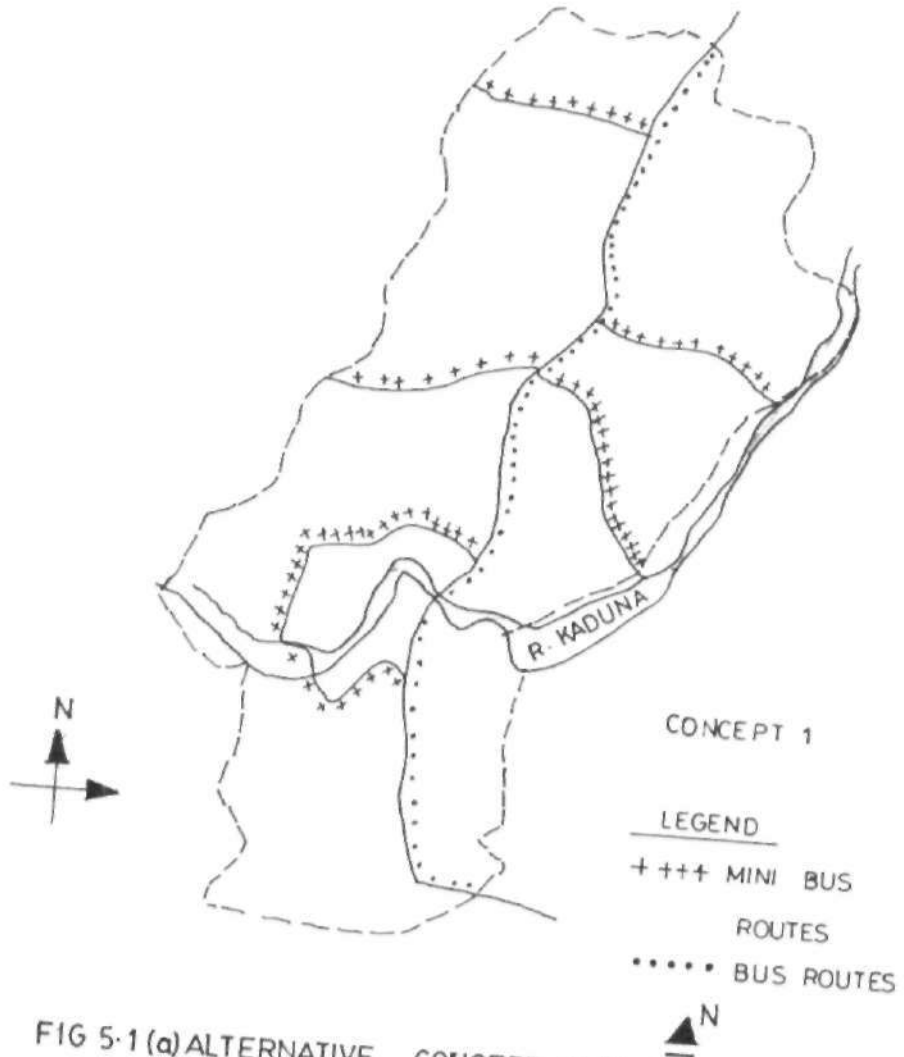



FIG 5·1 (a) ALTERNATIVE CONCEPT FOR PLANNING FOR THE CURRENT MASS TRANSIT PROGRAMME.

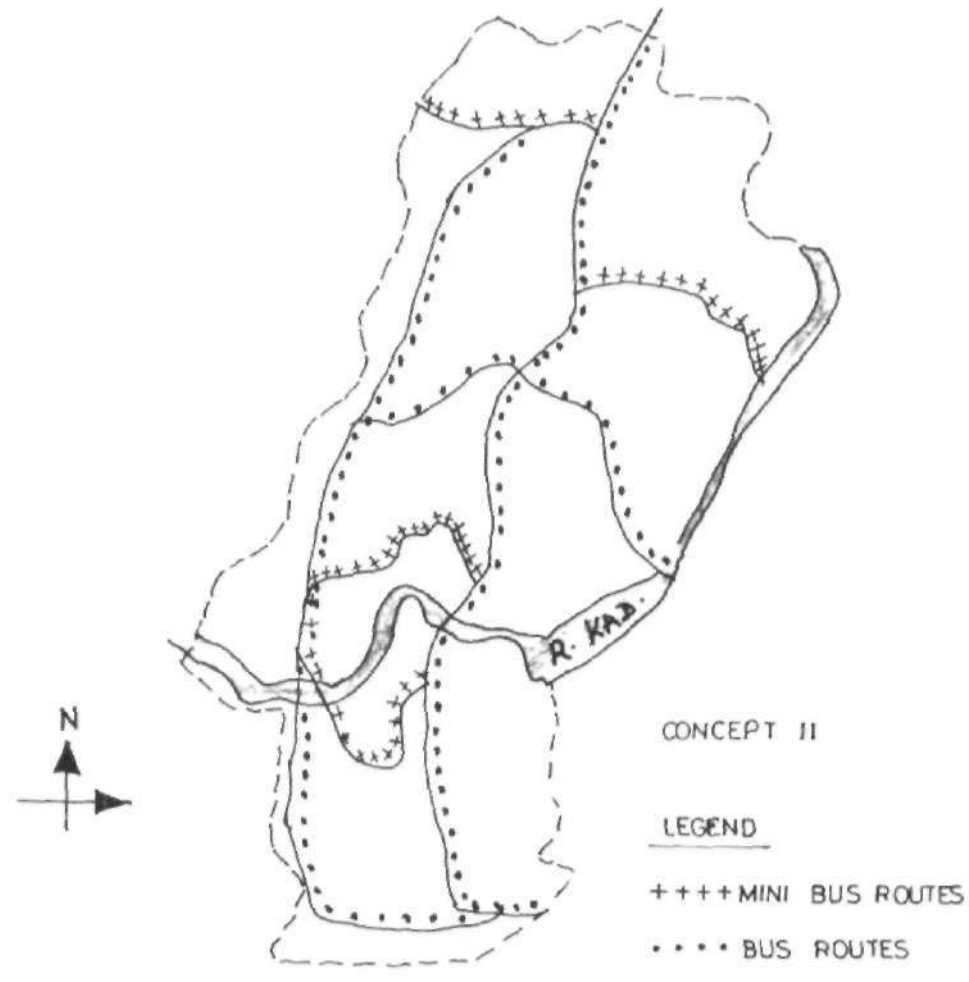



FIG. 5.1b ALTERNATIVE CONCEPT FOR PLANNING FOR THE CURRENT MASS TRANSIT PROGRAMME.

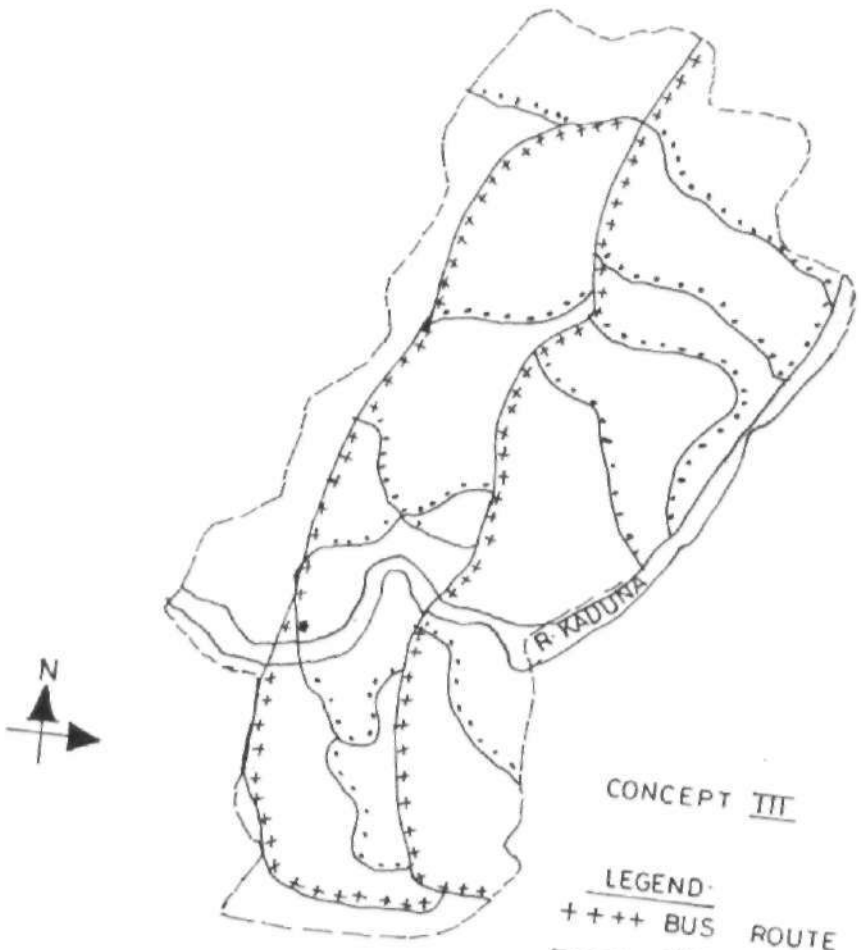



FIG.5.1c ALTERNATIVE CONCEPT FOR PLANNING FOR THE CURRENT MASS TRANSIT PROGRAMME.

cannot be got. A crude evaluation to serve as a preliminary screening has been undertaken using a rating scale. A crude rating scale has been introduced to rank the different concepts and recommend one of them. The rating scheme entails assigning an integer score of between 1 and 4 to each design concept to reflect its performance in each of the six areas considered crucial in evaluating the service. In assigning the score, the intention is that the score reflects the level of achievement indicated in table 5.1.

TABLE 5.1: SCORING BASES FOR EVALUATING THE DESIGN CONCEPTS

| SCORE | LEVEL OF ACHIEVEMENT |
|---|---|
| 1 | Very low |
| 2 | Low |
| 3 | High |
| 4 | Very high |

Also, the areas considered relevant for evaluation purposes are:

[i] Cost of construction of system facilities.

[ii] Disruption to traffic flow on major streets.

[iii] Minimising number of transfers [i.e. change of mode].

[iv] Capacity to redistribute worktrips.

[v] Travel time and speed

[vi] Accessibility of services to residences and workplaces.

The rating scores for the different design concepts are given in table 5.2.

TABLE 5.2 EVALUATION OF BUS ROUTING CONCEPTS

| | EVALUATION CRITERIA | CONCEPT I | CONCEPT II | CONCEPT III |
|---|---|---|---|---|
| 1 | Cost of construction of system facilities. | 3 | 4 | 1 |
| 2 | Disruption to traffic flow on major streets. | 1 | 2 | 3 |
| 3 | Minimising rate of change of mode. | 1 | 2 | 4 |
| 4 | Capacity to redistribute worktrips. | 2 | 3 | 4 |
| 5 | Travel time and speed. | 2 | 1 | 3 |
| 6 | Accessibility of services to residences and workplaces | 1 | 2 | 4 |
| | TOTAL | 10 | 14 | 19 |

Based on the evaluation criteria and rating scores of all the concepts in Table 5.2, concept III Scored the highest and is therefore the accepted concept and should be used in the future organization of the mass transit system.

5.1.2.2. FURTHER DETAILS ON THE IMPROVEMENT TO MASS TRANSIT SYSTEMS

[a] SIZE OF BUSES

The various vehicle types within the fleet of Kaduna State Transport Authority are in poor condition now. It is this situation that has brought about the complete absence of an organised mass transit service as of now in Kaduna Metropolis. The only semblance of mass transport services is provided by the labour Transport service that operates a fleet of ten/50-seated buses. Thus, it will be necessary for additional vehicles to be acquired in order to provide reasonable level of service to sustain the concept adopted. KSTA will need to reactivate all the broken down vehicles and purchase additional new ones. The big size of Kaduna town favours the use of big Buses 50-seaters, while minibuses, taxis and motorcycles will continue to be improved and used to supplement the big buses. This indeed, is the scheme adopted for improving the mass transit within Kaduna Metropolis.

[b] LOCATION AND SPACING OF BUS STOPS AND TERMINALS

Location and spacing of bus stops have profound influence on passengers travel time. The closer the spacing, the more the stops, and hence, the longer the travel time. On the other hand, excessive spacing of bus stops will increase the feeder trip time which could out

weigh the benefits of fast transit services. The normal practice is to resolve the situation analytically using real data. The required data is not available and only convenience of passengers has been used to adopt a maximum access time of 10 minutes, hence a maximum bus stop spacing of 500m is therefore recommended for the stops.

[c] PROPOSED FARE LEVEL AND FARE STRUCTURE

The fare level is the money value charged for a ride, while the fare structure refers to the principles adopted for determining the fare levels.

The options for the fare structure include:-

[i] Graduated fares where the charges are related to distance travelled [Amuda, 1986].

[ii] Flat fares, is when the distance is not considered but the same for all.

[iii] Zonal fares, in which the city zones are used. Trips within a zone could have a flat fare rate, while interzonal trips attract extra charges.

The choice of fare structure has implications on equity. At present, the zonal fare structure is used in Kaduna metropolis. This should be encouraged because it is equitable and prevents abuse of the system since it is a form of graduated fare. A more sophisticated graduated fare structure is complicated and could easily be abused by private operators in the setting of Kaduna.

The analysis of data on workers wishing to change from their present worktrip modes to mass transit shown in fig. 5.2 indicates that, apart from those using private cars [who are mainly high income earners], more than 60% wish to change to an organised mass transit system in Kaduna. This strongly supports a case for an organised mass transit system in Kaduna Metropolis.

The data on the affordable fares by workers in Kaduna metropolis in the different income groups, shown in fig.5.3, indicates that the low income groups prefer to pay N3 per drop, the middle income groups N4 while the high income groups N5. Based on the above results, a fare level of N5 per drop for travels within the zones is recommended.

5.1.3. SCHOOL AND STAFF BUSES

School authorities [both private and public] should be encouraged to provide buses for the students and staff respectively. Employers of labour within the metropolis should also be encouraged to buy staff buses for their workers. All these will supplement the services of the mass transit system.

Minibuses should also be made to extend their services to schools at peak periods. This will discourage workers who will leave their workplaces and go and collect their children and wards from school and also

reduce the 12.00 noon to 2.00pm peak hour delays on the roads.

5.1.4. TRAFFIC MANAGEMENT MEASURES

A package of traffic management measures needs to be designed to deal with the host of problems that now afflict traffic flow in Kaduna. Such problems include parking and stopping of vehicles on the major roads, [i.e. Ahmadu Bello way, Breweries road, New Bida road, Yakubu Gowon Way, Ali Akilu Road, etc.].

5.2. PREVENTIVE PLANNING PROPOSALS

The preventive planning proposals consist of long term plans directed at solving the problem of haphazard development of landuse which indirectly dictates the pattern of future worktrips.

5.2.1. DISTRIBUTION OF RESIDENCES AND WORKPLACES.

The ideal situation is to have the workers residences within walking or cycling distance of the workplaces or within reach by a short Journey. This would require considerable planning effort for an existing Urban area like Kaduna. The proposal calls for allocation of residential developments in workplaces concentration zones such as Kakuri, Nasarawa, Sabo and Television, and allocation of workplaces in residence concentrated zones like Kawo, Gari, Ungwan Rimi and Tudun Wada. In this regard, proposals have been generated. The proposals which are derived from the basic concepts contained in

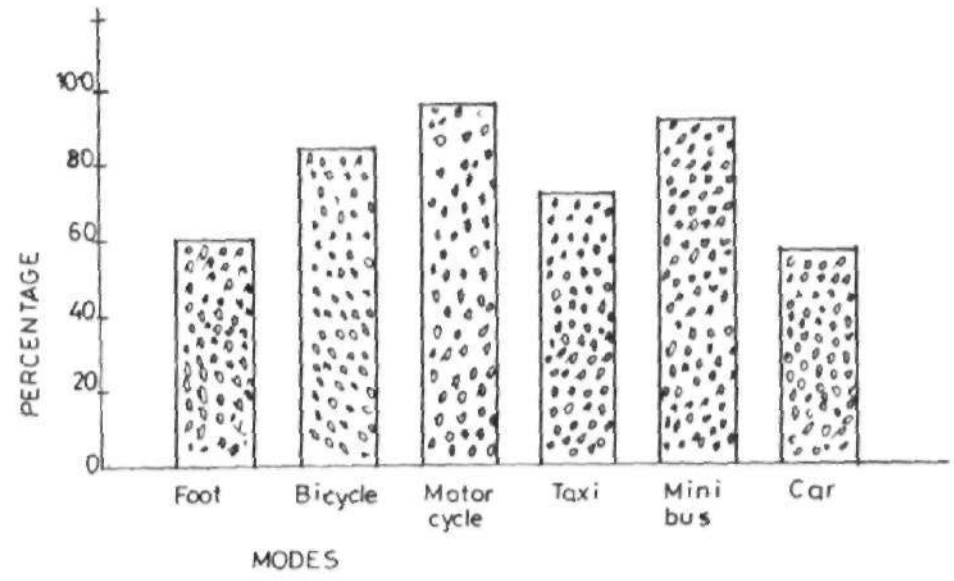



FIG. 5.2 PERCENTAGE OF WORKERS WISHING TO CHANGE THEIR PRESENT MODE TO MASS TRANSIT.

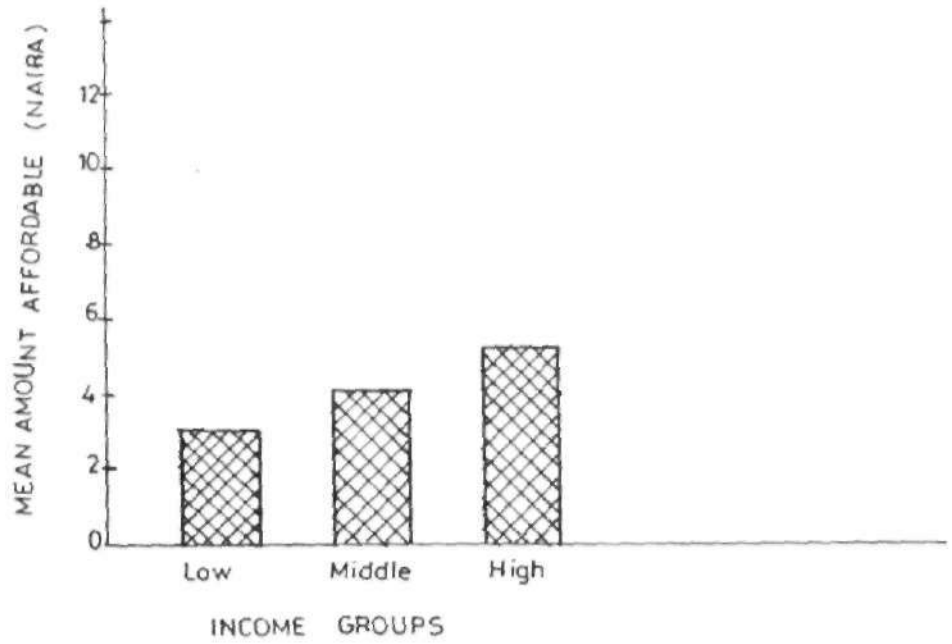



FIG. 5.3 AMOUNT AFFORDABLE PER DROP ON MASS TRANSIT BY THE INCOME GROUPS.

Welforth [1965] on the distributed patterns of residences and workplaces, are given as follows.

[a] PROPOSAL A

This proposal involves the decentralization of residential developments in the workplaces concentrated zones and decentralization of new workplaces in residences concentrated zones as shown in fig. 5.4[a]. In this case, it is believed that trips will originate from more dispersed locations and end in several locations.

[b] PROPOSAL B

This proposal is aimed at locating new residential areas in workplaces concentrated zones and concentrating workplaces in residences concentrated zones [fig.5.4[b]. Worktrip will then originate and
terminate in few locations or zone of conflux.

[c] PROPOSAL C

This proposal involves the centralisation of residences in workplaces concentrated zones and decentralization of workpalces in residences concentrated zones [fig.5.4.c.] In each zone, most worktrips will originate from a few locations but terminate in several locations.

[d] PROPOSAL D

Proposal D. calls for the decentralization of residential developments in work places concentrated

zones and the centralization of workpalces in residences concentrated zones as shown in fig.5.4[d].

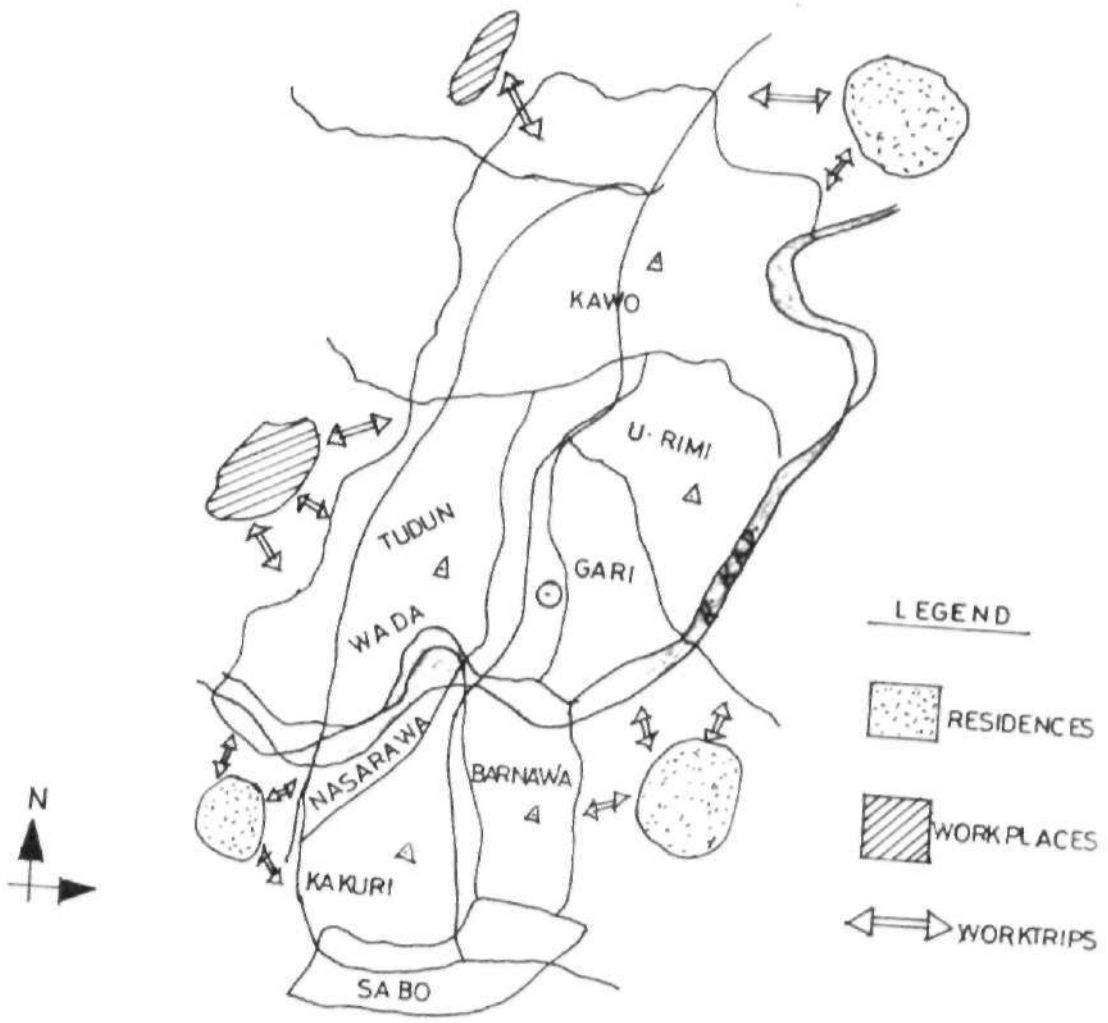
5.2.2. EVALUATION OF THE PROPOSALS

A rudimentary form of the goal achievement matrix technique has been adopted to evaluate the generated proposals. The technique is based on some evaluation criteria which assign weights to criteria considered relevant for the evaluation. A rating scale shown in Table 5.3 is used in assigning scores to the proposals for each criteria.

TABLE 5.3: RATING SCALE FOR EVALUATION OF THE PROPOSALS:

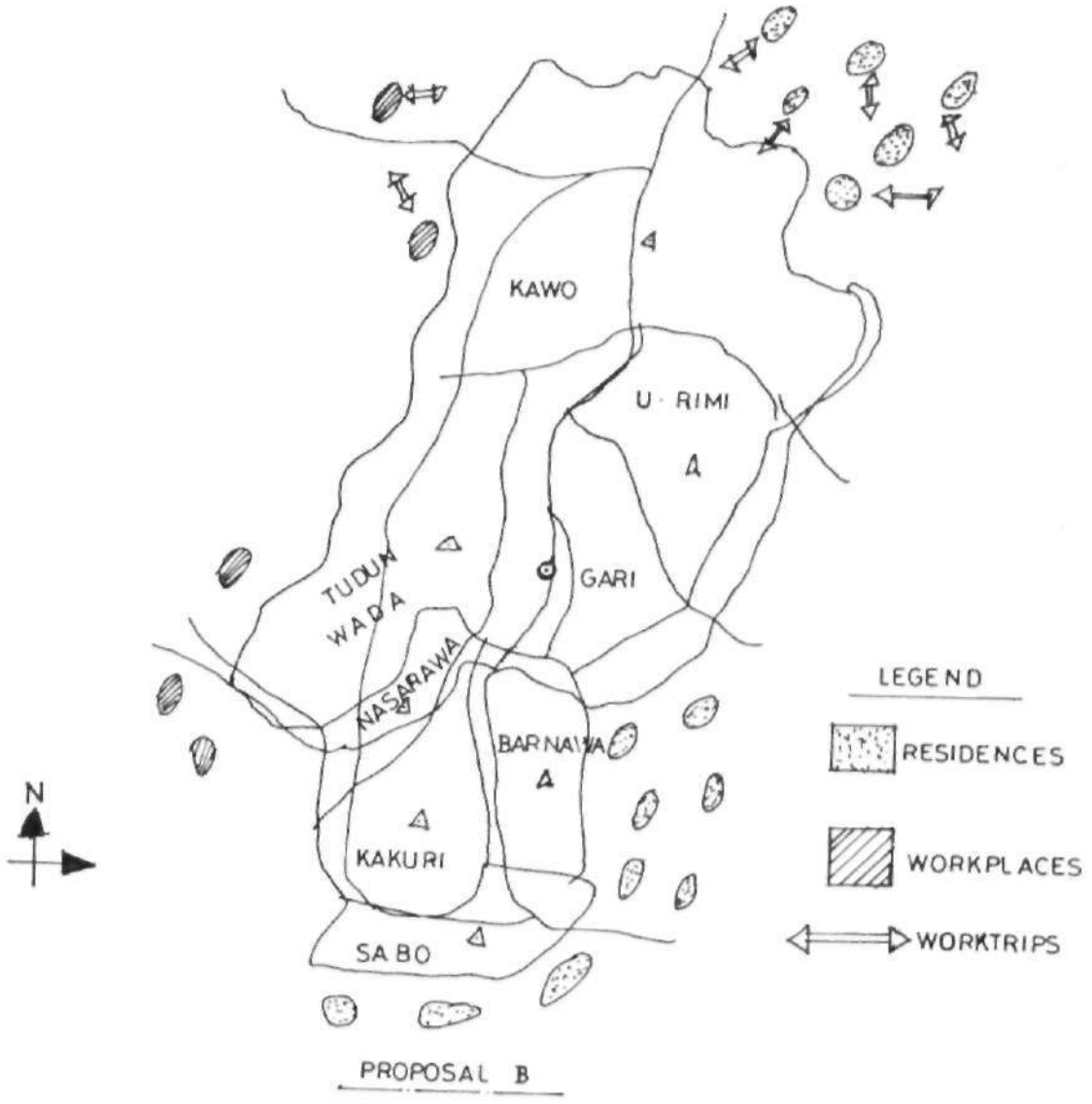
| SCORE | EVALUATION |
|---|---|
| 1 | Very low |
| 2 | low |
| 3 | fair |
| 4 | High |
| 5 | Very high |

The scores are multiplied by the weights of each criteria to give a composite score. The composite scores are then added up to give the total score for proposal. The scores so assigned are summerised in Table 5.4. The indication is that proposal A has the highest score. It is therefore the adopted proposal in distributing future residences and workplaces in Kaduna.

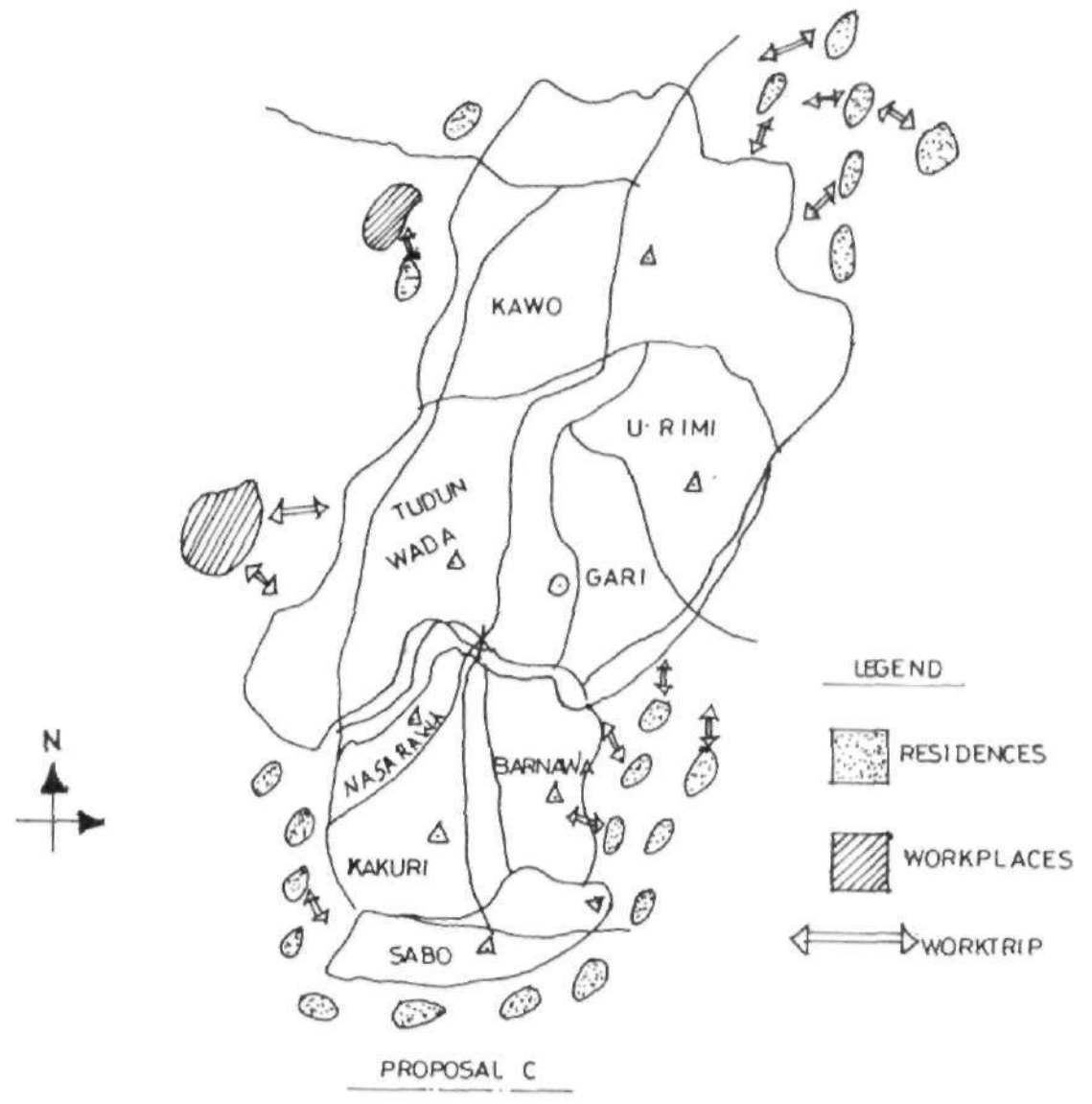



PROPOSAL A

FIG 5·4(a) RESIDENCES CONCENTRATED, WORKPLACES CONCENTRATED.




FIG·5·4 (b) RESIDENCES SCATTERED, WORKPLACES SCATTERED·




PROPOSAL C

FIG· 5·4 (c) RESIDENCES SCATTERED, WORKPLACES CONCENTRATED·

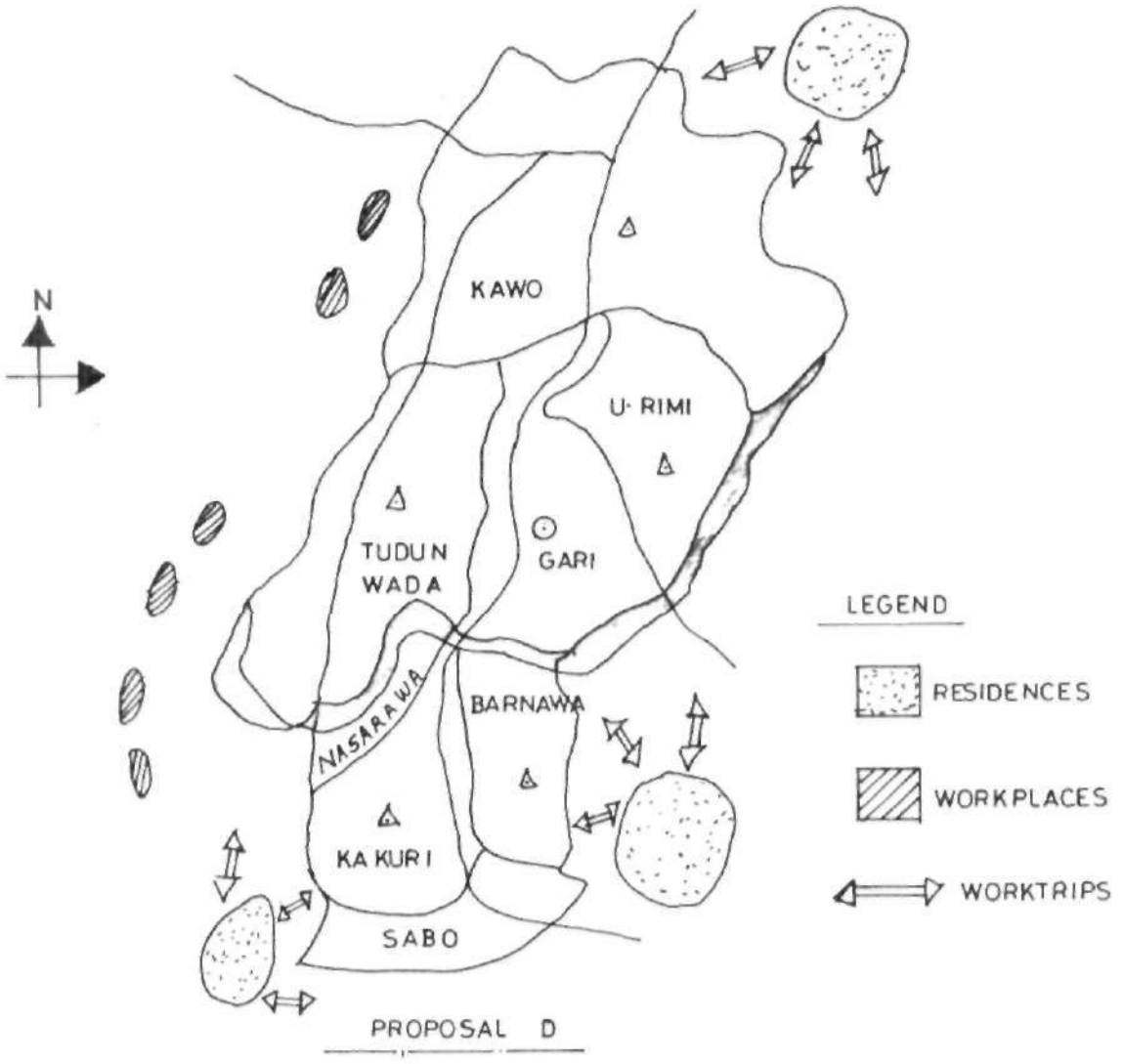



FIG- 5 · 4 (d) RESIDENCES CONCENTRATED, WORKPLACES SCATTERED-

TABLE 5.4: EVALUATION OF ALTERNATIVE PROPOSALS.

| | | PROPOSALS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| EVALUATION CRITERIA | WT | A SC | TOTAL | B SC | TOTAL | C SC | TOTAL | D SC | TOTAL |
| 1. Reducing distances between residences and workplaces. | 4 | 5 | 20 | 1 | 4 | 2 | 8 | 2 | 8 |
| 2. Dispersing worktrip flows. | 4 | 5 | 20 | 1 | 4 | 3 | 12 | 1 | 4 |
| 3. Minimising traffic delay. | 3 | 4 | 12 | 1 | 3 | 3 | 9 | 2 | 6 |
| 4. Minimising travel costs. | 3 | 3 | 9 | 1 | 3 | 2 | 6 | 2 | 6 |
| 5. Efficiency of mass transit system. | 2 | 1 | 2 | 5 | 10 | 2 | 4 | 3 | 6 |
| 6. Minimising inconveniences and strains. | 2 | 5 | 10 | 1 | 2 | 3 | 6 | 2 | 4 |
| 7. Integrating into existing development. | 1 | 5 | 5 | 1 | 1 | 2 | 2 | 3 | 3 |
| GRAND TOTAL | | | 78 | | 21 | | 47 | | 37 |

KEY

WT = WEIGHTS

SC = SCORE

5.2.3. CONTROL OF DEVELOPMENT

As a result of the present economic predicament, more people will have to depend on foot and bicycle for their journey to work. There is therefore the need to curtail the existing trend of Urban sprawl. This is achieved by planning for intensive development so that Kaduna becomes a compact town. This will help to conserve resources on transport development, fuel wastage, wears and tears of vehicles and other infrastructures. With a well developed drainage system, the density of existing development will be increased. Encouragement should be given to high structure development.

5.2.4. STAFF QUARTERS

Employers should provide staff quarters near workplaces for their employees. This will reduce transport cost, traffic delays, traffic volume and enhance easy access to their places of work.

5.2.5 TRAFFIC SEGREGATION: PLANNING FOR PEDESTRIANS AND MOTOR CYCLISTS.

Non-vehicular segregation in Urban centers can lead to high incident of knockdown of pedestrians cyclists and motorcyclists. With increasing number of people making journey to work on foot and motorcycles, it becomes imperative to plan for pedestrians and cyclists. Hence, in the construction of major and minor urban roads, pedestrians and cyclists have to be considered at the same time and attempts made to provide for them. A typical cross section of the major and minor arterials

The use of well labelled street names is also advocted to facilitate easy recognition of the streets thereby improving trffic flow.

5.2.7 CONSTRUCTION OF NEW ROADS

To remove the East-West constraint of flow of traffic, the construction of East-West new roads at suitable locations is advocated.

5.2.8 PUBLIC PARTCIPATION

Public participation is a major tool for enlightening the road users, fboth the pedestrians and driversl on the use of the recommended traffic signals and "zebra" crossings. This could be achieved through the use of electronic media, newspapers and signposts.

## 5.3. CONCLUSION

The characteristics of worktrip in Kaduna metropolis have been evaluated. Worktrip pattern has been found to be influenced by the location of residences with respect to workplaces, the mode of travel and the socio-economic characteristics of the worktrip makers.

It has also been observed that most sampled workers travel between 3 and 10 Km to their workplaces and the majority of them depend on an unorganised public transport system(minibus, taxi, motorcycles, etc.)for their worktrips. The public transport systems are inadequate and are characterised by inadequate route density with overcrowded vehicles.

Also, some routes are segmented thereby making some work trip makers to change mode at least once before getting to thier destination. All of the foregoing have led to such problems as long travel time, high travel cost,inconviviences and strains encountered by worktrip makers in Kaduna metropolis.

For effective worktrip withwin the metropolis, a peripheral city bus service, North-South and East - West routes with minibuses "feeding" these routes have been advocated.

The findings from this study are applicable only to major workplaces (organisations employing a minimum of 100 workers) in both public and private sectors.

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minimum distance approach social
Forces, Vol.45, PP 568 -578.

APPENDIX 1: LIST OF RANDOMLY SELECTED MAJOR WORK PLACES FOR THE STUDY.

| ZONE | DESCRIPTION | MAJOR WORKPLACE |
|---|---|---|
| 1 | SABO AND TELEVISION | NIGERIAN NATIONAL PETROLEUM COMPANY [N.N.P.C.] AND WHITE OIL COMPANY. |
| 2 | KAKURI AND MEKARA | UNITED NIGERIAN TEXTILE COMPANY,[UNTL] PEUGEOT AUTOMOBILE COMPANY [PAN] AND AREWA TEXTILES COMPANY PLC. |
| 3 | BARNAWA | COLLEGE OF ENVIRONMENTAL SERVICES, KADUNA POLYTECHNIC, AND MINISTRY OF LAND AND SURVEY. |
| 4 | GABASAWA [GARI] | KADUNA NORTH L.G. SECRETARIAT [MAGAJIN GARI] AND KADUNA STATE URBAN DEVELOPMENT AUTHORITY. |
| 5 | NASARAWA | FEDERAL MINISTRY OF WORKS TRAINING SCHOOL, KADUNA AND INTERNATIONAL BEER AND BEVERAGES INDUSTRIES [PLC] AND IDEAL FLOUR MILLS [PLC]. |
| 6 | TUDUN WADA AND UNGWAN SANUSI | KADUNA POLYTECHNIC, MAIN CAMPUS,TUDUN WADA GENERAL HOSPITAL AND SCHOOL OF HEALTH TECHNOLOGY. |
| 7 | UNGWAN RIMI AND G.R.A. | COLLEGE OF ADMINISTRATIVE AND BUSINESS STUDIES, KADUNA POLYTECHNIC, NIGERIAN TELECOMMUNICATIONS PLC, [NITEL], KADUNA STATE GOVERNMENT SECRETARIAT AND AHMODU BELLO UNIVERSITY TEACHING HOSPITAL [ABUTH] |
| 8. | KAWO | FEDERAL GOVERNMENT SECRETARIAT [ALL FEDERAL MINISTRIES AND PARASTATALS]. |

APPENDIX II: TRAFFIC SURVEY RESULT ON SOME SELECTED ROADS IN KADUNA, 1994

| ROAD | PER. | BICYCLE | | MOTOR CYCLE | | PRIVATE CAR | | TAXI | | MINI BUS PICK UP | | TRUCK & TRAILER | | BUS | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | UPH | PCU | UPH | PCU | UPH | PCU | UPH | PCU | UPH | PCU | UPH | PCU | UPH | PCU | UPH | PCU |
| GOLF COURSE | M | 14 | 5 | 208 | 156 | 380 | 380 | 226 | 226 | 584 | 1168 | 0 | 0 | 6 | 18 | 1418 | 1953 |
| | A | 18 | 6 | 34 | 26 | 376 | 376 | 138 | 138 | 602 | 1204 | 0 | 0 | 2 | 6 | 1170 | 1756 |
| | E | 14 | 5 | 156 | 117 | 394 | 394 | 156 | 156 | 500 | 1000 | 2 | 6 | 4 | 12 | 1226 | 1690 |
| MALLAM MADDRI | M | 96 | 32 | 1050 | 787 | 218 | 218 | 190 | 190 | 34 | 68 | 12 | 36 | 0 | 0 | 1600 | 1331 |
| | A | 44 | 15 | 566 | 424 | 120 | 120 | 100 | 100 | 16 | 32 | 8 | 24 | 0 | 0 | 854 | 715 |
| | E | 72 | 24 | 656 | 492 | 200 | 200 | 158 | 158 | 50 | 100 | 4 | 12 | 0 | 0 | 1140 | 986 |
| WESTERN BYE-PASS | M | 116 | 38 | 264 | 198 | 610 | 610 | 640 | 640 | 170 | 340 | 203 | 609 | 110 | 330 | 2113 | 2765 |
| | A | 26 | 9 | 94 | 71 | 580 | 580 | 400 | 400 | 106 | 212 | 77 | 231 | 72 | 216 | 1355 | 1719 |
| | E | 34 | 11 | 214 | 161 | 486 | 486 | 420 | 420 | 187 | 374 | 105 | 315 | 180 | 540 | 1626 | 2307 |
| KACHIA | M | 116 | 38 | 332 | 249 | 980 | 980 | 816 | 816 | 482 | 964 | 18 | 54 | 13 | 39 | 2757 | 3140 |
| | A | 28 | 9 | 64 | 48 | 750 | 750 | 640 | 640 | 310 | 620 | 21 | 63 | 4 | 12 | 1817 | 2142 |
| | E | 48 | 16 | 184 | 138 | 730 | 730 | 610 | 610 | 236 | 472 | 11 | 33 | 12 | 36 | 1831 | 2035 |
| AHMADU BELLO | M | 6 | 2 | 100 | 75 | 900 | 900 | 712 | 712 | 560 | 1120 | 25 | 75 | 1 | 3 | 2304 | 2887 |
| | A | 4 | 1 | 138 | 104 | 612 | 612 | 400 | 400 | 418 | 836 | 15 | 45 | 0 | 0 | 1587 | 1998 |
| | E | 4 | 1 | 70 | 53 | 680 | 680 | 440 | 440 | 426 | 852 | 18 | 54 | 0 | 0 | 1638 | 2080 |
| ALI AKILU | M | 18 | 6 | 274 | 206 | 380 | 380 | 166 | 166 | 706 | 1412 | 1 | 3 | 5 | 15 | 1550 | 2188 |
| | A | 14 | 5 | 244 | 183 | 314 | 314 | 208 | 208 | 622 | 1244 | 1 | 3 | 3 | 9 | 1406 | 1966 |
| | E | 2 | 1 | 14 | 11 | 500 | 500 | 400 | 400 | 428 | 856 | 18 | 54 | 5 | 15 | 1367 | 1837 |
| BREWERIES | M | 80 | 26 | 330 | 248 | 180 | 180 | 200 | 200 | 366 | 732 | 38 | 114 | 12 | 36 | 1206 | 1536 |
| | A | 104 | 34 | 306 | 230 | 150 | 150 | 140 | 140 | 320 | 640 | 58 | 174 | 30 | 90 | 1108 | 1458 |
| | E | 96 | 32 | 358 | 269 | 200 | 200 | 140 | 140 | 350 | 700 | 38 | 114 | 16 | 48 | 1198 | 1503 |
| TEXTILE | M | 80 | 26 | 340 | 255 | 164 | 164 | 120 | 120 | 220 | 440 | 50 | 150 | 10 | 30 | 984 | 1185 |
| | A | 66 | 22 | 210 | 158 | 188 | 188 | 142 | 142 | 120 | 240 | 44 | 132 | 14 | 42 | 784 | 924 |
| | E | 42 | 14 | 170 | 128 | 176 | 176 | 124 | 124 | 114 | 228 | 60 | 180 | 6 | 18 | 692 | 868 |

APPENDIX II : TRAFFIC SURVEY RESULT ON SOME SELECTED ROADS IN KADUNA, 1994

| ROAD | PER* | BICYCLE | | MOTOR CYCLE | | PRIVATE CAR | | TAXI | | MINI BUS PICK UP | | TRUCK & TANKER | | BUS | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | UPH | PCU | UPH | PCU | UPH | PCU | UPH | PCU | UPH | PCU | UPH | PCU | UPH | PCU | UPH | PCU |
| POLYTECHNIC | M | 80 | 26 | 1420 | 1065 | 600 | 600 | 296 | 296 | 346 | 692 | 18 | 54 | 42 | 126 | 2802 | 2859 |
| | A | 160 | 35 | 562 | 422 | 390 | 390 | 310 | 310 | 460 | 920 | 34 | 102 | 24 | 72 | 1886 | 2251 |
| | E | 64 | 21 | 286 | 215 | 416 | 416 | 300 | 300 | 560 | 1120 | 26 | 78 | 26 | 78 | 1678 | 2228 |
| GAMAGIRA | M | 2 | 1 | 280 | 210 | 198 | 198 | 184 | 184 | 306 | 612 | 8 | 24 | 22 | 66 | 1000 | 1295 |
| | A | 28 | 9 | 180 | 135 | 200 | 200 | 136 | 136 | 280 | 560 | 8 | 24 | 22 | 66 | 854 | 1130 |
| | E | 36 | 12 | 234 | 176 | 190 | 190 | 188 | 188 | 278 | 556 | 2 | 6 | 2 | 6 | 930 | 1134 |
| NEW BIDA | M | 28 | 9 | 334 | 251 | 480 | 480 | 140 | 140 | 32 | 64 | 4 | 12 | 2 | 6 | 1020 | 962 |
| | A | 68 | 22 | 446 | 335 | 200 | 200 | 166 | 166 | 38 | 76 | 0 | 0 | 10 | 30 | 918 | 829 |
| | E | 74 | 24 | 266 | 200 | 360 | 360 | 218 | 218 | 40 | 80 | 4 | 12 | 0 | 0 | 962 | 894 |
| ALIYU MAKAMU | M | 114 | 38 | 236 | 177 | 400 | 400 | 360 | 360 | 270 | 540 | 54 | 162 | 36 | 108 | 1470 | 1785 |
| | A | 82 | 27 | 156 | 117 | 412 | 412 | 180 | 180 | 186 | 372 | 58 | 174 | 32 | 96 | 1106 | 1378 |
| | E | 30 | 10 | 252 | 189 | 190 | 190 | 186 | 186 | 282 | 564 | 36 | 108 | 32 | 96 | 1008 | 1247 |
| CONSTITUTION | M | 40 | 13 | 150 | 113 | 280 | 280 | 200 | 200 | 100 | 200 | 16 | 48 | 14 | 42 | 520 | 896 |
| | A | 4 | 1 | 210 | 158 | 210 | 210 | 190 | 190 | 90 | 180 | 28 | 84 | 24 | 72 | 756 | 895 |
| | E | 6 | 2 | 180 | 135 | 200 | 200 | 160 | 160 | 40 | 80 | 40 | 120 | 10 | 30 | 636 | 727 |
| INDEPENDENCE | M | 2 | 1 | 204 | 153 | 390 | 390 | 200 | 200 | 160 | 320 | 10 | 30 | 4 | 12 | 970 | 1106 |
| | A | 6 | 2 | 136 | 102 | 370 | 370 | 170 | 170 | 150 | 300 | 16 | 48 | 14 | 42 | 862 | 1034 |
| | E | 14 | 5 | 90 | 68 | 400 | 400 | 260 | 260 | 130 | 260 | 30 | 90 | 10 | 30 | 934 | 1113 |
| YAKUBU GOWON | M | 26 | 9 | 460 | 345 | 282 | 282 | 220 | 220 | 298 | 596 | 2 | 6 | 12 | 36 | 1300 | 1494 |
| | A | 10 | 2 | 484 | 363 | 320 | 320 | 210 | 210 | 250 | 500 | 2 | 6 | 0 | 0 | 1276 | 1402 |
| | E | 70 | 23 | 440 | 330 | 284 | 284 | 214 | 214 | 304 | 608 | 4 | 12 | 0 | 0 | 1316 | 1471 |
| BROADCASTING | M | 76 | 25 | 498 | 378 | 292 | 292 | 200 | 200 | 324 | 648 | 4 | 12 | 0 | 0 | 1394 | 1555 |
| | A | 32 | 11 | 258 | 194 | 120 | 120 | 104 | 104 | 289 | 568 | 2 | 6 | 0 | 0 | 800 | 1003 |
| | E | 36 | 12 | 166 | 125 | 144 | 144 | 82 | 82 | 214 | 428 | 12 | 36 | 0 | 0 | 654 | 827 |

KEY:

M = Morning Peak (7.00 a.m. - 8.00 am)

A = Afternoon Peak (3.15 PM - 4.15 PM)

E = Evening Peak (6.00 pm - 7.00 pm)

PCU = Passenger Car Unit

VPH = Vehicle per Hour.

PER = Periods

SOURCE: FIELD WORK, 1994.

APPENDIX III: QUESTIONNAIRE USED IN THE STUDY.

QUESTIONNAIRE ADMINISTRATION

Department of Civil Engineering,
Ahmadu Bello University,
Zaria.

15th January, 1994.

Dear Respondent,

I am a Postgraduate student of the above University carrying out a research on Functional Transportation Engineering for effective worktrip in Kaduna Metropolis.

The aim of the research is to examine the problem of journey to work in Kaduna Urban area with a view to making planning proposals for achieving an effective transportation system. This is to make your journey to work speedy, direct and with minimum inconveniences encountered.

Please, tick [ ] or mark (X) in an appropriate checking space or write out your answer clearly, where the questions do not contain alternatives. You are however, assured that whatever information you give in this questionnaire will be kept confidential and used strictly for academic purpose.

This is why there is no provision for you to write your name on this questionnaire. In view of this your unbiased response is highly solicited for.

Thanks.

Yours faithfully

DANJUMA ALHASSAN

SECTION [A]: INFORMATION ON RESIDENCE/EMPLOYMENT

1. Home address [street name and number] e.g. 10 Jos Road, Kakuri,

Kaduna:.....
.....

2. How long have you lived at your present home address ? (i) 0 - 3yrs [ ], (ii) 3 - 5yrs [ ], (iii) 6 - 10yrs [ ], (iv) More than 10yrs [ ].

3. Do you own or rent the house you are living in now ?
(i) Own [ ], (ii) Rent [ ]

4. Place of work: -
.....
.....

5. Occupation:(i) Civil Servant ? [ ],(ii) Business ? [ ],(iii) Industrial worker ? [ ],(iv) Others ? [ ]

6. Why have you chosen to live in your present place of residence ? (i) Affordable rent [ ],(ii) near place of work [ ], (iii) No alternative place [ ], (iv] Near children/dependant's School [ ], (v) Live with husband/relative/family house [ ].

7. Where would you have wished to live if you were given a choice ? (i) where there is low rent [ ], (ii) Close to work place [ ], (iii) Close to children/dependant's school [ ], (iv) Close to market/recreational area [ ], (v) Close to place of worship [ ].

8 What is the rent paid for your house per Month ?

.....

9. Type of house ? (i) Thatched [ ], (ii) Flat [ ], [iii] Rooming house [ ], (iv) Duplex [ ].

SECTION B: INFORMATION ON YOUR JOURNEY TO WORK

1. What time do you always leave home for work ?....

2. What time do you return from work ?.....

3. Do you own a vehicle ? Yes [ ] No [ ]

4. If yes what type of vehicle ?
(i) Private Car [ ], (ii) Bicycle [ ], (iii) Motor cycle [ ], (iv) Tractor truck [ ], (v) Mini bus [ ],(vi) Taxi [ ].

5. If no, How much is your fare to work by public

transport ? .....

6. How many minutes do you spend in/on the vehicle to come to work every working day ? (i) Less than 5 minutes [ ], (ii) 5 to 10 minutes [ ], (iii) 11 to 15 minutes [ ], (iv) 16 - 20minutes [ ], (v) 21 - 25 minutes [ ], (vi) 26 - 30 minutes [ ], (vii) 31-35 minutes [ ], (viii) More than 35 minutes [ ].

7. Estimate the time you spend getting to the bus stop or taxi bording point, waiting for the bus or taxi and getting to work place after leaving the bus or taxi. (i) Less than 5 mins. [ ], (ii) 5-10mins [ ], (iii) 11-15mins [ ], (iv) 16-20mins.[ ], (v) 21-25mins [ ],(vi) 26-30mins [ ], (vii) 31 -35mins [ ], (viii) more than 35mins [ ] (ix) I don't know [ ]

8. If you come by public transport (bus or taxi), how many times do you have to change means of transport before reaching your work place ? (i) None [ ], (ii) One [ ], (iii) Two [ ] (iv) three [ ]

9. If you come to work by other means estimate the time spend out of/off the vehicle used. (i) Less than 10 mins [ ], (ii) 10 -15mins [ ], (iii) 16-20mins [ ] (iv) 21 - 25mins [ ], (v) 26-30mins [ ],(vi) 31-35mins [ ], (vii) more than 35 mine [ ] (viii) not applicable [ ]

10. Is the method you used to come to work today your usual means of transport to work ? (i) Yes [ ], (ii) No [ ]

11. If your answer is no, which is your usual means of going to work ? (i) Bus [ ], (ii) Private Car passenger [ ], (iii) Taxi [ ], (iv) Motorcycle [ ] (v) Bicycle [ ], (vi) Walk [ ].

12. If you come to work by public transport, which of the following is most inconvenient about coming to work by public transport ? (i) Too far to wait for bus or taxi [ ], (ii) not being certain of a seat on bus [ ], (iii) Too far to work to and from the bus stop [ ], (iv) No shelter at the bus stop [ ] (v) Having to change buses or taxi [ ], (vi) Please, state other problems you face in getting to your work place by public transport.

(a).....

(b).....

(c).....

13. If a well organised mass transit system is introduced will you use it as a means of transport to work (i) Yes [ ], (ii) No [ ].

SECTION C: INFORMATION ON SOCIO-ECONOMIC CHARACTERISTICS

1. What is your age ? (i) Under 20 years [ ], (ii) 21-39 years [ ], (iii) 50-59 years [ ], (iv) above 60 years [ ],

2. How many people are there in your household ? (i) One [ ], (ii) Two [ ], (iii) Three [ ], (iv) Four [ ], (v) Five [ ], (vi) more than five [ ]

3 How many cars are owned by your household ? (i) None [ ] (ii) One [ ], (iii) Two [ ], (iv) Three [ ], (v) More than three [ ].

4. What is your religion ? (i) Traditional [ ], (ii) Christianity [ ], (iii) Islam [ ],(iv) Others [ ].

5. Please, estimate your personal monthly income before tax. (i) N750 - N1000 [ ], (ii) N1001 - N1500 [ ], (iii) N1501 - N2000 [ ], (iv) N2001 - N2500 [ ], (v) N2501 - N3000 [ ], (vi) N3001 - N3500 [ ], (vii) N3501 - N4000 [ ] (viii) More than N4000 [ ]

6. Considering your monthly income, how much can you afford for mass transit system per drop ?----------