# PLANNING PROPOSAL FOR EFFICIENT INTRA-CITY VEHICULAR FLOW IN JOS

*BY*

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**DECEMBER, 1999**

# DECLARATION

I, TIJANI NASIRU OLAWALE, hereby declare that this thesis is an original work written by me based on field investigations. It has not been presented elsewhere for a higher Degree Award, and all sources of information quoted are specifically acknowledge by use of references.

Sign

15/1/2000
Date

# CERTIFICATION

This is to certify that the thesis "PLANNING PROPOSAL FOR EFFICIENT INTRA-CITY VEHICULAR FLOW IN JOS" submitted by TIJANI NASIRU OLAWALE, meets the requirements for the Award of the Master of Science Degree of the Ahmadu Bello University Zaria, is an original work based on field investigations that has been read approved by.

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# DEDICATION

To my father, Mr. TIJAN ISOLA, for his love for education and inspiration

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# ABSTRACT

**The Jos Metropolis is not free from the hurdles of mobility such as inadequate transportation system, high fare structure, poor road characteristics. accidents and congestion. The time wasted in the course of undertaking a trip within activity centres does not only result to economic loss at work but also reduces the time that could be spent in shopping, recreation and other activities.**

**The aim of this study is to make recommendations for achieving an efficient transportation system in Jos Urban Area.**

**The primary data collected include volumetric traffic counts on the major roads as well as inter-zonal movements. The secondary sources of data collected include the Jos Master Plan, Government Statistical Records. Maps. Published and Unpublished Materials.**

**The main transportation problems identifies are poor road network connectivity and absence of mass transit. Others are traffic delays on major roads ar peak periods, inefficient transportation system, poor traffic management scheme and relatively high transport fares, where in the problems are felt much more by the low income class.**

**The study therefore concludes that an effective transportation system in Jos urban area, demands the adoption of an efficient mass transit system.**

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# CHAPTER ONE

## 1.0. INTRODUCTION

The intensity of urban land uses in Nigeria can be traced to the establishment of administrative, political, social, economic, business or commercial and educational institutions immediately before and after independence in 1960. These have spelt very rapid development in the urban centres of the country.

Onokerhoraye and Omuta (1986) identified two processes of urban land-use development. These are intensification and outward expansion processes. Intensification process is an outcome of pre-colonial pattern of land-use coupled with socio-economic changes and rapid growth of some cities like Jos after the establishment of colonial rule. Mabogunje (1968) also classified this intensification process into two, the filling up of pre-colonial open spaces which is being done by building social infrastructures such as, post office, library, court, schools, etc. and the intensification of residential housing units which he called "Growth by Fission". The outward growth or spread of the built up parts of the cities is a feature of both pre-colonial and colonial cities.

One of the crucial factors responsible for the socio-economic changes in the urban centres and which led to the development of complex land-use in Nigeria cities was transportation. The complex urban morphology is more evident in the spatial distribution of land uses as industrial, recreational residential, commercial, educational and public land-uses, etc. The spatial arrangement of these activities has led to the observable spatial imbalance of desire and fulfillment. This spatial imbalance is an importance



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factor in urban movement pattern. It is therefore, not surprising that transport is seen as a factor of spatial integration that keeps the cities activities together (Ojekunle, 1994).

The role of transportation cannot be over-emphasised in cities. It is both a factor of their development at the same time as being a major factor of their sustenance. In recognition of this fact, Pederson has asserted that cities are creatures of transportation. Chapin (1976) also argued along the same line that transportation is essentially a service which enables people, firms and various other entities to carry on activities at sites selected for these purposes in separate locations in cities. In the same vein, Filani (1978) also argued that socio-economic development of any society, urban centres inclusive, depends largely on the nature and structure of the transportation, he further argued that transportation provides the arteries through which the economic life stream of society flows.

It is the recognition of the complex relationship between land-uses and transportation as well as its crucial role in the urban activities that has drawn the attention of scholars over the years to conduct researches on the structure and pattern of urban land-uses and how they affect urban travel pattern.

## 1.1 Statement of Research Problem

It has been observed that the trip generating capacity of the individual is a function of his space preference, his location within the overall space economy and the relative ease with which he may move from place to place within the system. That is, the level and pattern of trip generated or attracted depend, to a larger extent, on the degree of spatial accessibility of an area.

However, it is pertinent to expect that the degree of road network connectivity and bus accessibility explain to a larger extent the level of trip generation or attraction by an area. Previous studies focus on socio-economic factors as a basis for urban transportation planning, e.g. Ayeni (1974), Chiroma (1992) and Ojekunle (1994) among others.

The results and emphases of such studies give indication that the socio-economic variables are the major or only factors that explain the pattern of trip generation or attraction. The impact of spatial accessibility as it influences the level of trip generation or attraction are not understood. This gap needs to be filled through studies that would focus on investigating the importance of the road network and bus accessibility to the level and pattern of urban traffic generation and attraction by the urban land use. These factors, road network and bus accessibility are the bases for the planning of land use and provision of urban transportation facilities.

## 1.2 Aims

Central to this study is the exploration of the relevance of the road network connectivity and bus accessibility in urban areas to the level and pattern of trip generation as a basis for solving traffic problems using Jos as a case study.

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## 1.3 Objectives

The above aim shall be achieved through the following objectives:

1. To review the concepts and approaches for planning vehicular circulation in an urban area.
2. To examine the concept of trip generation, the factors influencing it, and its role in the urban transportation planning process.
3. To determine the relative contribution of road network connectivity and bus accessibility to the level and pattern of trip generated and attracted in Jos.

4. To analyse the nature of the traffic problems in Jos in relation to road network connectivity and bus accessibility.
5. To make planning proposals to ease vehicular flow in Jos.

## 1.4 Hypothesis to be Tested

In order to achieve the above stated objectives, the following hypothesis shall be tested.

**H0:** There is no significant relationship between spatial accessibility and level of trip generated or attracted in Jos.

**HA:** There is significant relationship between spatial accessibility and level of trip generated or attracted in Jos.

## 1.5 Scope and Limitation

The study covers Jos urban area with specific attention to factors that hinder effective circulation.

A study of this nature should normally consider both vehicular and pedestrian circulation. However, in this study, greater emphasis shall be given to vehicular circulation. Pedestrian travel has not received the analytical attention of motorized transport because it seldom represents the critical element of demand for space on most streets in our cities.

## 1.6 Definition of Terms

***Trip:*** Is a single journey made by an individual between two points by a specified mode of travel and for a defined purpose (Hobbs, 1979). Thus, any one-way person movement by a mechanised mode of transport having two ends - an origin (starting point) and a destination (terminating point) is considered a trip. Trips are further classified as home-based and non-

home-based trips, trip production and attraction, and trip purposes as defined below.

***Home-based trips:***

Are those having one end of the trip either the origin or the destination at the home. These constitute the majority of urban person trips.

***Non-home-based trips:***

are all other trips that neither originate nor terminate at home.

***Trip generation:***

Describes the volume of trips and their purpose that are either produced by or attracted to a traffic zone in relation to the urban area. Some transport analysts further sub-divided trip generation into trip productions and trip attractions (this study does not make this distinction - both attractions and productions of trips are analysed broadly as trip generation) as defined below.

***Trip productions:***

Are usually associated with residential areas where production points are either the home end of any home-based-trip, or the beginning of a non-home-based trip.

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*Mass Transit*:

is taken in this study to mean any vehicle that capable of conveying at least minimum of ten passengers at a time. e.g. mini-bus.

***Trip attractions:***

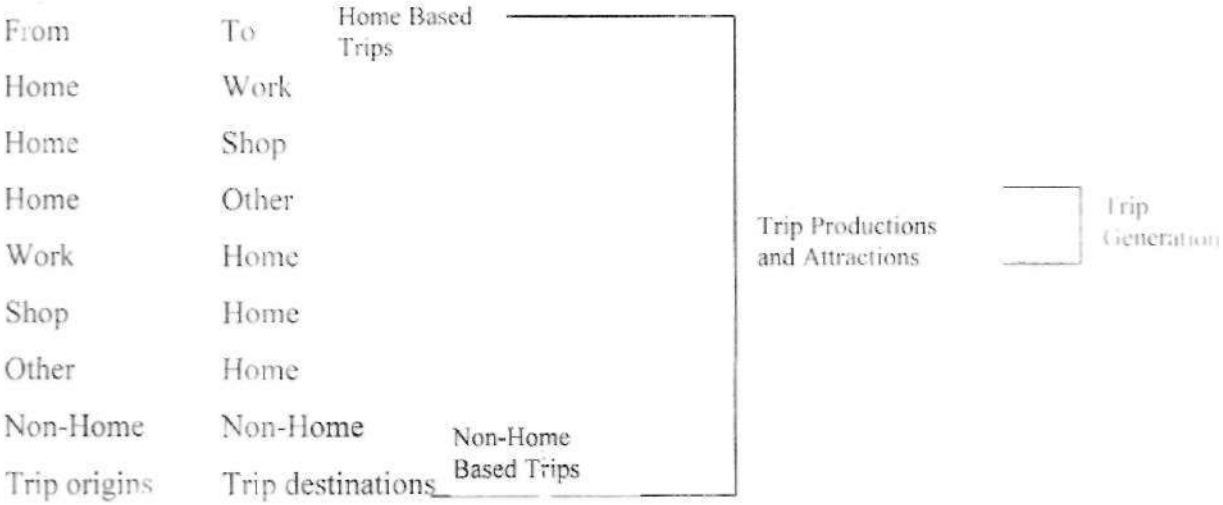
Are identified as trips generated by work or other purposes (other than residential). They are the non-home end of a home-based-trip or the destination of a non-home-based trip.

***Trip purpose:***

Trips are classified by purpose in order to simplify the complexity in travel pattern. A typical classification include work, business, school, shopping, social/recreational/sports, hospital and other trips.

Sources are the American Municipal Association (1964), Bruton (1975), Morlock (1978), and Hobbs (1979).

The above cluster of terms are all inter-related and can be simplified into a general framework for trip generation as shown in Figure 1.1. below.




*Source:* Chiroma (1992)

*Fig. 1.1.* Trip Generation and Related Concepts

## 1.7 Methodology For Research

The study methodology can be examined through:

a. Data collection. i.e. surveys of traffic, parking inter-section study, questionnaire administrations, etc.

b. Technique of data analysis.

### 1.7.1 Traffic Surveys

In order to determine the level of congestion on some major roads, especially at the peak periods, manual traffic counts were carried out on recognized congested routes. Six roads were selected The counting took place from 6.30 am to 6.30 pm. This was done for three consecutive days. The average of the figures was used as the main data.

### 1.7.2 Running And Journey Speed And Delay Studies

In order to measure traffic congestion/delays, a survey was also carried out to determine running and stopping time of vehicles.

For this survey, the registration number method was used whereby observers with sychronised watches were stationed at both ends of the road section being studied. Each vehicle that passed was recorded. Later, the analysis showed the amount of time spent in making trip between the two observation points.

Delay studies were conducted using the *moving observer technique*. It was carried out with the use of a survey log. A *car was started* at a test station, with the aid of a stop watch for all locations times of stopping and time spent were noted as well as the reasons for the stops/delays. Two types of delays were looked for: Fixed delays which result



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from regulation on road usage such as traffic controls (manual or electronic, roundabouts, inter-section, railway crossings, etc.

1.7.3 Intersection Survey

Inter-sections which are likely to cause congestion on the entire route if undue delay occurs were selected for survey. This is to establish cause of delay at junctions and to find out types of control.

1.7.4 Questionnaire Administration

Questionnaire was structured and designed to elicit all the information required on the socio-economic characteristics of the trip makers and their trip patterns. The questionnaire was basically divided into three sections, these are information about the respondents, information about trips and information about problems encountered during the time of trip making.

To administer the questionnaire, a systematic sampling of one out of 100 houses was visited while for the CBD/Industry important working places/shops were visited at random. A total of 920 questionnaires were administered representing about 1% of the total household in Jos. But 900 were returned and after removing the defective ones, only 875 questionnaire (which is approximately 95% of the total questionnaire have been analysed and used in this report.

1.7.5 Secondary Data

The secondary sources of data collection for the study included land use maps, Jos Master Plan, Government Statistical Records, Unpublished and Published Materials.

1.7.6 Land Use Survey

1. To identify uses of major influence and the traffic generated or attracted.
2. To identify large buildings or major land uses with possible parking problems.
3. To identify new projects and functions in specific corridors.
4. To identify the nature of activities carried on in various functional use areas.

1.7.7 Techniques Of Data Analysis

Descriptive and structural tools are employed in the analysis of data. For example, the mean, percentage, graph and charts were used to described the socio-economic variables and the pattern of trips of the respondents. Products moment correlation technique is also used to test the relationship between the volume of traffic generated and spatial accessibility.

For the purpose of estimating and predicting trip generation, multiple regression model is used. The detail of these techniques are discussed in the appropriate sections where they have been used.

# CHAPTER TWO

## LITERATURE REVIEW

### 2.1. INTRODUCTION

The main objective of this is to summarize existing literature and point out problem areas that merit further research. According to Seltiz et al (1964), this study rest on early ones and provides the basis for future ones, the more the link that can be established between a given study or a body of theory, the greater the probable contribution. It is from this derivation that this chapter generally deals with the review of literature, relevant to this study.

### 2.1. FACTORS INFLUENCING TRIP GENERATION AND ITS ROLE IN THE URBAN TRANSPORTATION PROCESS

One of the earliest studies that attempted a theoretical explanation for the basis for movement is the interaction model developed by Ullman (1956). Ullman attempted a simplification of factors of movement into three vis: Complementary, intervening opportunity and transferability.

The concept of complementary states that interaction between two or more places is a function of specific inter-dependence. For two or more places to interact, there must be specific demand in one place and a supply in another.

The intervening opportunity explains the emergence of new alternative sources of supply which may be closer to the area of demand than the initial area of supply. Such area of supply, therefore movement between the two initial complementary areas will stop or at least reduce. Hence, intervening opportunity is often described as a spatial

sponge that absorbs all the potential interaction between two or more complementary places.

The third concept is transferability, this focuses on the factor of movement. The cost factor of movement refers to the cost paid in overcoming the friction of distance (time money and discomfort) the long the distance the higher the cost. Therefore, people make less contact with far distant locations especially if the interaction is not justifiable economically.

However, Lowe and Moryades (1975) noted that it is possible for a region to satisfy the complimentary, intervening opportunity and transferability and yet not satisfy the basis of movement. They also noted that factors such as, political boundary, economic system, culture and religion are constraints to movement. Hurst (1974), also identified several other factors that can also influence movement between places, among these are, culture, race, religion, life style, belief, personal utility, etc.

albert, Adams and Goulds (1972) argued that the basis for trip making rests on the locational structure of different but complimentary activities, their type, location, intensity of land-use, geographic pattern of various population units, and their social and economic characteristics from one residential area to another.

Another importance concept to this study is the concept of accessibility and reliability. The two terms are used as measures of the quality of transport services provided in a given place. The two concepts are operationally related, this is because sometimes, the reliability of the road network which may also depend to some extent on the locational arrangement of land use among after factors.

Thus, accessibility is a measure of ease at which intending passengers can get vehicle and at the same time be dropped at points close to their destination. According to Forbe (1964), accessibility is defined as the ease of getting to a place. Therefore, accessibility can be measured physically (Okafor, 1979). According to Mrakpor (1986), social distance are determined by socio-economic status or class, these are in turn affected by education, income or the combination of the two. The economic distance is measured in terms of cost such as time and cost of transport. The physical distance is measured in terms of linear distance from generating zone to the attracting zone.

It is therefore, possible to use the concept of accessibility to determine the relationship between the capacity of the road to accommodate vehicles and the number of vehicle seeking to enter it.

The other related concept is reliability which is often considered in the study of transport and land use interaction. According to Robinson (1975), reliability implies the ability of the transport service to perform efficiently while strictly. Adhering to the time schedule. Due to the fact that, there exists difference in the spatial distribution or location of land use activities within the city, this creates origin and destination of movement by individual commuters at any point in time. Therefore, the two concepts are very important in the analysis of the trip distribution and pattern of trip generated and attracted by any land use.

Smith (1970), in his own contribution has identified three factors of movement namely, volume of flow, structure of flow and effectiveness of flow. To him, the volume of flow is concerned with making diagnostic statement about the magnitude of flow within two areas. For example, the quantity of the number of people or thing to move,

while the structure deals with the identification of general locational characteristics of origins and destinations. The efficiency of flow relates to the descriptive and normative routings of flow since transport network does not always link two areas through the shortest possible distance.

Land use system according to Mitchell and Rapkin (1952) and Hurst (1976) is very important as it may be a trip generator and attractor. This is so because both residential and non-residential land uses attract different types and volumes of movement in cities be it in terms of journeys to work, schools, shopping, recreational and social trips. Population on the other hand, as was viewed by Onakomaiya and Smith (1968) and Filani (1977) is a vital determinant of trip generation and attraction. For example, Filani (1977) used population as a surrogate measure of size in a study on air traffic in the Unites States of America.

### 2.1.2. Land Use and Transport Interactions

Cities are made up of specific parts such as various land uses which are located in different urban spaces. These land use have different capacity to generated and attract both vehicular and non-vehicular traffic within the city systems, this consequently creates spatial imbalance which can only be bridged by transport.

The importance attached to land use and transport systems has drawn attention all over the world. It has been discovered that land use influences the development of transport system and at the same time, transport system has been found to also influence the development of land use. The dynamic nature of land use activities and transport system indicates that the medium of interaction between them is traffic. The need for

efficient and effective traffic flow is based on the fact that movement or traffic flow in city determines the level of socio-economic interaction and activities of urban dwellers.

It is in recognition of this fact that scholars over the years have focused their studies on land use and transport interactions. According to Roberts (1982), he argued that the fundamental assumption is that movement demands are directly related to the distribution and intensity of land uses and that these can be accurately predicted. Thus, planning information according to him is a vital input to any land use transport study.

Losch (1954) argues that changes in the network structure has an impact on the social and economic development of the cities and at the same time influence the pattern of land use development in such cities as well as their accessibility.

However, the relationship between transport and land use development is a subject of considerable theoretical interest and of practical importance to transport geographers. There are three schools of thought on the relationship between transport and development (whether land use, economic, social, regional or urban development). The first school of thought argues that transport pre-dates development of land use while the second opinion argues that transport post-dates development. The third school of thought which is becoming more acceptable by the scholars in the one that argues that transport is concomitant to any development (i.e. land use development in case of urban development). However, whatever view is held, one thing that is noted is that transport in urban centres is a crucial factor of land use development.

It is in the light of this that Nelson (1969) argued that transport not only ties the urban structure together, but also profoundly affects the arrangement and function of elements in the structure of the city. He drew empirical examples from America where he



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carried out his study, that there are centripetal forces that affect the nature and structure of land uses in cities. The centrifugal forces according to Nelson (1969), mean the forces that attract the people to migrate or move from the city centre to the periphery and centripetal force is the one that tends to hold certain functions in the central zone and also attracts other activities from periphery to the centre of the city.

Dickon (1974) also in his study of urban transportation was primarily concerned with the separation of work place and residential location. The long distance of separation between the two different land-use was possible by the development of cheap and rapid transport system.

Ayeni (1983), recognised urban transportation as affecting links between people and activities, and people. The system is characterised by a set of origins and destinations as well as trip types. Ogunjumo (1986) while discussing the trip generation in Ile-Ife observed that peak-hour urban transport problem has its major cause in the land use pattern that predate the location of the new work places and the motor vehicles. He further stressed that the peak hour problem can be attributed to the problem of land use and socio-economic characteristics of the people.

Damina (1982) working on intra-urban transportation in Jos revealed that dual peak at the time of going and returning from work have been due to the arrangement of land use in the city. Olayemi (1977) also revealed in his study of Lagos that the relationship between transport facilities and land use in Lagos is not harmonious. According to him, location of work places, schools, and residences are not in harmony with the transport system. He cited the case of Lagos Island where most work places were located and Lagos mainland where most workers reside. The location arrangement

of work places and residence causes a lot of traffic problems between mainland and Lagos Island during the working days of the week.

Adeniji (1985) also examined the existing relationship between transport infrastructures and services in Nigeria. He identified some factors that influence pattern of urban movement. these include size, density and types of land use, distance of journey, income, household characteristics, etc. All these factors are identified to influence the pattern of movement in cities. Asuquo (1981) also argues that the location and characteristics of transport network affect the ease of travel between locations and hence in some situations largely determine the value and types to which a land is put into use.

It is quite evident that land use pattern in cities is interrelated to the physical characteristics of the transportation network and this is the reason why the uses of land determine the location of various activities. Therefore, attempt to meet various socio-economic needs of the city dwellers requires people and goods to move or travel between these locations which results into traffic flow through the elements of the transportation modes within the cities.

### 2.1.3. Land Use and Traffic Generation

It has been identified that land use types and intensity are the causes of trip generation in the city. For instance, most empirical studies i.e. Kolade (1982), Adeshina (1995), etc. show that residential land use in cities generates substantially the volume of traffic flow while other land uses have different capacities to generate and attract traffic. Therefore, the spatial arrangement of land uses and the level of traffic they generate are very important in planning and management of land uses and the level of traffic they generate are very important in planning and management of traffic in cities. This is why



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many scholars have been greatly concerned by the pattern and the characteristics of trip generation of various land uses in cities.

Olayemi (1977) made a critical study of the characteristics of work trips in Lagos and identified six main urban trip patterns in the city, these are journey to work places, school trips, business trips, social trips and job seekers trip. He discovered that trip to places of work and schools dominated the characteristics in Lagos. Bondada (1982) in three American Cities identified that the C. B. D. accounted for the highest concentration of day time population and variety of intra-city bus district trips depend on certain factors, such as location of residence, the number and the composition of workers, travel mode and their level of services and as well as relative location of different activities within the cities.

Similarly, certain conditions like urban oriented activities, volume of daily travel generated by office building and the dominance of office floor space prompted the Greater London Council (G. L. C.) to undertake a study of traffic generation by using a sample of fifteen office buildings with 91 firms in London. All trips, including visitor trips, non work trips, service vehicles vehicle journeys and use of parking space were all monitored along with the journey to work in and out during the day. A similar study was also undertaken in sub-urban London using ten office buildings, the major conclusion derived from the studies relates to the degree of variability in the trip generation and characteristics of the office buildings according to their locations. These factors were identified to influence other modal split of travel to the office and was responsible for a spatial condition of the work trips recorded in both studies.

Ayeni (1983), further revealed in his study that patterns of interaction in cities possess both spatial and temporal dimensions. The spatial component deals with variations in trips attracted and generated in different parts of the city, while the temporal dimension examines the flow of traffic over a time period say a day or a week.

Arnold (1985), studied trip generation at special sites along virginal highway. His objective was to find out the rate of trip generation by eleven land uses. These are, drive-two services, convenience market, condominium, drive in bank, high rise apartment, planned unit development, mobile home park, day care centre, church, post office and sub-urban motel. He found out that restaurants attracts more traffic during the lunch hours. He went further to assert that traffic increases around the super hours particularly after 6.00 pm.

In analysing the traffic flow at market places, Arnold asserted that it coincides with the morning and afternoon rush hours. Week day peak traffic at bank generally occurs around lunch. At planned unit development, according to him, traffic patterns are governed by the predominant land use, i.e. residential and those found at the residential areas.

Chorley (1980) also conducted a study on the trip generation pattern of students of Bolton Institute of technology. His aims was to find out their movement pattern from their residential homes to the college. He also considered the full and part time students with the aim of getting information about their residential areas, journey distance and mode of daily travel and cost of transport to the institute. He found out that the factors affecting the modal choice are the distance between the place of residence and the institution and also the availability of vehicles to the full time students is also a factor.



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Lawton (1963) studied industrial land use and residential area with the aim of explaining trip generation pattern in the urban area. He found that new types of industries which required large land use area or sea frontages necessarily generate longer trips as they were not established near residential area.

Eliot Hurst (1970) also carried out a study on the structure of land use in an urban area, he found out that urban land use structure imposes certain pattern of movement relationship. This was discovered in a study of non-residential land use which he conducted in Perith, Scotland. When he attempted to analyse some of the land use traffic generation relationships, the result of his analysis indicates that there is a functional relationship between land use and the volume of urban travel and it appears that location and intensity of the land use are also important variables in such a relationship.

Daniel and Warnes (1983) worked on urban transport and travel pattern, the aim was to find out the purpose, distance and frequently of trips generated by residential land use to various work places. They asserted that distances, purpose and frequency of journeys in cities are functional of the spatial distribution of the residential land use in relation to other land uses in cities and that residential land use is majorly a traffic generating zone in cities.

Starkie (1968) in his study of traffic generation by a group of manufacturing industries in Medway Town in London discovered that the relationship between trip generation and the size of manufacturing plants is non-linear in nature. He was able to discover that variation in trip generation by manufacturing industries to the city centre was not due to inherent effect of location, but in an industrial structure that varies in respect of both types and size of plant between different districts within the city.



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Therefore, it was confirmed by his findings that both types and size of plants are important determinants of the intensity of commercial vehicle trip generation.

Wooton and Pick (1967), classify the factors affecting trip generation by household into two groups, these they called internal influences which include: income, car ownership,, family structure (particularly number in employment) and family size. External influences are: rail and bus, accessibility, particularly the latter, because former is primarily a factor affecting trip generation for the journey to work.

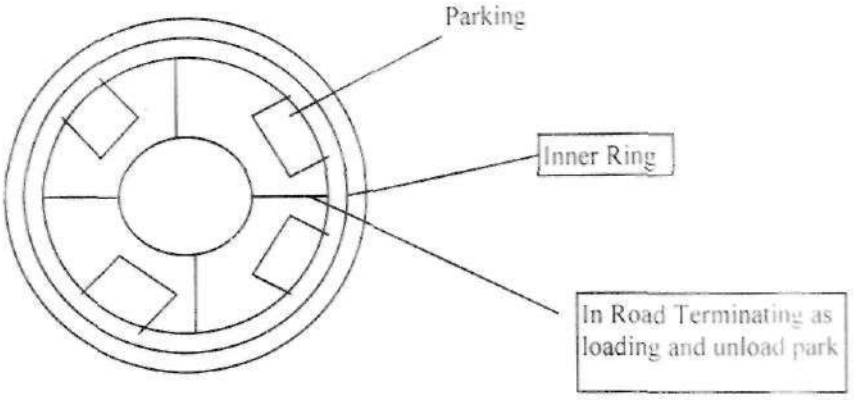
Malthy (1970) also worked on trip generated by industrial plants, he considered that the number of cars used for the journey to work decreased as plant size increased. Car occupancy rates to a group of small steel manufacturing plants averaged 1.16 persons, compared with 1.36 persons for a group of large steel manufacturing plants in Sheffield. The occupancy rates of journey from work to home were also higher than for home to work trips, so that the demand for public transport is likely to be lower at the end of a shift than at the start. It will also vary according to whether normal day-working or shift-working is involved. For the former, Malty found that for travel to work, bus trips represented some 69% of the total for 15 steel manufacturing plants and for travel from work the figure decreased to 55%. For shift-workers, particularly the 0.600 - 14.00 hours shift, public transport was less used because of the greater inconveniences of using services at that time of the day.

## 2.2.0. APPROACHES FOR PLANNING VEHICULAR CIRCULATION IN URBAN AREA

### 2.2.1. Precinct Development

This is a design for city center which also attempt to relief traffic flow within it. The whole principle revolved round the separation of through traffic from intra-city traffic while the centre is left for pedestrian circulation. this normally achieve through inner ring route created through the centre so that traffic which is not bound for the centre can easily drive on.

Fig. 2.1 DIAGRAM




Adapted from Alker Trippin (1942) and cited by Dung (1999)

The concept has been useful in design of city centres. Feddrick Gilber (town design) attempts to seek to discover the function and inherent character of the different building groups and incorporate these groups in the plan as a series of precinct (areas not disturbed) around which traffic is made to circulate.

The value of this arrangement is that it ease movement and provide parking for shoppers. The main set back of the principle is that it is too expensive especially if we are to do it as renewal programmed since it will involve demolition of property of which

the value cannot be compared with creation of ring road. Though in the long term, it may pay back. Besides, the high land value make the provision of parking space difficult. The question that always result is that who is expected to provide the so called parking lot. Is it public or private? Etc.

Similarly, another pattern of vehicular circulation pattern are those that developed over time without formal planning. Lachene (1968) provide five explanatory factors for such type of pattern:

- A grid of footpath emerges.
- Some settlement begin to develop.
- New technology begins to emerged, e.g. Rail-lines.
- Roads are formally constructed to link Rail-lines
- A deliberate government policy comes up by constructing more roads.

However, because it is not formally planned, the road network are always poorly connected and tend to cause heavy traffic delay in the city. The road network of Jos and other traditional cities in Nigeria are in this pattern.

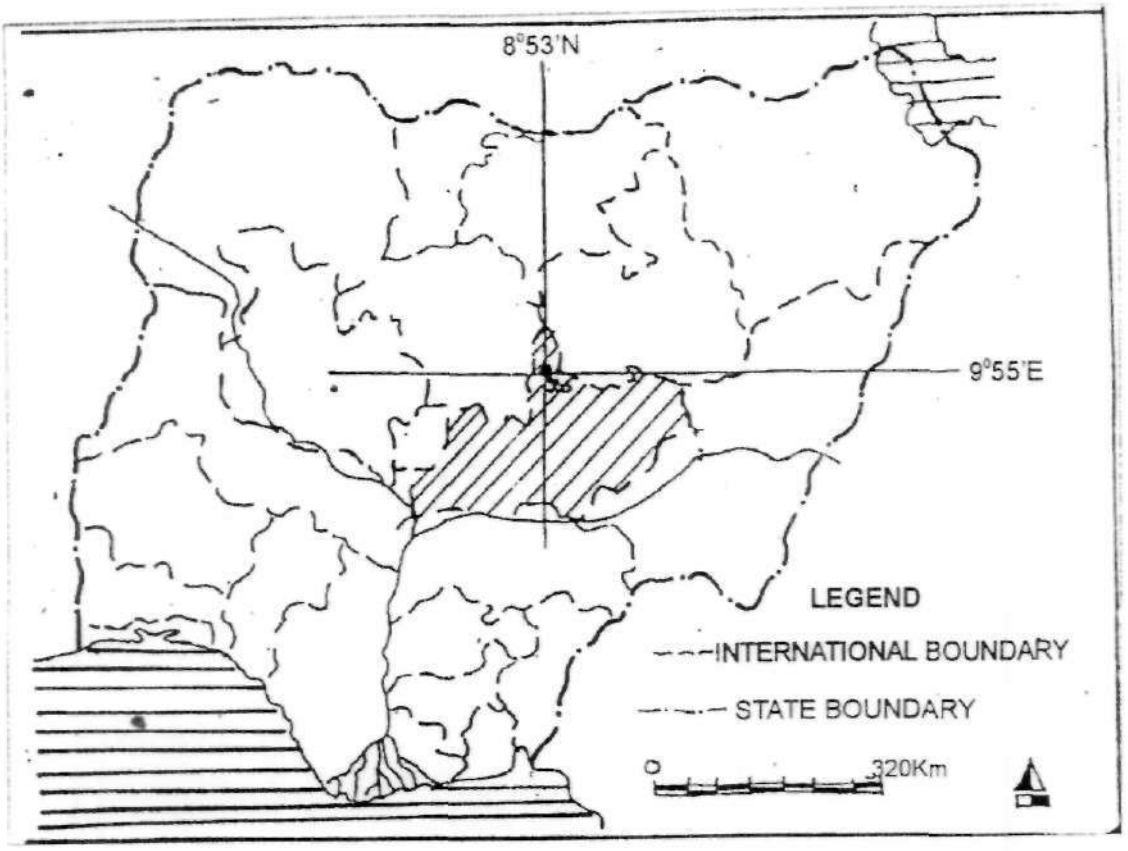
# CHAPTER THREE

## CHARACTERISTICS OF LAND USE AND TRANSPORTATION IN JOS

### 3.1.0. INTRODUCTION

Jos, the administrative capital of Plateau State is located on latitude 90 55N and longitude 80 53 E. It is bounded to the north by Naraguta village, to the south by Bukuru, to the east by Gwom and Rayfield and to the west by the Jos Bukuru express road. The town is surrounded by the shere hills (1,766m) to the north east and the Rukuba hills (1,275m) the west. To the south just beyond Bukuru are the Kuru hills (1.43m) and Ngyel river. Other striking features about Jos and its environ includes granitic inselbergs, numerous creeks, ponds, reservoirs and moulds of earth which are relics of mining activities. Jos urban area will be loosely defined as that part of land and extent of town which has been demarcated and gazetted in accordance to the provisions of the land use constitute what is known as Greater Jos (see figure 3.1. and 3.2.) for the location of Jos and Greater Jos.

Jos has acquired over the years the status of administrative, industrial, commercial, educational and tourist centre. The scattered concentration of wide variety of these urban functions has meant that increasing traffic is inevitable between these various parts of the city, for the movement of people, information, goods and services. The nature of the topography is such that road development is expensive to undertake, expand and to maintain. The recent influx of people to Jos, mostly, from the neigbouring states experiencing wars, i.e. religions, tribal, etc. has increased both the rate of population and development, which has now become difficult to handle. This has in no




LOCATION OF JOS IN NIGERIA

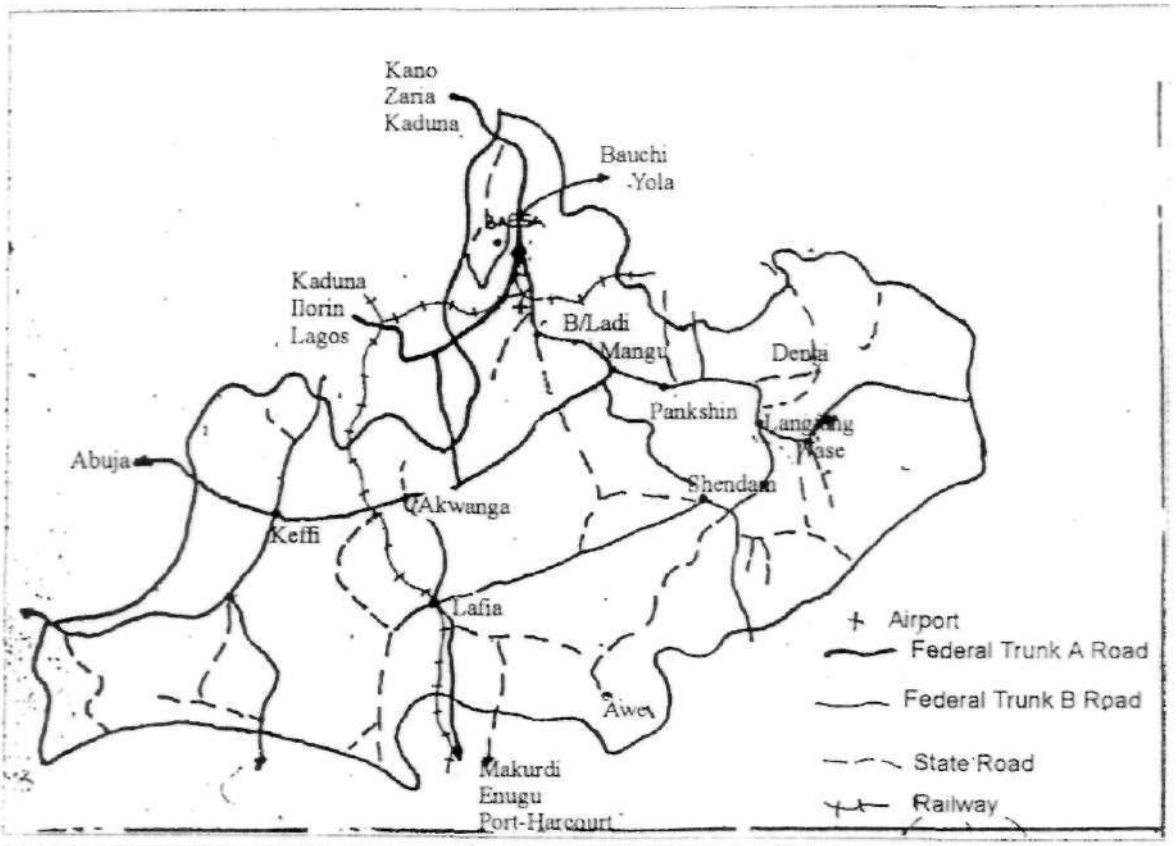
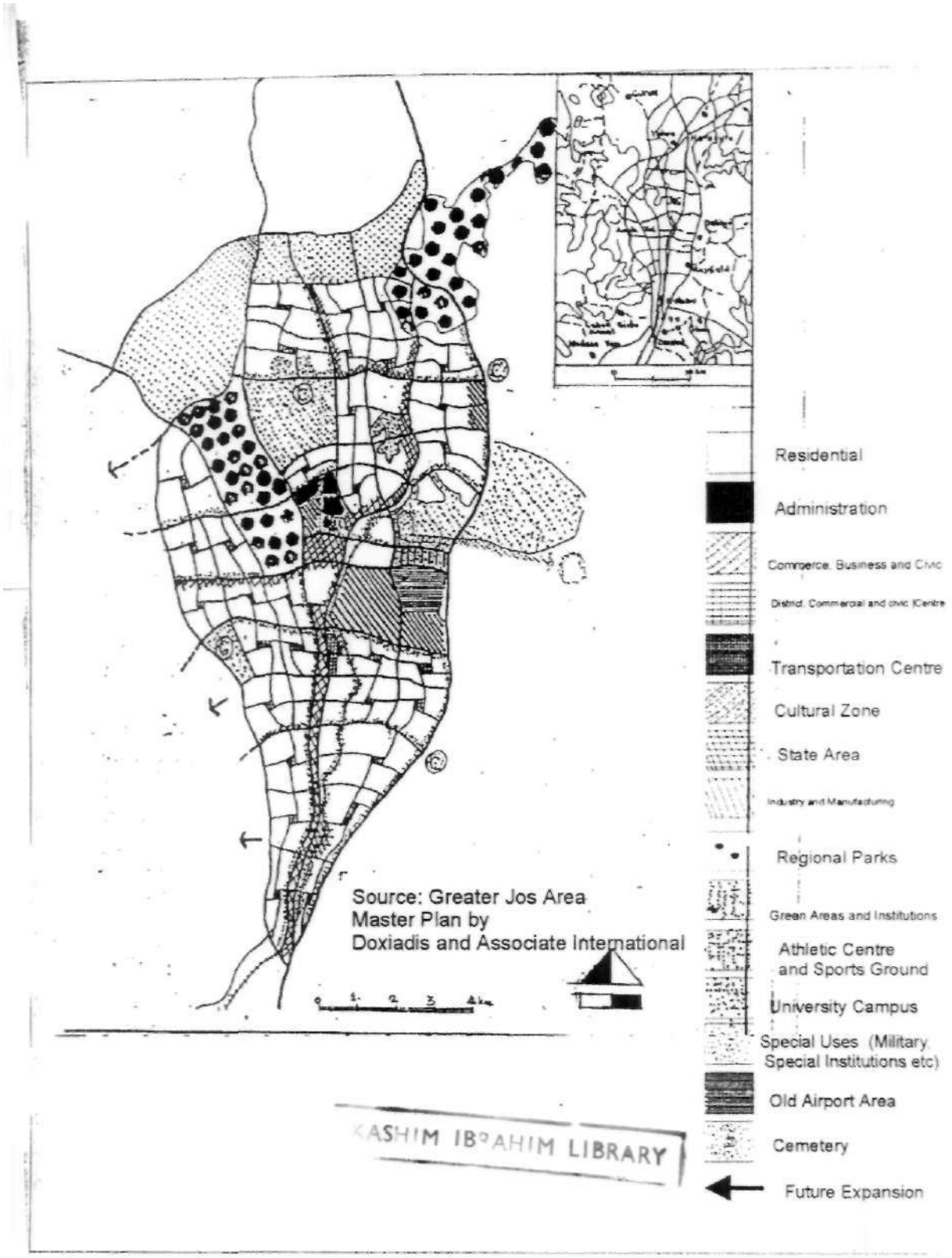



Fig. 3.1: JOS WITHIN ITS IMMEDIATE REGION

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M.Sc. URP '99




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Fig. 3.21: JOS METROPOLITAN AREA-GREATER JOS

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MS.c. URP

small measure induced traffic congestion as there is usually little provision for vehicular movement. In (1963), Jos had 105,000 people. By (1991), the population had reached 622.873 and approximately, 735,140 people in (1997).

### 3.2.0. Urban Land Use Pattern and Transportation in Jos

The distribution of the various land use over the Jos Urban area does not seem to follow any organised pattern. The pattern can best be described as mixed with major uses - commercial, residential and industrial being located throughout the city. However, certain concentrations of predominant uses can be identified in certain areas. They are not necessarily located organically in relation to the other functions in the city. The existing land use pattern and their proportions is shwon in figure 3.3. and table 3.4. respectively. The most important observation that can be made with respect to the distribution of the land use are as follows:

#### 3.2.1. Residential Land Use

The residential area dominates the urban land uses pattern of Jos, (fig. 3.3). The study area is divided into three main residential zones: The old residential district, the new and government residential area. The old residential district comprises of the built-up parts of the pre-colonial period as well as those built-up during the early years of the British colonial administration. The area has an intricate network of narrow and winding streets with no apparent urban plan. These areas include Bukuru, Nassarawa, etc.

The new residential areas comprise the built-up parts of the city of the colonial period and thereafter. The most remarkable improvement and expansion of the new residential area took place after Jos became a state capital in 1976.

Most parts of the area have accessible road network. The area is inhabited by people of different socio-economic status as well as ethnic groups but most of them belong to the middle income group. The government residential area (G.R.A.) forms the nucleus of the high status residential neighbourhood. Each house in the area is designated to accommodate one family and its has most modern facilities required in a standard dwelling. The population density within it is lowest in the town. Generally, it is between 20 and 50 persons per hectare (Keku 1991).

3.2.2. Commercial Land Use

Most of the commercial and business activities is concentrated in the central business district of Jos. This forms actually the centre of gravity of the city. The central business district lies in the central eastern part of the city, and is therefore easily accessible from the surrounding new development. Apart from the market being next to the General hospital. (now JUTH), the C. B. D. can roughly be defined by the following streets:

a. To the east by Hospital road.

b. To the west by Rwang Pam street.

c. To the north by Kasuwan Dere street.

d. To the south by Barracks street.

The above boundary have been chosen as the nearest clear demarcation of the C. B. D. The central activities of this business area extends further north and south along Beach street, Bauchi road, Bukuru road, Zaria bye-pass and 'Massalachin Jumma'a road. Other retailing establishments are located throughout the urban fabric, dovetailing so

closely with residential concentrations that, indeed, most residences and commercial establishments occupy the same physical space.

3.2.4. Industrial Land Use

Industrial activities in metropolitan Jos are broken down into rough categories in order to discuss their locations. The first is composed of large scale establishments employing from roughly 500 persons and above. The second category comprises those establishments of less than 500 workers (500 is the criteria according to 1979 industrial decree).

The Anglo Jos industrial area is the most significant conglomeration of large scale manufacturing plants. It is located to the west of Anglo-Jos, and to the southern edge of the land opposite Dadin Kowa. Industries here include the Fibre Factory, Household Products, Nasco Biscuits, Jos International Breweries, Jos Rolling Mills, etc.

The small scale industries such as bakeries, repairs, black smithing, furniture works, block-making, etc. are generally located in the mixed land uses throughout the metropolis, but largely within residential and commercial land uses.

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3.2.5. Public and Semi-Public Land Use

Most of the federal and state establishments are found in the new area on the periphery of Jos. The area devoted to administrative land use is clearly demarcated by Yakubu Gowon Way, Federal Secretariat Junction and the General Hospital.

The Local Government Secretariat is located near the city core adjacent to Bauchi Road. The vicinity is largely inhabited by the relative low income class.

The University of Jos Teaching Hospital (JUTH) Jos temporary site has now assume the status of a permanent site as a result of improved infrastructure. It is sited at



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the far end of Bauchi road. The senior staff quarters are on the opposite location. The permanent site of the University is sited along the Jos-Kaduna road where there is the student and phase two of senior staff quarters with many structures already realized.

Within the same vicinity, there is a building complex housing Faculty of Arts and Social Science. At the outlet of the city on the same stretch of road leading to Bauchi, Abuja hostels respectively. The Plateau State Polytechnic also has campuses scattered all over Jos, notably, there is the centre for continuing education near National Library, Jos Branch, along Yakubu Gowon Way, the mechanical engineering site situated on the way to Vom Veterinary Research Centre and the Nigerian Institute of Policy and Strategic Studies (NIPSS), Kuru. The permanent site of the polytechnic is situated at Barkin-Ladi about 15km from the city centre. Most primary and post primary institutions are clustered around the Kaduna outlet.

The Military Barracks is sited at Rukuba about ten kilometers north-east of Jos. The Girls Airforce School is located opposite the West African Examination Council building along the express way towards the Bukuru area.

All these activity centres generate or attract traffic. As Lord Buchanan correctly observed in his seminar book "Traffic in Towns" (1963), traffic is a function of land uses.

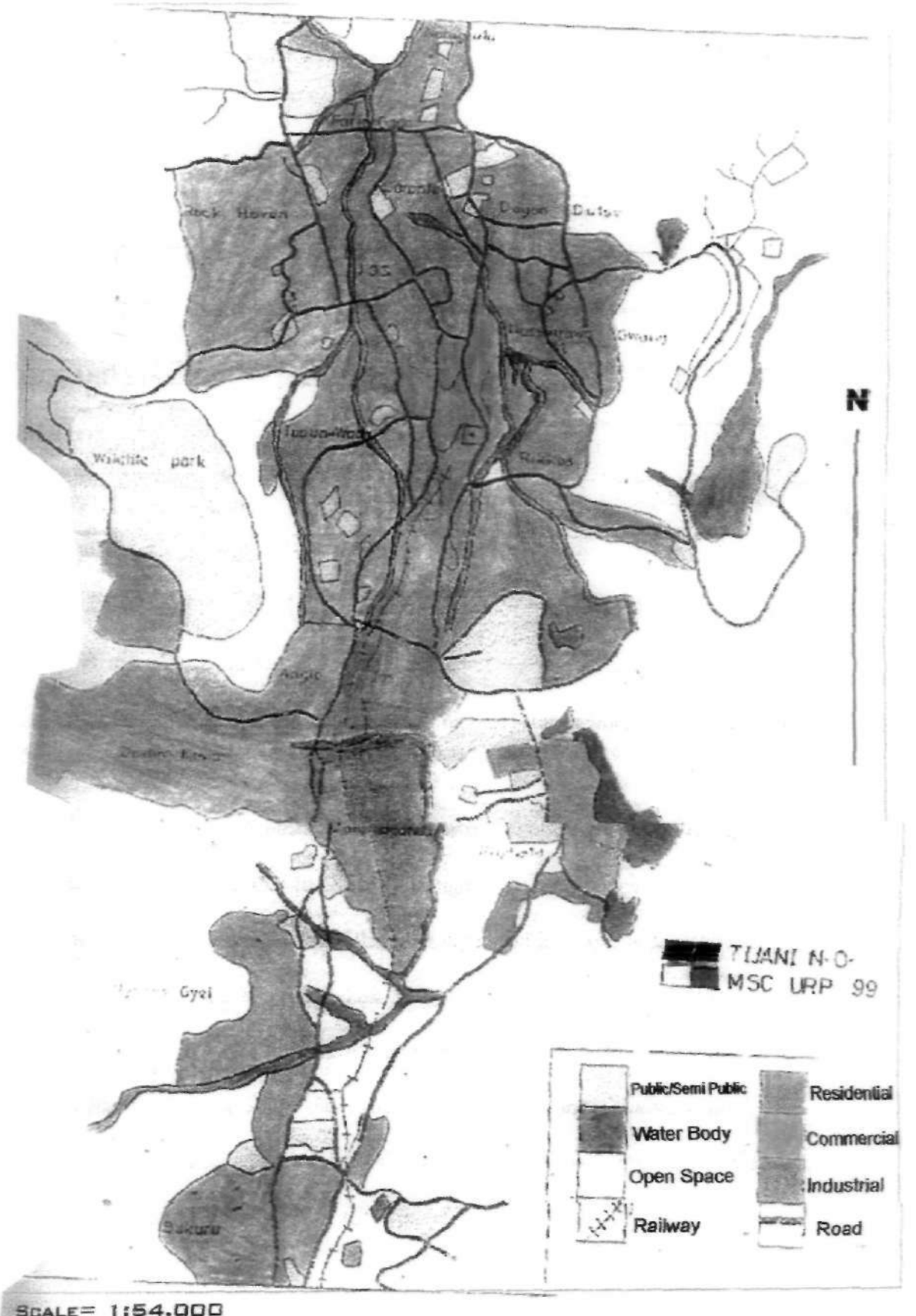



Fig. 3.3: EXISTING LAND-USE MAP OF JOS- BUKURU METROPOLIS

*Table 3.1. Breakdown of Land use of the Jos Master Plan*

| LAND USES | AREA IN $KM^2$ | PERCENTAGE |
|---|---|---|
| RESIDENTIAL | 80.7 | 53.5 |
| COMMERCIAL | 4.9 | 3.2 |
| INDUSTRIAL | 5.8 | 3.8 |
| PUBLIC/SEMI PUBLIC | 14 | 9.3 |
| PARKS AND PLAY FIELDS | 18.7 | 12.4 |
| ROADS AND STREETS | 12 | 7.9 |
| OTHER USES | 14.9 | 9.9 |
| Σ | 151 | 100 |

*Source:* Author Field Survey, 1998.

As may be seen in Table 3.1, the overall land area covered by the master plan is 1512 km for manufacturing, railways, university campus, special uses requiring large expanses of land, such as athletic centre, areas reserved for regional parks, abattoir, unforeseen special uses, etc.

Similarly, like many other cities in industrialized countries, Jos has an urban transportation infrastructure that has initially designed for largely non-motorized travel. Only a small percentage - about 7.9% of the city's urbanized land area is devoted to roads. This figure is similar to the 7% in Bangkok, 9% in Shanghai and 11% in Calcutta; and is much lower than the 20% - 25% in most European cities (Qing, 1979). Furthermore, the population density of Jos is among the highest in the country, and the urban centre is the most densely populated area in the city. Consequently, the road network has a small capacity but is intensively used. Even at the current level of motorization, the portion of

the road network inside the central district has virtually no surplus capacity. Most of the streets are narrow. The average width of the streets inside the central district is only 7.5 metres. Because motor vehicles must share the narrow roads with bicycles, and motorcycles, they are usually confined to a single lane in each direction and cannot pass one another. Under this circumstances, as Keku (1991) observes, any minor accident can halt the traffic.

### 3.3.0. ANALYSIS OF ROAD NETWORK CONNECTIVITY AND NODE ACCESSIBILITY

The main road network in the metropolitan area of Jos (fig.3.4) was abstracted into a set of nodes (points) and edges (links) connecting the nodes (fig.3.5). Based on this, all pairs of relationships between the nodes were enumerated. The information derived was used in constructing a set of graph theoretical indices as illustrated in Table 3.2. There are 109 edges (e) and 65 nodes (v) in the network. The connectivity values thus derived for the road network using the Beta (β) and Alpha (α) indices have equally been illustrated in Table 3.2.

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*Table 3.2: Connectivity Values of the Road Network of Jos*

| Index of Computation | Index Formular and Application | Connectivity Value |
|---|---|---|
| Beta (β) | $\frac{e}{v} = \frac{109}{65}$ | 1.68 |
| Alpha (α) | $\frac{e-v+1}{2v-5} = \frac{109-65+1}{2(65)-5}$ | 0.36 |

The above (β) is indicative of the average number of links leading in and out of a node; this is approximately 2, as seen in the table. This means that every node on the

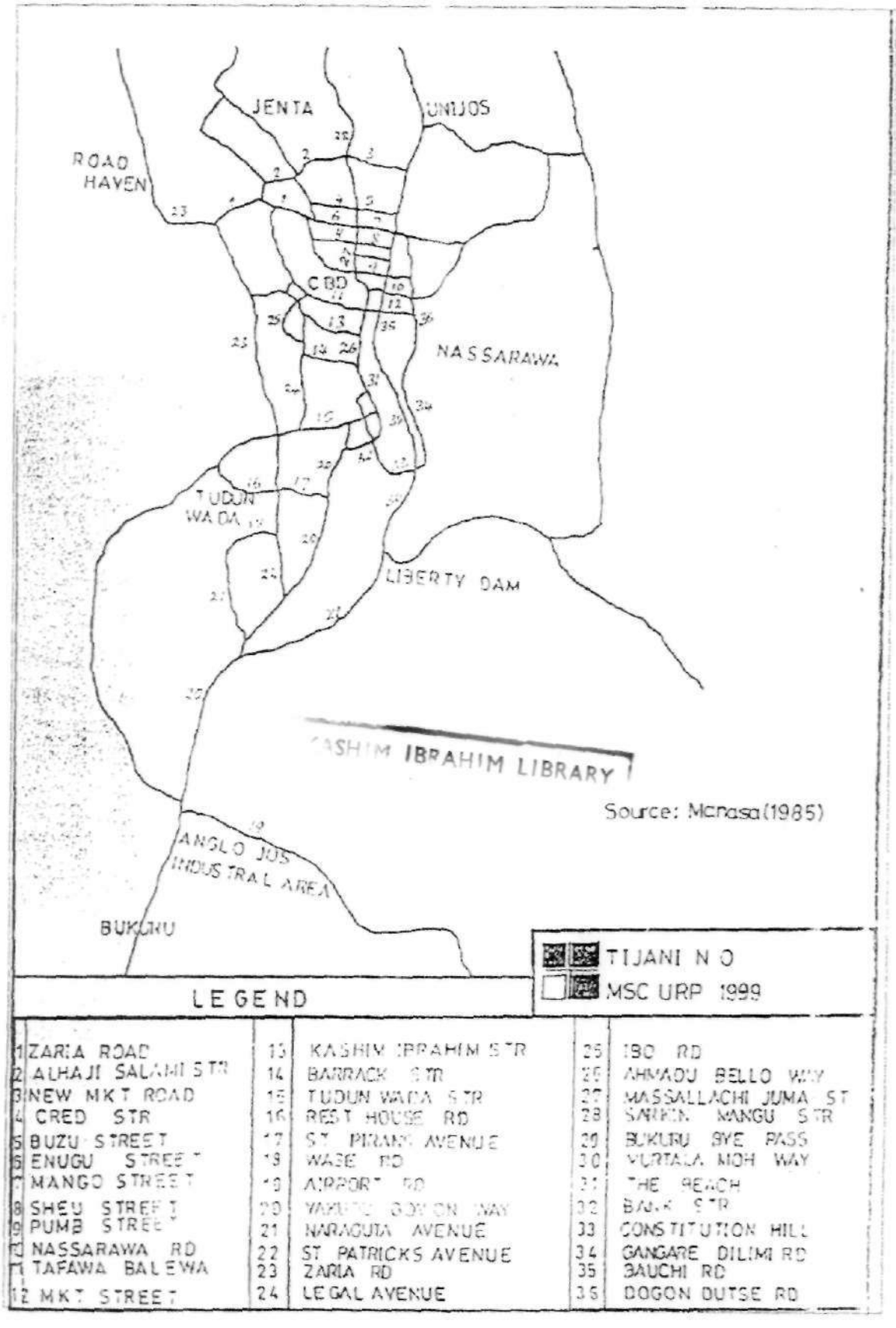
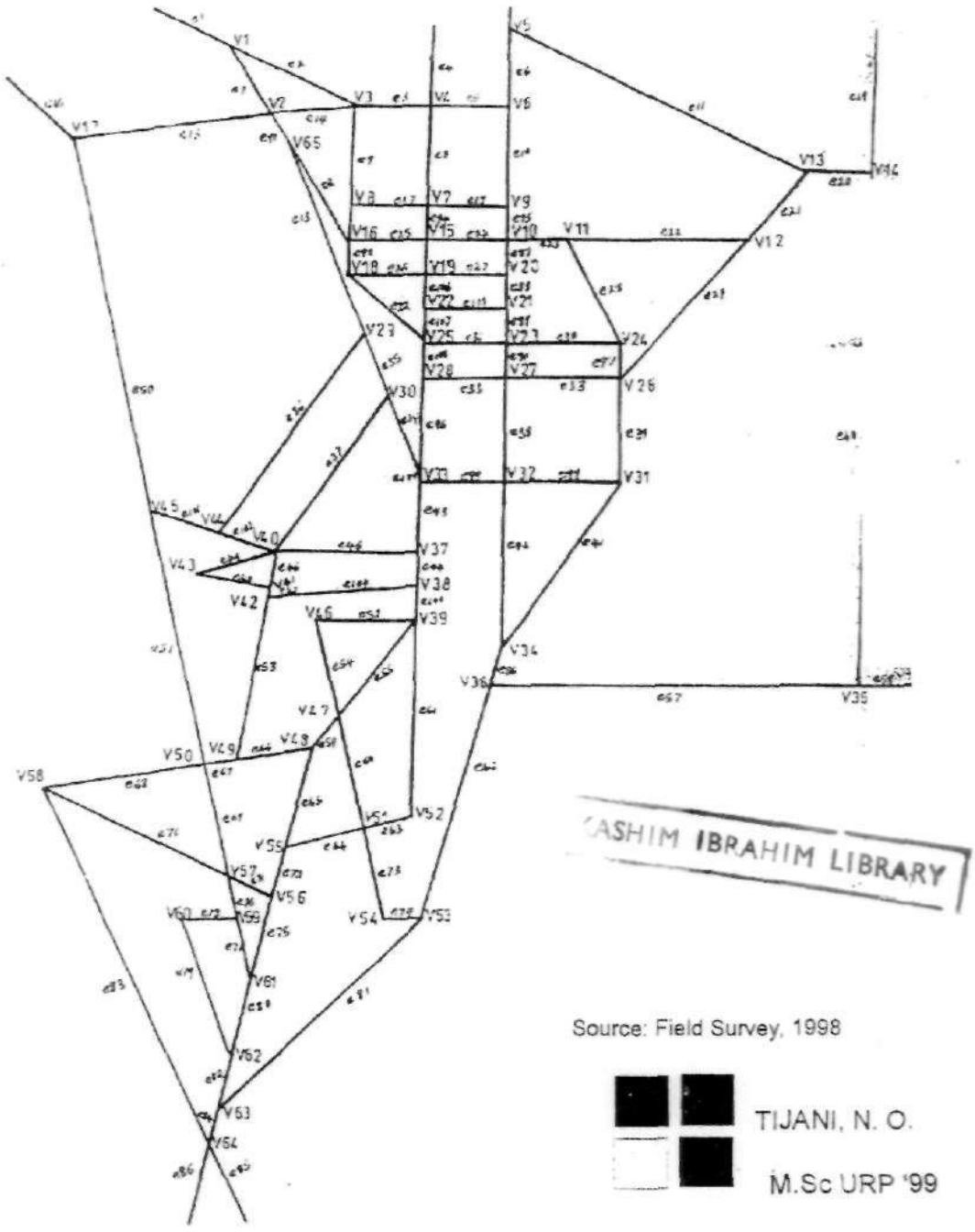



Fig. 3.4: MAIN ROAD PATTERN IN JOS




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Fig. 3.5: GRAPH OF THE MAIN ROAD NETWORK PATTERN OF JOS

average is linked with at most two routes. By all standards, this connectivity value is low (Kansky, 1963). This suggests that Jos metropolitan are is not properly connected or linked. The Alpha index which shows the degree to which the total road network permits direct movement between the various nodes in an area, is found to be 36%. This reveals the connectivity levels, and is quite indicative of the level of road development in Jos. However, the connectivity level revealed by Alpha index could be said to be true if the roads were free from problems of on-street parking. In central area of Jos, over 59% of the roads capacity are usually reserved for on-street parking. This is a pointer to the genesis of traffic problems in the area.

In estimating the accessibility of the nodes in the area, the binary connectivity table by Stutz (1973) cited by Sumaila (1992) was constructed for all the nodes in the study area. In Stutz's table, unity (1) indicates direct connection while zero (0) indicates no direct connection between the nodes. Each of the row entries when summed gives the number of direct linkages from a given node to the set of all other nodes in the network. Table 3.3 (column 4) is the extract of the sampled nodes from the accessibility matrix of the road network of metropolitan area of Jos.

*Table 3.3. Spatial Accessibility and the Level of Trip*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **S/N** | **Zones** | **Modal Accessibility** | **Nodal Accessibility** | **X Accessibility** | **Y Accessibility** |
| 1 | Unijos | 5 | 2 | 7 | 3105 |
| 2 | Anglo Jos | 5 | 3 | 8 | 4799 |
| 3 | Tundu | 4 | 3 | 7 | 4661 |
| 4 | Jenta | 4 | 2 | 6 | 2144 |
| 5 | C.B.D. | 5 | 4 | 9 | 6516 |
| 6 | Nassarawa | 5 | 3 | 8 | 2352 |
| 7 | Liberty Dam | 5 | 3 | 8 | 3298 |
| 8 | Dadin Kowa | 4 | 2 | 6 | 2749 |
| 9 | Rock Haven | 4 | 2 | 6 | 2834 |
| 10 | Bukuru | 5 | 2 | 7 | 4388 |

A product moment correlation analysis was applied on the data presented in Table 3.3. in order to measure the correlation coefficient between the two variables - accessibility (x) and level of trip generated (y). The result of the analysis is presented in Table 3.4. while the calculation is shown in appendix 3.

*Table 3.4. Result of Correlation Analysis Between Spatial Accessibility X and Level of Trip Generated Y*

| | RXY | Coefficient of Determinant | Calculated t-Value | Table t-value at 0.1 |
|---|---|---|---|---|
| PMCC of X and Y | 0.92 | 85.9% | 6.64 | 5.04 |

The table 3.4, the R x Y value of 0.92 reveals that the relationship between r and y is positive and strong. This thus indicates that level of trip generated in Jo depend on degree of accessibility of an area.

The coefficient of explanation r x y2 (0.922 x 100) shows that accessibility alone accounts for 85.9% of the factors responsible for trip generated, while the remaining 14% is attributable to other factors, i.e. socio-economic variables.

However, the table value of t which is less than the calculated value also go further to confirm that there is high correlation between the degree of accessibility and level of trip generation in Jos.

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### 3.3.1. Estimating Trip Generation and Attraction

The need to estimate or forecast trip generation and trip attraction by various land uses in urban centre cannot be over emphasised. This is because, the planning and design of any urban transport system requires some anticipated volume of flow for a design year (Ogunsanya 1983).

From the analysis of the road network characteristics and the review of literatures, certain observations become apparent. Among these observations is that socio-economic

characteristics and spatial accessibility have been identified as factors that qualitatively affect the level and pattern of trips made by respondents in the study area. These variables include: income, car ownership, family size, educational level, occupation type, marital status, sex, age and spatial accessibility.

Therefore, it can be conceptualised that there is a set of variables x1, x2, x3, x4 . . . xn . . . .(1) which help to explain the number of trips generated and attracted by urban land use. This may be put mathematically thus:

$$Y = F(x1, x2, x3, x4 \ldots x n) \ldots\ldots\ldots\ldots\ldots (2)$$

Where Y represents the number of trip made by respondents

X 1 = Accessibility

X 2 = Number of household

X 3 = Sex

X 4 = Occupation types

X 5 = Vehicle ownership

X 6 = Income

Equation (2) above is made operational in the form of a regression equation.

$$Y = b0 + bi\ xi + b2\ x2 \ldots\ldots b6\ x6 \ldots\ldots\ldots\ldots\ldots (3)$$

where Y = dependent variable

xi . . . . . x6 represent independent variables

b0 bi . . . . b6 represent the regression constants.

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### 2.3.2. Measurement of Variables

| *Variable* | **Measurement** |
|---|---|
| *Income:* | Measured on the basis of amount of income earned in (₦). |
| *Car ownership:* | Measured by the number of cars owned by the respondent. For example, has no car = 0, has one car = 1, has two cars = 2, has greater than 2 = 3, |
| *Family size:* | Measured by the number of people living in a family of respondents. |
| *Level of education:* | Measured on the basis of level of educational qualification. For example, "No formal education" = 0, primary education = 1, post primary = 2, HND/BSc. = 3, Msc./PHD = 5. |
| *Occupational types:* | Classified on the basis of their income earned and measured ordinarily. For example, depedent/student = 1, civil servant = 2, business = 3, non academic staff = 4 and academic staff = 5. |
| *Marital status:* | Measured in ordinal scale. e.g. single = 1, married = 2. |
| *Sex:* | Measured in ordinal scale. e.g. male = 1, female = 2. |
| *Age:* | Measure in years. |
| *Spatial accessibility:* (i). | Measured by mode of public transport operating in the zone i.e. Bus = 5, Tax = 4, Motorcycle = 3, Pedestrian = 2, No linkages = 1. |

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(ii). Nodal accessibility, measured by number of road that directly link a particular zone.

***Trip:*** Measured by the average number of trips made in a day per zone.

Ordinal measurement of socio-economic variables has been commonly used by scholars for measurement as well as to provide measurable value for the variables that are involved in the quantitative analysis. Ozo (1987), Ogunsanya (1983 and 1986) to mention just a few, used this method to measure socio-economic variables in their various studies.

### 3.3.3. Estimating Trip Generation

In the analysis of household trip generation and socio-economic and spatial variables measured on a satisfactory basins, the step-wise version of the linear multiple regression model has been applied. The distinguishing character of the model is its ability to identify the relative importance of each of these predictor (independent) variables on the criterion (dependent) variable. In all, there were six predictor variables and one criterion variable. The predictor variables are the level of income, car ownership, household number per zone, sex, occupational types, and spatial accessibility. The criterion or dependent variable is the volume of trips generated by households per day. A total of 875 households were used in the regression analysis.

At least, two types of interpretation may be carried out on the results. The first concerns the order of significance while the second concerns the overall interpretations of the regression model. On the first score, table 3.5 shows the variables in their order of importance. It is pertinent to note that level of accessibility, number of household,

vehicle ownership are significantly contributed to the level of trip generated in Jos. while occupational types and income are not significant.

*Table 3.5: The order of importance of the predictor variables of trip generation at the household level*

| S/N | Variable Name | B | SEB | T | Significant T |
|---|---|---|---|---|---|
| 1 | Accessibility* | 0.6652 | 0.62857 | 1.060 | 0.3668 |
| 2 | Number of Household* | 9.47741 | 8.04248 | 1.178 | 0.3236 |
| 3 | Sex | 3.87602 | 7.55212 | 0.513 | 0.6432 |
| 4 | Vehicle Ownership* | 0.71439 | 0.86236 | 0.828 | 0.4682 |
| 5 | Occupational Types | -7.0700 | 4.7005 | -1.504 | 0.2296 |
| 6 | Income | -174.971 | 343.698 | -0.509 | 0.6458 |

*Significant at 0.01. Number of households used in the modal = 875

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The above results are somehow unexpected; especially for the following variables. occupational types and level of income. One would intuitively expect these variables to be more important than they are presently. Of course, their relative unimportance may be due to multicollinearity among the variables. Multcollinearity occurs when the correlation between two or more independent variables are high. Under such a situation. the sampling error of the partial sloped and partial correlation coefficients would be large and then there would be a number of different combinations of regression coefficients

which would give almost equally good fittings to the empirical data (Blalock 1963). Although, multicollinearity does not constitute a threat when the regression model is being used for prediction, it does when one is merely interested in explanations.

Similarly, the analysis of correlation coefficient of these variables is presented in the table below.

*Table 3.6. Correlation coefficient of the dependent and independent variables for trip generation*

| | X1 | X2 | X3 | X4 | X5 | X6 |
|---|---|---|---|---|---|---|
| X1 | - | 0.9016** | 0.9301** | -0.2020 | -0.0920 | 0.6988 |
| X2 | 0.9016** | - | 0.8911** | -0.3881 | 0.0380 | 0.7237 |
| X3 | 0.9301** | 0.8911** | - | -0.1949 | 0.0801 | 0.5922 |
| X4 | -0.2020 | -0.3881 | -0.1949 | - | -0.0351 | -0.1012 |
| X5 | -0.0920 | 0.0380 | 0.0801 | -0.0351 | - | 0.3759 |
| X6 | 0.6988 | 0.7237 | 0.5922 | -0.1012 | 0.3759 | - |
| Y | 0.929** | 0.9522** | 0.9467** | -0.4245 | 0.0899 | 0.6596 |

No of cases: 10

1 - tailed significant: x ⇒ 0.01 xx ⇒ 0.001

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An examination of table 3.6 above reveals a variety of relationship, outstanding among them is the fact that about 9 out of the 42 relationships are significant at 0.001 while only 2 relationship are significant at 0.01 while only relationship are significant at 0.01 making the number of relationship that are significant to be 11. This builds in

problem of multicollinearity. But multi-collinearity is not a problem, if it continues into the future together.

The above observation is important for the second interpretation of the regression analysis as an explanatory model. This second interpretation should concentrate on the examination of not only the overall coefficient of determination (R2) but also the significance of the individual partial regression coefficients. This regression equation is given by:

$$Y = 1577 + 0.66x1 + 9.47x2 + 3.87x3 + 0.71x4 - 7.07x5 - 174.97x6$$

$$(1.60)\ x\ (1.178)\ x\ (0.513)\ (0.828)x\ (-1.504)\ (-0.509)$$

$$R = 0.99 \text{ and } F = 30.99$$

Where y is the volume of trips generated per day by a household. Xi (I = 1, 2 . . . 6) are the socio-economic and spatial accessibility variables discussed above.

x significant at the o.01 level.

The t values for the regression coefficient are shown in brackets.

The correlation coefficient of 0.99 with coefficient of determination of 98% is found to be highly significant at the 0.01 level implying that the correlation between the criterion and predictor variables is not a chance occurrence. The analysis of variance value of F = 30.99 also confirms the significance of the regression equation as an explanatory model of some determinants of the level of trip generated. However, when the statistical usefulness of the model for forecasting is taken into consideration a slightly different story emerges. This is so because the partial regression coefficients are not all significant. The only significant ones are the spatial accessibility, number of household and vehicle ownership. This therefore, means that as far as Jos is concerned accessibility,

number of household per zone (population surrogate) and the car ownership determine to a large extent the trip generating capacity of the household. The level of income, sex and occupational type have not proved important as trip generating variables. Or it may be that their contribution were submerged due to the problem of mult-collinearity.

These are questions that arise and their detailed answers require a further search. However, the objective of this study has been satisfied in the sense that conventional socio-economic variables are not adequate as explanatory factors for trip generation in urban area. For instance, study carried out by Ayeni (1975) on the contribution of socio-economic variables to the level of trip generation in Jos produced a multiple correlation coefficient of 0.677 with coefficient of determination (R-square) of 46%, implying that the socio-economic variables used in the analysis could explain only 46% of the total variation. Thus, when one consider socio-economic and spatial accessibility like we did in this study, the analysis produced a multiple correlation coefficient of 0.99 with coefficient of determination (R-square) of 98% implying that socio-economic plus spatial accessibility accounted for 98% of the total variation in the level of trip generation in Jos.

*Table 3.7: Origin - Destination Survey*

| | Jenta | Unijos | Rock | CBD | Nassa | Tudun | Liberty | Dadin | Industrial | Bukuru |
|---|---|---|---|---|---|---|---|---|---|---|
| Jenta | | 207 | 507 | 565 | 106 | 411 | 53 | 22 | 162 | 111 |
| Unijos | 207 | - | 257 | 1615 | 406 | 311 | 158 | 19 | 26 | 106 |
| Rock Haven | 507 | 257 | - | 715 | 306 | 811 | 130 | 24 | 17 | 67 |
| CBD | 565 | 1615 | 715 | - | 606 | 511 | 688 | 132 | 173 | 1511 |
| Nassarawa | 106 | 406 | 306 | 606 | - | 211 | 151 | 67 | 226 | 273 |
| Tudun | 411 | 311 | 811 | 511 | 211 | - | 608 | 657 | 710 | 431 |
| Liberty | 53 | 158 | 130 | 688 | 151 | 608 | - | 247 | 812 | 451 |
| Dadin Kowa | 22 | 19 | 24 | 132 | 67 | 657 | 247 | - | 1412 | 169 |
| Industrial | 162 | 26 | 17 | 173 | 226 | 710 | 812 | 1412 | - | 1261 |
| Bukuru | 111 | 106 | 67 | 1511 | 273 | 431 | 451 | 169 | 1261 | - |
| $\Sigma$ | 2144 | 3105 | 2834 | 6516 | 2352 | 4661 | 3298 | 2749 | 4799 | 4388 Trips |

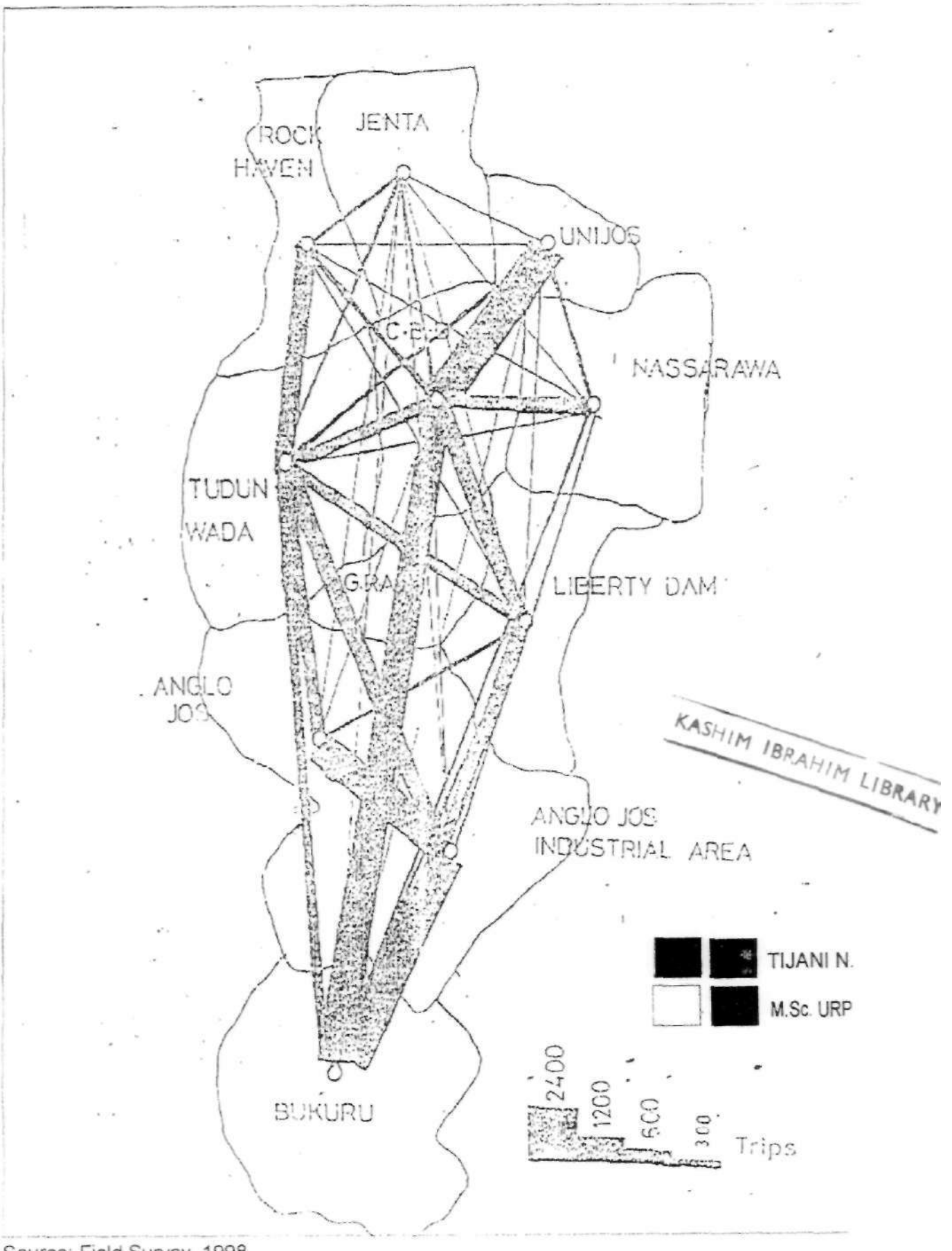
*Source:* Field Survey (May, 1998)

### 3.3.4. Trip Distribution (Origin - Destination)

The data in table 3.2 was used to draw the desire line (figure 3.4 - 3.6). The figures however shows that central area of Jos attract more commuters than any other parts in the city. The individual need of commuters to visit the central area for one thing or the others and the high accessibility of the area explain why the area experiences more of traffic congestion than any other parts in the city. For instance, 52% of commuters

from Unijos, 35% from Bukuru and about 26% of commuters from Nassarawa made their daily trips to CBD.

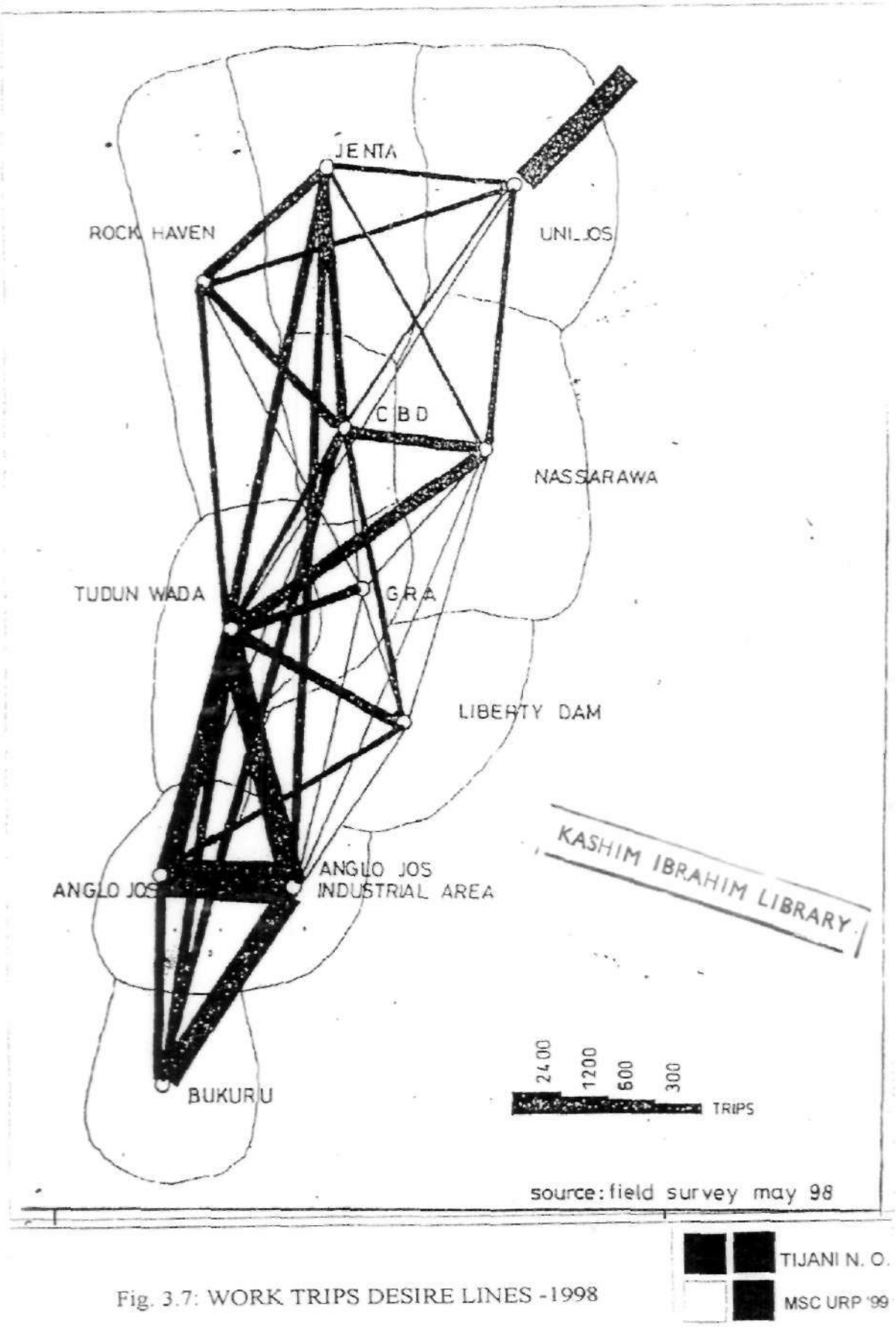
Moreover, the figure also indicate that non residential area in Jos, i.e. Unijos, CBD, industrial area, etc. attract more commuters than the residential areas i.e. Nassarawa, Tudun Wada, G. R. A., etc. This situation however explain the reason why traffic congestion is more pronounced in the former than the latter. However, the consequence of such movement and resulted traffic problems are discussed in the next chapter.




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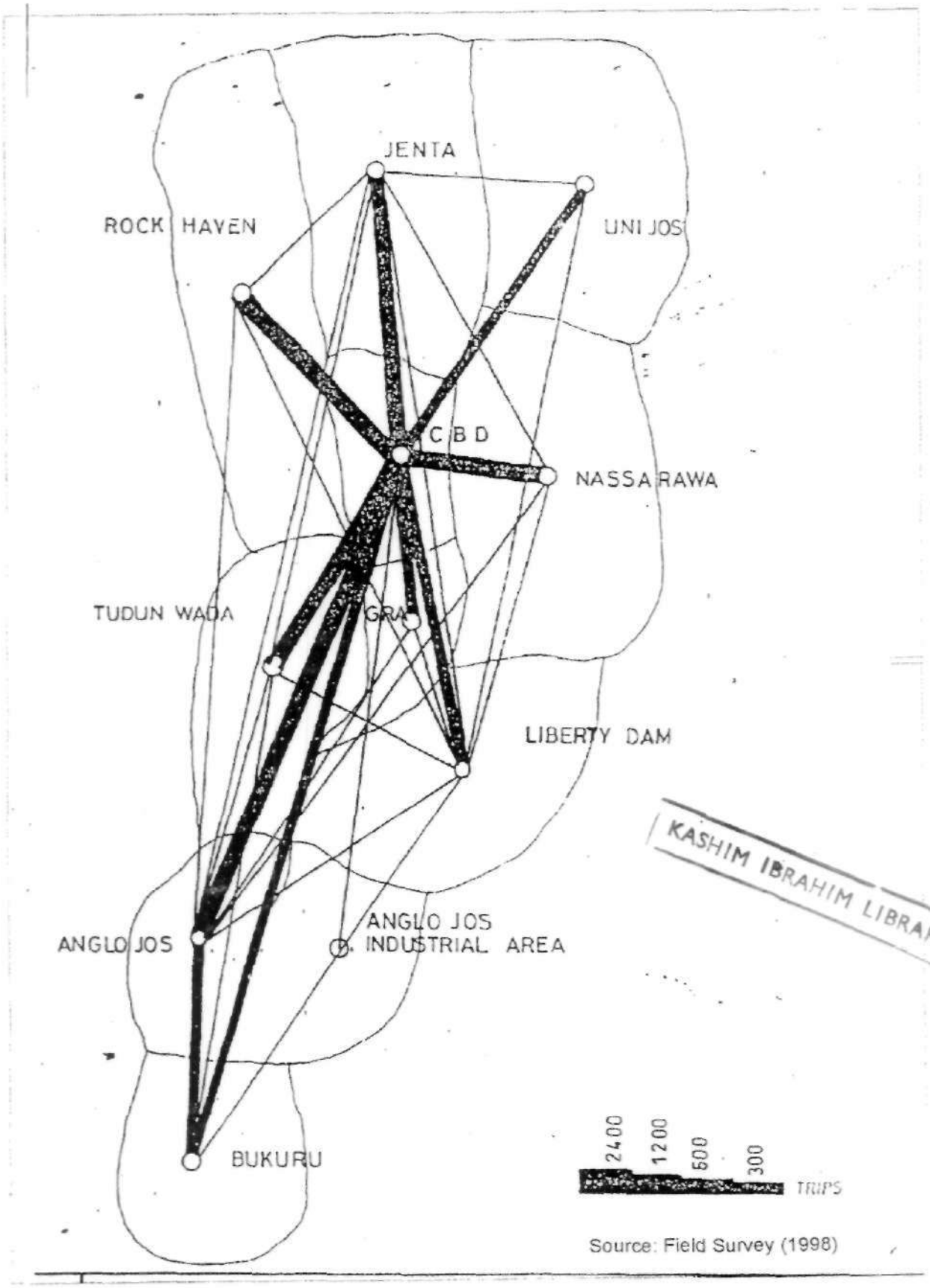
Source: Field Survey, 1998

Fig. 3.6: DESIRE LINE SHOWING TRIP PATTERN IN JOS




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Fig. 3.7: WORK TRIPS DESIRE LINES -1998




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Fig. 3.8: SHOPPING TRIPS DESIRE LINES -98

# CHAPTER FOUR

## 4.0.0. TRAFFIC PROBLEMS

### 4.1.0 INTRODUCTION

This chapter, general treats data presentation and analysis on the intra-city traffic operation in Jos with the sole aim to determine traffic problems in the area. It examines the arterial capacity and subsequently parking facilities, traffic composition as well as other causes of traffic delay, i.e. side-walk tracking, uncontrolled intersection, over population, etc.

### 4.2.0. ROAD CAPACITY

In this section, arterial capacity in the study area are examined. This is to ascertain the adequacy of the existing road capacity in the area. Result of field measurement and exercise were presented in table 4.1. for this purpose.

*Table 4.1. Road capacities.*

| Street | Design Capacity | Possible Capacity | Space Capacity | Design Speed Capacity | Possible Speed Capacity | Lane Width | No. of lan |
|---|---|---|---|---|---|---|---|
| Muritala Mohammed | 2877 | 1811 | 37.1% | 50 | 29 | 7 | 2 |
| Bauchi Road | 2877 | 1576 | 45.2% | 50 | 25 | 7 | 2 |
| Oyewunmi Road | 3000 | 1562 | 48% | 50 | 27 | 7.3 | 2 |
| Tafawa Balewa Road | 3082 | 1580 | 4?% | 50 | 30 | 7.5 | 2 |
| Ahmadu Bello (Post Office) | 3288 | 1904 | 42.1% | 50 | 31 | 8 | 2 |
| Ahmadu Bello (Old Bukuru Park. | 3288 | 1974 | 40% | 50 | 28 | 8 | 2 |
| $\Sigma$ | 18412 | 10409 | 43.5% | | | | |

*Source:* Field Survey (May, 1998).

The design capacities of selected arterials in Jos based on the lane widths, speed and traffic volume were compared with the possible capacities in order to establish the degree of traffic congestion in the study area. This are presented in table 4.1 in columns:

Column 1 street name

Column 2 Design capacity - This is the maximum flow possible

without causing unreasonable delay.

Column 3 Possible capacity - This is the maximum flow under preventing condition.

Column 4 spare capacity - This is the design capacity minus possible capacity.

$$Sc = \frac{(Qp - F)\ 100}{Qp}$$

where

Sc = Spare capacity

Qp = Design capacity

F = Possible capacity

Column 5 design speed capacity - This is the maximum speed possible without causing unreasonable delay.

Column 6 possible speed capacity - This is the maximum speed under preventing conditions.

*Table 4.2 : Main Road Inventory*

| Name of Streets | Zaria Road | Abdul Salami Road | Zaria Bye-Pass | Ibrahim Taiwo Road | Bauchi Road | Bukuru By Pass | Tafawa Balewa | Mango Road | Masalachi Jumma Road | Bauchi Bye-Pass | Nasarawa Road | A. Bello Way |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surface of Carriage Way | Asphalt | Asphalt | Asphalt | Asphalt | Asphalt | Asphalt | Asphalt | Asphalt | Asphalt | Asphalt | Asphalt | Asphalt |
| Condition of Carriage Way | Good | Good | Good | Good | Good | Good | Good | Good | Good | Good | Good | Good |
| Effective Width of Road | 8m | 7.5m | 9m | 9m | 14 Dual Carriage | 10m | 7.5m | 7m | 15m Dual Carriage | 9m | 7m | 16m Dual Carriage |
| Type of Drain | Open | Open | Open | No Drain | Open | Open | Open | Open | Partly Covered | Open | Open | Covered |
| Condition of Drain | N.M | N.M | N.M | Need Construction | N.M | N.M | N.M | N.M | N.M | N.M | N.M | N.M |
| Existence of Traffic Control Devices | Traffic Warden | Traffic Warden | Traffic Warden | Traffic Warden | Traffic Warden | Traffic Warden & Railway Crossing Str. Signs | Traffic Warden | Traffic Warden | Traffic Warden & Round about Channelization | Traffic Warden | Traffic Warden | Traffic Warden & Round about Channelization |

Source: Field Survey (May, 1998)

N.M. Needs Maintenance

Similarly, given all these information (table 4.1 and 4.2) casual observation shows that arterial and collector roads in the area have reduced speed not because they are over - loaded/bad condition. for instance, the total design capacity volume for the six roads in table 4.3. is 18,412 while the possible capacity is 10,409 with the spare capacity of 43.5%. thus, the spare capacity of 43.5 imply that motorist in Jos are only making use of 56.5% of the total road capacity in the area. Therefore, the capacity of roads in the area are adequate.

The T - Test statistical technique was also used to test the degree of differences between the design and possible road capacity in Jos. The calculated T - value is 154.54 (see appendix) greater than the theoretical values at 0.01 significance levels which is 3.17. Since the calculated T - value is highly greater than the table T - value, we conclude that there is significant differences between the design arterial capacity and possible capacity in Jos.

However, the delay and congestion on these route (table 4.3) express in form of speed reduction ranges from 2- 25 minutes as shown in column 5 and 6 in table 4.3 must be due to the on-street parking of vehicles in the area. The impact of on-street parking will be discuss in the subsequent section.

## 4.3.0. PARKING STUDIES

In the previous chapter, it was shown that the land allocated to transportation in Jos metropolis was inadequate. In-spite of this, it is still instructive to investigate traffic operations in the district with the existing facilities. Part of the work involving study parking problem and the accumulation of vehicles in the CBD.

Parking is an important consideration in traffic operations since the vehicles which operate on streets and highways have a terminal point requiring parking. Considering this, parking pattern were examined on all the major roads in the study area. Parking inventory results are shown in table 4.3.

however, the following key observations are made. That the type of general parking provided in Jos is roadside parking (on-street parking). It is only in Bauchi and Murtala Mohammed way that off street parking is provided. On-street parking has a negative effect upon traffic movement and safety. It also reduces, in some instances, the capacity of the actual travel lanes. For example, field measurement shows that capacity of Bauchi road, Ahmadu Bello way and Tafawa Balewa road reduced from 7.5 metres to 4 metres, 8.5 metres to 6 metres and 7 metres to 4.0 metres respectively.

Also, plate 1 and 2 shows typical on-street parking arrangement along Ahmadu Bellow way in Jos. Plate 1 is an example of official parking (on-street provision) while plate 2 is a typical example of illegal parking arrangement.

Moreover, from the survey of uses in Jos, the following land use that generate traffic have been identified as potential areas from which traffic problem would start:

1. Total Petrol Station - Murtala Mohammed Street.
2. First Bank - Bauchi Road
3. Terminus Hotel - Oyewunmi Road.

The total petroleum filling station, first bank building.

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395.N6.T7

*Table 4.3. Parking Inventory*

| Type of Parking | Parking Location | Parking Availability (Official) | Name of Street |
|---|---|---|---|
| Parallel<br>$90^0$ | On-Street<br>Off-Street | Not Available | Massalachin |
| Parallel<br>$40^0$ | On-Street<br>Off-Street | Not Available | Bauchi Road |
| Parallel | On-Street<br>Off-Street | Not Available | Bauchi Road |
| Parallel | On-Street | Not Available | Zaria Road |
| Parallel | On-Street | Not Available | Zaria Bye Pass |
| Parallel | On and Off Street | Not Available | Bukuru Bye-Pass |
| Parallel<br>$90^0$ | On -Street<br>Off-Street | Not Available | Tafawa Balewa Road |
| All Types<br>$45^0$ Dominant | On-Street | Available | Ahmadu Bello Way |
| Parallel | On and Off Street | Available | Murtala Mohammed Way |
| All Types | On-Street | Not Available | NECO Market Road |
| Parallel | On and Off Street | Not Available | Bukuru Road |
| Parallel | On-Street | Not Available | Abdul Salami Street |
| Parallel | On-Street | Not Available | Nasarawa Road |
| Parallel<br>$45^0$ | On-Street | Not Available | Dilimi Street |

Source: Field Survey (May, 1998).

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Plate 1: Showing official on-street parking provision along Ahmadu Bello way (Post Office Street). This has reduced lane width capacity from 8.5 meters to 6 meters

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Plate 2: Showing illegal on-street parking provision along Ahmadu Bello way (Tafawa Balewa Junction), Jos. This has reduced lane width capacity from 7.5 meters to 4 meters

and Terminus Hotel in these corridors do not have enough space for their operation in their various locations. The fact that they are all capable of attracting traffic with the attending problem of parking create lot of traffic problem here, most especially during the peak period.

It is therefore, common to see them parking indiscriminately on the roads. Double parking of vehicles is a common phenomena.

Some of the roads are even blocked for long part of the day because most of the available space have been used for parking. Thus, obstructing the free-flow of traffic which at time may result in a long delay. The commercial minibus, they have illegal converted part of Oyewunmi road between Terminus Junction and Ahmadu Bello Junction into a motor park. Commuters using this road are usually held up for long at the peak periods. In case of Terminus Hotel; the problem tend to aggravated during the period of fuel scarcity. It has been observed from field survey that none of the uses have parking facility for their customers.

Thus, what can be said about motor parks and terminal facilities in the study area is that few of them are located within the CBD area. This result in congestion and parking problems.

### 4.4.0. PEAK PERIOD ON DIFFERENT ROADS IN CENTRE AREAS OF JOS

It can be seen from figure (3.31 - 4.36) that three peaks were experienced daily, namely morning, afternoon and evening peaks. Morning peaks usually occurred between 8.00am to 10.00 am and this correspond with the time that workers, traders, shoppers, etc. rushed to their respective working or business premises.

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Another peak occurred in the afternoon around 12.00 noon to 2.00 pm. This could be attributed to workers going on break, parents driving their children home from schools and business/shopping trips. The Friday afternoon peak was more pronounced than any other days because of Muslims rushing to Mosques for the Friday congregational prayers.

The third peak occurred between 5.00 pm to 7.00 pm and was as a result of mass exodus of people as they returned home after the days business. Since cordon counts gave the relative importance of each route, the order of importance of the routes (in term of traffic volume) is Ahmadu Bello way with a total of 37,327 p. c. u. traffic passes in 12 hours. This is followed by Murtala Mohammed way, Oyewunmi street, Bauchi road and Tafawa Balewa street (table 4.4).

Generally, the inbound vehicles were more in the morning as people rushed to their respective business and working places. The flow balances out around mid-day and out bound flow takes place takes precedence as people rushed home after day's business.

## 4.5. TRAFFIC COMPOSITION

This section examine traffic composition in Jos, an attempt was also made to compare the existing composition to World Bank aggregate recommendation as reported by Armstrong (1973). Table 4.4 present the result of the finding.

*Table 4.4. Traffic Composition*

| Route | Direction | Bus | Mini Bus | Taxi | Lorry | P/Car | M/Cycle | Bicycle |
|---|---|---|---|---|---|---|---|---|
| Bauchi Road | IN | 39 | 2385 | 3900 | 42 | 1912 | 108 | |
| | OUT | 99 | 1903 | 2536 | 67 | 1698 | 154 | |
| | TOTAL | 138 | 4288 | 6434 | 109 | 3610 | 262 | |
| | % | 0.7 | 20.8 | 31 | 0.5 | 17.5 | 1.3 | |
| Muritala | IN | 54 | 2211 | 3666 | 27 | 3612 | 940 | 255 |
| Mohammed | OUT | 51 | 2325 | 4019 | 61 | 4282 | 1494 | 92 |
| | TOTAL | 105 | 4536 | 7685 | 88 | 7894 | 2484 | 347 |
| | % | 0.45 | 19.7 | 33 | 0.4 | 34.2 | 10.5 | 0.7 |
| Oyewunmi | IN | 110 | 2010 | 4307 | 45 | 3887 | 1805 | 140 |
| | OUT | 90 | 1909 | 3817 | 62 | 3609 | 1578 | 95 |
| | TOTAL | 200 | 3919 | 8124 | 107 | 7496 | 3383. | 235 |
| | % | 0.8 | 16.7 | 34.6 | 0.5 | 31.9 | 14.4 | 1.0 |
| Ahmadu | IN | 112 | 247 | 9911 | 233 | 8451 | 1914 | 95 |
| Bello(Post | OUT | 80 | 266 | 6814 | 160 | 6689 | 1686 | 75 |
| Office) | TOTAL | 192 | 513 | 16725 | 393 | 15140 | 3600 | 170 |
| | % | 0.5 | 1.4 | 45.5 | 1.07 | 41 | 9.8 | 0.46 |
| Ahmadu | IN | 67 | 816 | 4714 | 14 | 2317 | 782 | 173 |
| Bello (Old | OUT | 63 | 1898 | 5094 | 56 | 2977 | 812 | 174 |
| Bukuru Park) | TOTAL | 130 | 2714 | 9808 | 70 | 5294 | 1594 | 347 |
| | % | 0.7 | 13.6 | 49 | 0.4 | 26.5 | 8 | 1.7 |
| Tafawa | IN | 62 | 143 | 5002 | 120 | 3945 | 1905 | 62 |
| Balewa | OUT | 384 | 518 | 5164 | 160 | 3440 | 1206 | 75 |
| | TOTAL | 446 | 661 | 10166 | 280 | 7385 | 3111 | 137 |
| | % | 2.0 | 3.0 | 45.8 | 1.3 | 33.3 | 14.02 | 0.6 |

*Source:* Field Survey (May, 1998).

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The table shows that light vehicles i.e. private car and taxi constitute more than half of the traffic on all roads in central area of Jos. for instance, its about 59% in Bauchi road, 67.2 on Murtala Mohammed way, 66.6% on Oyewunmi street, 75.5% on Ahmadu Bello way and 79.1% on Tafawa Balewa street. All these are significantly greater than 15-30% recommended by World Bank (Armstrong, 1993).

The heavy vehicle on these five roads share about 0.45% compare to 50 - 70% recommended by world bank. While the two - wheel traffic (bicycles and motorcycles) is much more than 18.8% on Bauchi road, 11.2% on Murtala Mohammed way, 15.4% on Oyewunmi street, 9.7% on Ahmadu Bello way and 14.6% on Tafawa Balewa Street. Thus, the high prevalence of LOV (Low Occupancy Vehicle) more than HOV (High Occupancy Vehicle) and the absence of public bus services as modes of intra-city traffic circulation in Jos urban area have contributed largely to the high volume of traffic usually witness on major roads at peak periods. This usually results in prolonged delay as many vehicles operate far below the design speed of the road (table 4.1).

Chi-square statistical technique was also used to determined the variation in the proportion of traffic composition in the area. The calculated X2 value is 19,877 (see appendix) greater than the theoretical values at 0.01 significance levels which is 50.89, since the calculated X2 value is highly greater than the table X2 value, we conclude that there is a significant differences in the proportion of traffic composition in Jos.

## 4.6. INTERSECTION STUDIES

An intersection is the area shared by the journey or crossing of two or more roads. The main operational functions of the intersection is to permits a change in travel route. It is in the process of this route changing that a lot of maneuvers, resulted in many


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conflicts, delays and accidents occur. The intersection is therefore, the focal point of conflicts, delays and accidents and as these become accentuated the need to control the intersection also becomes more. Maneuvers at the intersection may be merging, cutting, diverging, cutting and merging, etc.

Because of the above consideration, intersections are of special importance due to considerable influence that they have on vehicle safety, speed, flow of vehicles and efficiency of movements.

Of the two major types of intersections at - grade (ordinary give-way) and grade - separated (flyover), at-grade intersection are more pronounce in Jos.

### 4.6.1. Nature of Intersection

All the intersections in the CBD of Jos are either at-grade or grade-separate roundabout. It is important to note that all at-grade intersection have no traffic light. The only mode of control at the important busy intersection is by a traffic warden. In this particular study, attention is given to peak hour turning movements and delay caused to vehicles at peak hour on the approaches at some selected important intersections.

The intersections considered for the purpose of this study are listed below, and for easy reference, some of the intersections are named in accordance with one important feature in their vicinities as:-

1. Bauchi road / Murtala Mohammed road junction will be called "Terminus" junction.
2. Ahmadu Bello Way / Tafawa Balewa road is to be known as Ahmadu Bello junction.

3. Ahmadu Bello /Old Bukuru road motor park will be known as "Old Bukuru road junction".
4. Ahmadu Bello / Massalacin Juma'a road will be known as "Massallacin junction".
5. Bauchi road / Nassarawa road junction will be known as "Nassarawa junction".

1. ***"Terminus Junction***

This is effectively grade-separated roundabout where in Ahmadu Bello road and market road intersects Bauchi road to produce cross-junction which has now been channelizing with the aid of roundabout. The major road is Bauchi road and the minor ones are Oyewunmi and Market road.

2. ***"Ahmadu Bello" Junction***

Again, this is another grade-separated roundabout wherein Terminus road intersect Ahmadu Bello road in the west. Tafawa Balewa intersect it in the eastern part to produce cross-junction which has now also been channelized by roundabout. The major road is Ahmadu Bello road and the minor ones are Tafawa Balewa and Oyewunmi road.

3. ***"Old Bukuru Road" Junction***

This is skewed or "y" intersection. Main street (Ahmadu Bello) runs straight through the intersection while Old Bukuru road joins it at an angle. The intersection is sometimes controlled by a traffic warden during the day time (7.30 am to 6.00 pm).

4. ***"Massallacin" Junction***

This is three-legged or "T" junction wherein Ibrahim Dasuki road, Massalacin Juma'a road and Ahmadu Bellow road intersect one another. The three roads are

separated with the aid of roundabout to produce effective channelization. Ahmadu Bello road that later renamed Massallacin road after roundabout is the major road and the minor one is Ibrahim Dasuki road.

5. ***Nassarawa" Junction***

This is a cross-junction. The main street (Bauchi road) runs straight through the intersection while Nassarawa road joins it in the west and Katako road join it in the east to produce the cross-junction. This intersection is sometimes controlled by a traffic warden during the day time (7.30 am to 6.00 pm).

4.6.2. **Turning Movement**

Because of the general lack of proper traffic control measures at most intersections within the CBD, the flow of traffic is somewhat chaotic at most of them. For the turning movements study, two of the five intersections were selected. The three rejected intersections were Terminus, Ahmadu Bello and Massallacin junctions because they are already provided with roundabout. Thus, the causes of traffic delay there is not on account of lack of traffic control or channelization. This will be examine in the next section.

The result of the turning movement count on old Bukuru junction and Nassarwa junction are shown in table 4.6. It can be seen from the results of table 4.5 that "Nassarawa" junction handles the highest volume of traffic. From Terminus approach alone, 1094 pcu/hr were counted, while Unijos road, Katako road and Nassarawa road approach catered for 536,400 and 374 pcu/hr respectively. From Terminus approach, the straight through traffic has the highest volume followed by right turn and little left turn.

Nassarawa road registered the highest left turn. White vehicles from Unijos and Katako road mostly pass through.

However, at "Old Bukuru" junction, the Kasua Dare approach records the highest volume of 912 pcu/hr with straight through movement of 560 pcu/hr and left turn of 352 pcu/hr and no right turn. This is followed by Ahmadu Bello road approach with 911 pcu/hr and old Bukuru road record 565 pcu/hr with straight movement of 58 pcu/hr and right turn of 505 pcu/hr with and no left turn. It is worth while to note that of the two intersections, its only here that u-turn was observed.

*Table 4.5. Peak Hour Turning Movements of Traffic at Intersections in Jos CBD*

| **Intersection** | **Approach** | **Straight** | **Right Turn** | **Left Turn** | **U-Turn** | **Equivalent PCU** |
|---|---|---|---|---|---|---|
| Nasarawa | From Terminus Junction | 598 | 470 | 26 | | 1094 |
| | From Unijos Road | 504 | 18 | 14 | | 536 |
| | From Nasarawa Road | 341 | 09 | 24 | | 374 |
| | From Katako Road | 360 | 18 | 22 | | 400 |
| | | | | | | |
| Old Bukuru Park | Kasuan Dere Road | 560 | Nil | 352 | | 912 |
| | Ahmadu Bello Road | 891 | 18 | Nil | 2 | 911 |
| | Old Bukuru Park | 58 | 505 | Nil | 2 | 565 |

*Source:* Field Survey (May, 1998).

### 4.6.3. Intersection Delay Studies

Most of congestion and delays in cities arise from intersection. There is heavy economic waste through traffic congestion and because of this, intersections deserve to be carefully studied and designed. Intersection delays arise from conflicting maneuvers of high volume of traffic at such a small area. A number of factors affect intersection delay such as physical factors (number of lanes, grade, width, access control etc), traffic factors (number of approaches, turning movements, vehicle classifications, driver characteristics, etc) and traffic control (types and turning of signals, stop or yield sign, etc).

The stopped time delay method that uses the sampling technique was adopted. Two observes were assigned to each approach of an intersection. One observer counted the number of vehicles stopped in the approach at successive interval of 15 seconds, while the other continue counting the vehicles as they passed simultaneously.

The field work was done at a volume of traffic very close to the peak hour volume. This is because at peak hours, queues will be too long and difficult to count at such small intervals. Five minutes duration was used for each approach. The result of the field work is shown in table 4.6 while the underlying computation is illustrated as follows:

The delay caused by vehicles in each approach to an intersection D, is given by average total delay;

AD = n x t (stop vehicles x seems of delay)

To obtain average delay by all vehicles, we divide by total number of vehicles observed (N).

Average delay / vehicle = $\frac{n \times t}{N}$

*where*

AD is average delay of all vehicles

N is total number of vehicles observed (stop and passing vehicles)

n is number of vehicles stop

t is time interval

The delay data of table 4.6 is used to compute delay as follows:

Taking "Terminus" junction and considering Ahmadu Bello approach.

N = 87

n = 81

t = 15 seconds

So, average delay / vehicle = $\frac{81 \times 15}{87} = 13.9$

Also, percentage of vehicle delayed by Terminus junction is calculated by:

$$\frac{n \times 100}{N}$$

$$\frac{81 \times 100}{87} = 93\%$$

In this other way, all other delays are computed for each of the approaches, of the different intersections and the result is summarized in table 4.6.

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*Table 4.6. Table of Computed Delay at Intersection in Jos CBD Based on 5 Seconds Intervals*

| Intersection | Approach | Total No. of Vehicles Stopped | No. of Vehicles Passing | Average Delay of all Vehicle | % of Vehicle Delayed |
|---|---|---|---|---|---|
| Terminus | Bukuru | 73 | 11 | 13.03 | 87% |
| | Ahmadu Bello | 81 | 06 | 13.90 | 93% |
| | Unijos | 69 | 09 | 13.30 | 88.5% |
| | Market Road | 05 | 02 | 10.7 | 71.4% |
| Ahmadu Bello | Post Office | 60 | 15 | 12 | 80% |
| | Terminus | 65 | 14 | 12.3 | 82.3% |
| | Tafawa Balewa | 60 | 17 | 11.6 | 78% |
| | Katako | 66 | 15 | 12.2 | 81.5% |
| Nasarawa | Teminus | 63 | 10 | 12.9 | 86.3% |
| | Unijos | 67 | 09 | 13.2 | 88.2% |
| | Nasarawa | 60 | 11 | 12.6 | 85% |
| | Katako | 56 | 15 | 11.8 | 79% |
| Old Bukuru | Kasuan Dere | 49 | 07 | 13.1 | 88% |
| | Ahmadu Bello | 44 | 11 | 12 | 80% |
| | Old Bukuru | 47 | 09 | 12.6 | 84% |
| Masallacin | Ahmadu Bello | 29 | 34 | 8.1 | 46% |
| | Ibrahim Dasuki | 28 | 36 | 8.4 | 44% |
| | Masallacin | 27 | 37 | 8.7 | 42% |

*Source:* Field Survey (May, 1998).

### 4.6.4. Discussion of Result

From the delay of table 4.6, long delay was caused to vehicles from Ahmadu Bello approach of Terminus junction (13.9 seconds or 93%). The reason for this high delay could be attributed to the high concentration of land uses along this route, i.e. Terminus Hotel, Total Filling Station, First Bank Building, etc. Most of these land use activities attract traffic with attending problems of parking. Lack of parking lot led motorist to park along the road (on-street parking). This tend to reduce amount of space available to vehicle for effective "weaving", that is, for traffic to cross from one lane on the roundabout to the other.

The proportion of space reduced due to on-street parking vary from one intersection to the others in CBD of Jos which in turn account for variation in percentage of vehicle delayed in the area. This ranges from 42% on Massalacin Juma'a approach junction (plate 2).

Moreover, the high delay recorded at Nassarawa and Old Bukuru junction ranges between (80 - 88%) resulted from lack of effective channelization since the two junctions are "ordinary give-way" as such, they tend to serve as conflict spot whenever they are not manned by traffic warden.

## 4.7.0 RECENT CONSTRUCTION IN A CONGESTED CORRIDOR

The construction of street corner shops on the right in the picture (Plate 3) shows the type of planning mistake in terms of non-consideration for traffic to be generated. The location is the already congested segment of Muritala Mohammed street. Infact, the particular segment have very high pedestrian flow, high frontage development and no off

street parking. By the time the building starts functioning, traffic by it would be worse than it is now.



Plate 3: Showing rcent market stalls (under construction along Murtala Muhammed Way) in Jos

### 4.7.1 OVERSTRAINED FACILITIES

Problem created by hapharzard development in the background (Plate 4), construction of street corner shops going on inspite of the traffic problem along this same corridor. This problem is further aggravated by the lack of road courtesy, indisciplined driving usually found among the bus operators and motor cyclists. In the same way, the load and unload passengers right on the street causing undue delay for other motorists.

There are also problem of hawkers trying to sell to motorists and in the process causing delay as seen on (Plate 5).



Plate 4: Showing overstrained facilities in the Terminal area of Jos.



Plate 5: Showing hawkers trying to sell to motorist right on the carriage way.

### 4.7.2 SIDE-WALK TRADERS

Delay to motorists is also caused by street trading where pedestrians are forced to encroach on the road space because the side walk provided have taken over by street traders as in (Plate 6) or in some cases, there conditions (Side-Walk) are not good for pedestrians safety as shown in (Plate 7).



Plate 6: Showing side walk traders along Ahmadu Bello way (Before old Buku



Plate 7: Showing lack of maintenance of side walk along Ahmadu Bello way (Before Old Bukuru Park) in Jos.

## 4.8.0. SPATIAL VARIATION IN AVERAGE DAILY PEAK HOUR DELAY TIME (IN SECONDS) ON SELECTED ROAD IN JOS

In this section, the extends of the delay due to various factors are discussed. These are illustrated in table 4.7 below.

*Table 4.7. Spatial Variation in Average Daily Peak Hour Delay on Selected roads in Jos*

| S/N | Route | Road Intersection | Parking Problems | Pedestrian Crossing | Accident | Road Condition | Total Seconds |
|---|---|---|---|---|---|---|---|
| 1 | Bukuru-Main Market | 49 | 31 | 15 | 17 | 25 | 137 |
| 2 | Farin Gada-Main Market | 160 | 113 | 17 | 21 | 40 | 351 |
| 3 | Main Market - Bauchi Road | 93 | 53 | 19 | 30 | 23 | 218 |
| 4 | Katako-Nasarawa | 24 | 49 | 13 | 25 | 13 | 124 |
| 5 | Main Market-Secretariat | 58 | 44 | 13 | 19 | 37 | 171 |
| 6 | M/Juma'a-Jenta | 23 | 48 | 12 | 24 | 12 | 119 |
| | $\Sigma$ | 407 | 338 | 89 | 136 | 150 | 1120 |

*Source:* Field Survey (May, 1998).

Table 4.7 shows the extent of traffic delay due to various factors. From the table, the road intersections and parking problems are the predominant causes of delay at peak hours as they accounted for 407 and 338 delay respectively, out of 1,120 total delay in the area, representing 67% of the causes.



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Carefully considered, the spatial variation in the extent of delay in the area Farin Gada - Main Market route recorded the highest (351) out of the six routes considered for study, this is followed by Main Market - Bauchi road (218). Altogether, the two road accounted for 51% total delay. It is obvious from these that, routes that link commercial land use tend to experience more delay than others. For instance, Massalacin Juma'a - Jental that link residential recorded the lowest (119) representing just 11% of the total delay.

# CHAPTER FIVE

## RECOMMENDATION AND CONCLUSION

### 5.1.0 INTRODUCTION

The problems of traffic flow in Jos metropolitan area today have been established and the findings revealed:

- Low level of road development
- Absence of mass transit
- Inadequate parking facilities
- Poor road network connectivity

These have invariably resulted in a deficient street network in terms of capacity and safety, encroachment upon street allowances for many purposes other than movement of vehicles operators in accordance with driving laws and regulations. As earlier stated the analysis shows that the level of road development in Jos is approximately 40%. This could be said to be true if the roads were free from problems of on-street parking. In the central area of Jos. over 50% of the roads capacity are usually reserved you on-street parking. To improve the level of road development in Jos, therefore:

### 5.1.1 OPTION A

By increasing the level of road construction and widening of the existing road (table 5.1) for instance, the Zaria road can be extended to link secretariat directly, which will be approximately 3km in length. Another road can be constructed to connect Unijos/Angwan Rogo directly to Katako etc.

The importance of these roads are to relieve both Bauchi and Ahmadu Bello roads of their heavy traffic respectively. Thereby increase the journey speed on the two roads.

However, using the Federal Ministry of work and housing construction cost for instance of =N=

8.5million cost for 1km length of asphalt road and =N=0.99 million for 3 bedroom prototype houses, it is too enormous to construct new roads and resettled about 1,000 household in order to give room for road expansion, with this, option A appear to be invisible both socially and economically.

Table 5.1 RECOMMENDATIOS : ROAD WIDENING AND CONSTRUCTION

| **Route** | **Present condition** | **Recommendations** |
|---|---|---|
| Zaria Road | Average width 8.4m | Expected width over 16m |
| Katako Road | Average width 6.5m | Expected width 12m |
| Nassarawa Road | Average width 5.4m | Expected width 15m |
| Murtala Muhammed way | Average width 9m | Expected width 16m |
| Secretariat Junction | Serious Traffic delays | Construction of a new road from Zaria road linking Bauchi road. |
| Bauchi road/Nassarawa Junction | Serious accident spot from pupils crossing the road | Need for a pedestrian over-head bridge. |

Source: field survey, May (1998)

5.2.0 **OPTION B.**

This option suggest that by improving the efficiency of the existing roads we can avoid construction of more roads. This can be achieve through the following measure.

5.2.1 Enforce Street Parking Control.

It is recommended that parking control should be enforced in these areas: it include Bauchi road, Oyewunmi street, Muritala Muhammed way, Ahmadu Bello way, Katako road, Nassarawa and secretariat junctions. The present measure against indiscriminate parking should be stepped up by towing vehicles immediately they are found in undesirable locations.

5.2.2 Legislate on Street Parking

Legislate on street parking should be enforce in as much as it does not interfere with free movement of traffic such as Ahmadu Bello way along post office.

On-street parking in places like Bauchi road where parking conflict occur should be removed. Also the left sides of Tafawa Balewa street and Oyewunmi approach to Ahmadu Bello junction.

Provision for pedestrian sidewalks should be made on all street, within the Jos metropolitan area.

Shop operator should not encroach on pedestrian ways with their goods thus reducing the effective road way.

5.2.3 Specific Improvements

**Bauchi road.**

It is recommended that frontage development should be discouraged especially at the approached to Terminus, Nassarawa and Kasuwa Dare junctions. These are characterised by heavy pedestrian flow, on-street parking, major bus routes and narrow side walk.

It is proposed that parking control should be stricter in this area.

5.2.4 Oyewunmi Street.

This street is characterised by heavy pedestrian activities. it is congested with buses and delay occur often at the intersection on Ahmadu Bello way. It is recommended that:

1. The bus terminus at the junction of Ahmadu Bello and Tafawa Balewa should be moved to main market, to reduce conflict at that intersection.
2. Traffic control such as signals should be used at the intersection.
3. Commercial transport operators should be controlled
4. Stopping of vehicles on the right side should not be permitted as it would hinder smooth turning into Ahmadu Bello street.

5.2.5 Tafawa Balewa and Katako road

Strict control of taxi and bus operators on the street is proposed as traffic problem is basically due to loading and unloading of passengers. Thus illegal parking should be abolished on this route as recommended earlier.

Nassarawa and Terminus junction

Loading and unloading of passengers by taxi and buses especially at the intersection area should be discouraged.

5.2.6 Traffic Signal/Control Location

Traffic signals should be provided at all major intersection especially areas noted for intersection conflicts. The idea of using traffic warden as a substitute do create problems especially at he night hour.

5.2.7 Hawkers Spaces

Since the major operating environment for hawkers is where vehicles are either stationary or at traffic jams, it is therefore proposed that spaces should be acquired for parking spaces, for the purpose of resettling all hawkers within the area in one spot. Hence

1. The site of old post office can be converted to hawker usages.
2. The existing inter-city motor park near old post office should be converted into intra-city motor park for buses plying Terminus to Katako and Terminus to Farin-gada. While the existing intra-city can be move and matched with Bauchi road motor park.

5.2.8 Provision of Parking Space

It is also recommended that parking spaces be provided along main transportation arteries like Bauchi road. This is to discourage the on-street parking by motorist along the roads. If parking facilities are provided, it will reduce the associated problem of delay along the road. Bus-stops should also be provided along these roads and motorists be forced to drop passengers only at designated bus-stops.

5.2.9 Control on Drivers

There is need for more serious enlightenment programme about drivers conduct behind the wheels on the highway. Careless driving should be discouraged as much as possible.

Drivers should not drive when they are drunk. Only drivers that can read road signs should be allowed to drive within the town. In the light of the increasing accident rate, there is also need for traffic education. The periodic holdings of seminars on traffic

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education to educate road users is therefore highly recommended, as well as the use of the media like; radio and local papers.

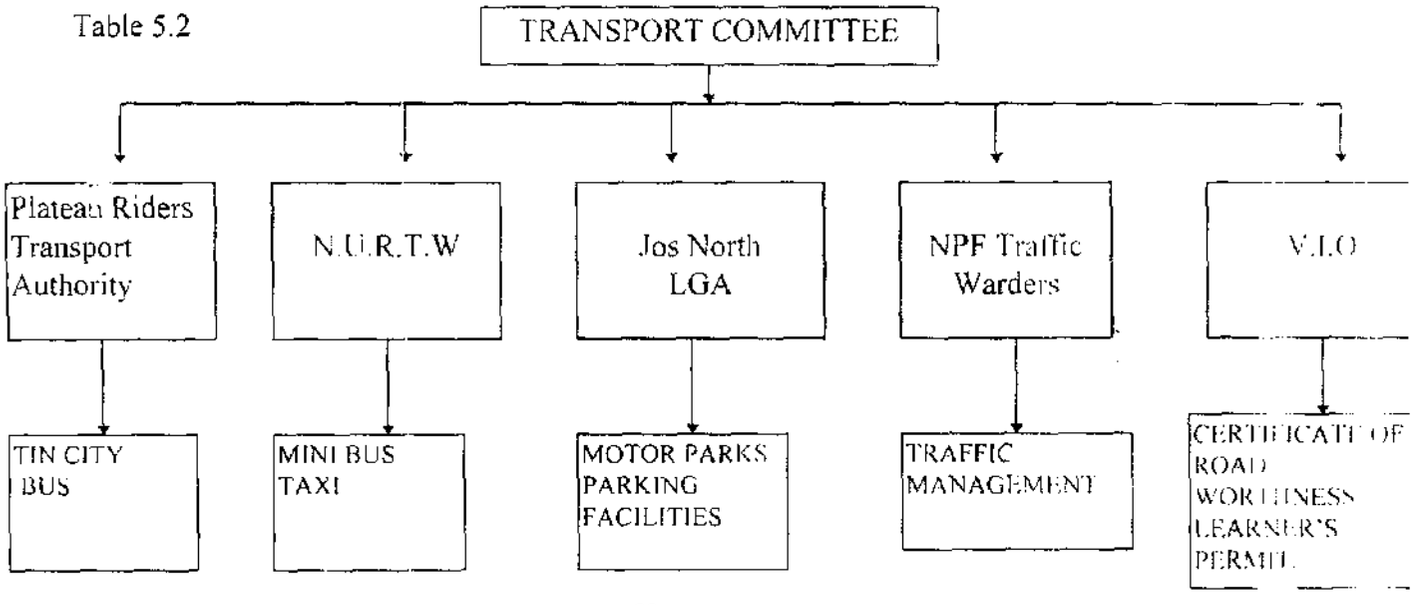
In order to encourage safety of the users at level crossings, it is recommended that gates should be build at the level crossings. They should be closed only when a train is closely approaching the crossing and open immediately it passes.

5.3.0 Transportation Administration

To implement the recommendation in section (5.2.1 - 5.29) a committee is suggested to be formed by the Jos metropolitan Development Board known as Transportation Committee. The Chairman of the committee is to be the General Manager of the JMDB. The committee shall be made up of representatives from Plateau Rider Transport Authority, the Chief Town Planning Officer, Jos North Local Government, the Nigeria Police, Traffic Warden and the V.I.O.

The function of the committee is to co-ordinate the activities of the town service division of the NURTW and the TIN CITY BUSES whenever its re-introduce into the city. Issues like the regulation of buses, minibuses and taxi and the banning of on-street parking will also be deliberated upon.

Table 5.2



5.3.1 Mass Transit.

The introduction of mass Transit in Jos has been beneficial by reducing travel cost (Kwar, 1994). However, inadequacy of vehicles later led to withdrawal of TIN-CITY BUSES by Plateau Riders Authority as mode of intra-city transportation in Jos. This shows that the problems of mass transit in Jos is more of finance rather than operational/management issues. Study on operation/management has been reported by Manasa (1985).

Given this background, this study shall only pre-occupied itself by recommending to government and the transport enterprises on options open to them to surmount the financial difficulties. A few of the recommendations in this regard are as follows:

- A revisit of the establishment of a Transport Development Bank as a source of long-term finance for transport enterprises;
- The inclusion, by the central Bank, of transportation as a "productive" or preferred sector in prescribing its sectorial credit policies to the commercial and merchant Bank;
- Subsiding the capital cost of provision on intra-urban transport service by state-owned Transport Companies; and quantitatively defined subsidy for other social services provided;
- Arrangement of a loan guarantee scheme for the transport operators so as to enable them borrow more easily and at more affordable terms;
- The revamping of existing laws and practices in connection with instalmental credit arrangements particularly hire purchase facilities;

- Arrangement of transport business to eventually operate as Public Limited Companies (PLC) and especially get quoted in the stock exchange - as a long term strategy for raising debentures and share capital from within the country and international financial institutions like the international finance corporation with relative ease;
- Encouragement of transport business to improve their profit performance and make them generate internal finance. The transport business should plan better, set appropriate cost based tarrifs etc. The Government should assist them in this regard. The owner-government should interfere less or no more in the day to day operations of the transport parastatals; the Federal Government should consider the need for subsidises and imported tax reductions (or abolition) on the inputs being used in transport business; and the Governments should improved the road network and other transport related infrastructures in the country;
- Improve significantly Government's funding of FUMTA (Federal Urban Mass Transport Authority). FUMTA should not succumb to off budget financing but insist on following regular budget procedure to enable a proper planning of its activities (Odedokun, 1996).

### 5.4.0 PROVISION OF SCHOOL BUSES AND STAFF BUSES.

Schools and employers should be encouraged to introduced school and staff buses respectively. This will bring about order at bus stops and reduce the pressure on the available buses. This will also reduce the burden of going to pick children after school by parents since these school buses will take children near home. It will also reduce traffic



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congestion on the roads especially at the peak periods as the number of vehicles on a particular road will be significantly reduced.

## 5.5.0 CONCLUSION

The study has been able to identify the transportation and traffic problems in Jos. This include; problems resulting from the spatial separation of people's dwellings due to the rapid urban growth and constraints to physical development, problems associated with the modes, the road network as well as the transport disadvantaged class.

These information were collected from fieldwork involving data on road inventory, traffic counts, origin and destination survey, parking survey and other information from secondary sources.

It was discovered that Jos metropolis has poor road network, thereby leading to traffic congestion because of increasing motorised traffic for the available road space. This congestion is most pronounced for routes between terminus to bukuru routes, Bauchi road, Ahmadu Bello Way and Murtala Mohammed Way. There are not enough parking facilities in Jos thereby worsening the congestion problem. A package of recommendations on traffic management schemes and improvement of road network were advanced.

Finally, an effective transportation system in Nigerian urban centres and especially in Jos also demands the adoption of an efficient mass transit system that will be adequate, reliable, safe and with a realistic fare structure that will respond to the aspirations of the Jos Urban population.

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# APPENDIX 1

Ho : There is no significant difference between the design capacity and possible capacity of roads network in Jos.

HA: There is significant difference between the design capacity and possible capacity of roads network in Jos.

| Street | Design capacity | Possible capacity | Design speed capacity | Possible speed capacity |
|---|---|---|---|---|
| Murtala Muhammed | 2877 | 1811 | 50 | 29 |
| Bauchi | 2877 | 1576 | 50 | 25 |
| Oyewunmi | 3000 | 1562 | 50 | 27 |
| Tafawa Balewa | 3082 | 1580 | 50 | 30 |
| Ahmadu Bello (post office) | 3288 | 1904 | 50 | 31 |
| Ahmadu Bello (old bukuru) | 3288 | 1974 | 50 | 28 |
| Σ | 18412 | 10407 | 300 | 170 |
| X | 3068.67 | 1734 5 | 50 | 28.3333 |
| SD | 187.90 | 184.77 | 0 | 2.16 |
| CV% | 6.12 | 10.65 | 0 | 7.62 |

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TRAFFIC VOLUME

$$T = \frac{1\bar{x} - 1\bar{x}}{\sqrt{\frac{SDX}{n-1} \quad \frac{SDY}{n-1}}}$$

$$T = \frac{3068.67 - 1734.5}{\sqrt{\frac{187.9}{6-1} + \frac{184.77}{6-1}}}$$

$$T = \frac{1334.17}{\sqrt{37.58 + 36.95}}$$

$$T = \frac{1334.17}{\sqrt{74.534}}$$

$$T = \frac{1334.17}{8.633}$$

$$T = 154.54$$

TRAFFIC SPEED

$$T = \frac{50 - 28.33}{\sqrt{\frac{0}{5} + \frac{2.16}{5}}}$$

$$T = \frac{21.67}{\sqrt{0.432}} \quad DF = (n-1) + (n-1)$$

$$(6-1) + (6-1) = 10 \quad \text{At } 0.01 = 3.17$$

$$T = \frac{21.67}{0.657}$$

$$T = 32.9832$$

# APPENDIX II

Ho : There is no significant differences in the proportion of traffic composition in Jos.

HA : There is significant differences in the proportion of traffic composition in Jos.

| Route | Bus | Mim Bus | Taxi | Lorry | Private car | Motor cycle | Bicycle | Total |
|---|---|---|---|---|---|---|---|---|
| Bauchi | 138 | 4288 | 6434 | 109 | 5774 | 3610 | 262 | 20,615 |
| Murtala | 105 | 4536 | 7685 | 88 | 7894 | 2484 | 347 | 23,139 |
| Gyewu nmi | 200 | 3919 | 8124 | 107 | 7496 | 3383 | 235 | 23,464 |
| Ahmad u (post) | 192 | 513 | 16725 | 393 | 15140 | 3600 | 170 | 36,733 |
| Ahmad u (old) | 130 | 2714 | 9808 | 70 | 5294 | 1594 | 347 | 19,957 |
| Tafawa | 446 | 661 | 10166 | 280 | 7385 | 3111 | 137 | 22,186 |
| Total | 1211 | 16631 | 58,943 | 1047 | 48983 | 17782 | 1498 | 146,095 |

EXPECTED TABLE FREQAUENCY.

| Route | Bus | Mim Bus | Taxi | Lorry | Private car | Motor cycle | Bicycle |
|---|---|---|---|---|---|---|---|
| Bauchi | 170.88 | 2346.75 | 8317.26 | 147.74 | 6911.84 | 2509.16 | 211.38 |
| Muritala | 191.80 | 2634.07 | 9335.58 | 165.83 | 7758.09 | 2816.37 | 237.26 |
| Oyewunmi | 194.50 | 2671.07 | 9466.71 | 168.16 | 7867.05 | 2855.93 | 240.59 |
| Ahmadu (post) | 304.48 | 4181.57 | 14820.17 | 263.25 | 12,315.91 | 4470.97 | 376.65 |
| Anmadu (old) | 165.43 | 2,271.84 | 8051.78 | 143.02 | 6691.22 | 2429.07 | 204.63 |
| Tafawa | 183.90 | 2525.59 | 8951.09 | 159.00 | 7438.56 | 2700.38 | 227.49 |

$$X^2 = \frac{(O_i - E_i)^2}{E}$$

$$\frac{(138-170.88)^2}{170.88} + \frac{(4288-2346.75)^2}{2346} + \frac{(6434-8317.26)^2}{8317.26} +$$

$$\frac{(109-147.74)^2}{147.74} + \frac{(5774-6911.84)^2}{6911.84} + \frac{(3610-2509.16)^2}{2509.16} + \frac{(262-211.38)^2}{12.12} = 2731.13$$

$$X^2 = \frac{(105-191.80)^2}{191.80} + \frac{(4536-2634.07)^2}{2634.07} + \frac{(7685-9335.58)^2}{9335.58} + \frac{(88-165.83)^2}{165.83} + \frac{(7894-7758.09)}{7758.09}$$

$$+ \frac{((2484-2816.37)^2)}{2816.37} + \frac{(347-237.26)^2}{237.26} = 1833.29$$

$$X_{?}^{2} = \frac{(200 - 194.50)^2}{194.50} + \frac{(3919 - 2671.07)^2}{2671.07} + \frac{(8124 - 9466.71)^2}{9466.71} + \frac{(107 - 168.16)^2}{168.16} + \frac{(7496 - 7867.05)^2}{7867.05}$$

$$+ \frac{(3383 - 2855.93)^2}{2855.93} + \frac{(235 + 240.59)^2}{240.59} = 91078$$

$$X_{5}^{2} = \frac{(192 - 304.48)^2}{304.48} + \frac{(513 - 4181.52)^2}{4181.52} + \frac{(16725 - 14820.17)^2}{14820.17} + \frac{(393 - 263.25)^2}{263.25} + \frac{(15140 - 12315.91)^2}{12315}$$

$$+ \frac{(3600 - 4470.97)^2}{2429.07} + \frac{(170 - 376.65)^2}{376.65} = 4499.41$$

$$X_{5}^{2} = \frac{(136 - 165.43)^2}{165.43} + \frac{(2714 - 2271.84)^2}{2271.84} + \frac{(9808 - 8051.78)^2}{8051.78} + \frac{(70 - 143.02)^2}{143.02} + \frac{(5294 - 6691.22)^2}{6691.22} + \frac{(1594 - 2429.07)^2}{2429.07}$$

$$+ \frac{(347 - 204.63)^2}{204.63} = 7794.69$$

$$X_{6}^{2} = \frac{(446 - 183.90)^2}{183.90} + \frac{(661 - 2525.59)^2}{2525.59} + \frac{(10166 - 8951.09)^2}{8951.09} + \frac{(280 - 159)^2}{159} + \frac{(7385 - 7438.56)^2}{7438.56} + \frac{(311 - 2700.38)^2}{2700.38}$$

$$+ \frac{(137 - 227.49)^2}{227.49} = 2107.47 \quad X^2 = 19,877$$

*To* determine degree of freedom (df)

DF = (r - 1) x (c - 1) where r = 6 and c = 7

=(6-1) x (7-1) =30

using $X^2$ table

df at level 0.5 = 43.77

df at level 0.01 = 50.89

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# APPENDIX 3

| S/N | Zone | X Accessibility | Y Trips | dx | dy | $dx^2$ | $dy^2$ | dxdy |
|---|---|---|---|---|---|---|---|---|
| 1 | Unijos | 7 | 3105 | -0.2 | -579.6 | 0.04 | 335936.16 | 115.92 |
| 2 | Anglo Jos | 8 | 4799 | 0.8 | 1114.4 | 0.64 | 1241887.36 | 891.52 |
| 3 | Jenta | 6 | 2144 | -1.2 | -1540.6 | 1.44 | 2373448.36 | 1848.72 |
| 4 | Tundun | 7 | 4661 | -0.2 | 976.4 | 0.04 | 953356.96 | 195.28 |
| 5 | C.B.D | 9 | 6516 | 1.8 | 2831.4 | 3.24 | 8016825.96 | 5096.52 |
| 6 | Nassarawa | 8 | 2352 | 0.8 | -1332.6 | 0.64 | 1775822.76 | 1066.08 |
| 7 | Liberty | 8 | 3298 | 0.8 | -386.6 | 0.64 | 149459.56 | 309.28 |
| 8 | Dadin | 6 | 2749 | -1.2 | -935.6 | 1.44 | 875347.36 | 1122.72 |
| 9 | Rock | 6 | 2834 | -1.2 | -850.6 | 1.44 | 723520.36 | 1020.72 |
| 10 | Bukuru | 7 | 4382 | -0.2 | 703.4 | 0.04 | 494771.56 | 140.68 |
| | $\frac{\Sigma}{X}$ | 72<br>7.2 | 36,846<br>3684.6 | 0 | 0 | 9.6 | 16940376.4 | 11807.44 |

$$rx = \sqrt{\frac{\Sigma dx^2}{\cap}} = \sqrt{\frac{9.6}{10}} = 0.979$$

$$ry = \sqrt{\frac{\Sigma dy^2}{\cap}} = \sqrt{\frac{16940376.4}{10}} = 1301.552$$

The mean value of dxdy is

$$rxy = \frac{\Sigma dxdy}{\cap} = 11807.44$$

The coefficient of correction is

$$Rxy = \frac{rxy}{rxry} = \frac{1180.744}{1274.211}$$

$$= 0.9266$$

*Coefficient* of determination 85.866%

$$t = Rxy\frac{\sqrt{\cap - 2}}{\sqrt{1 - Rxy^2}}$$

$$= \frac{0.92\sqrt{10 - 2}}{\sqrt{1 - 0.92^2}} = \frac{2.602}{\sqrt{0.1536}}$$

$$= \frac{2.602}{0.3913}$$

$$t = 6.649$$

# APPENDIX 4

## QUESTIONNAIRE

This questionnaire is basically meant to collect information on urban travel pattern and characteristics of people in Jos metropolitan area. every information given is absolutely meant for research purpose and shall be strictly treated as confidential.

INFORMATION ABOUT RESPONDENTS.

1.1 Sex

1.2 Age

1.3 Marital status

1.4 Family size

1.5 Residential location (address)

1.6 Educational background, tick where applicable

(a) No formal education

(b) Primary education

(c) Post primary/Secondary education

(d) N.C.E/O.N.D

(e) H.N.D/B.Sc or B.A/graduate

(f) Other specify

1.7 Occupational type

1.8 Income level per month, tick where applicable

(a) Below =N= 3,000

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(b) Between =N=30001 and =N=6000

(c) Between =N=60001 and =N=9000

(d) Between =N=90001 and =N=12000

(e) =N=12000 and above.

1.9 Vehicle ownership _____ Number of vehicle_____

1.10 Type of vehicle. car _____ Bus _____ Motor cycle _____ others _____

INFORMATION ABOUT TRIPS

| Trips made yesterday | Origin of trip and time | Destination of trip and time | Purpose of trip | Mode of travel | Normal frequency of such trips | Cost of travel |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |

Guidelines for purpose of trip

a. Journey to work

b. Journey to school

c. Business trip

d. Social trip

e Others specify

For trip Mode

a. By foot

b. by pedal cycle

c. by motor cycle

d. by car

e. by bus

f. by taxi

For Frequency of trip

a. once in a day 1/24hours

b. once in a week 1/7days

c. once in a month 1/30days

d. once in a year 1/12years.

e. Others..

3.0 PROBLEM ENCOUNTERED DURING THE TIME OF MAKING TRIPSS

3.1 List some of the problems encountered

a. _____

b. _____

c. _____

4734

d. _____

3.2 Suggest possible solutions

a. _____

b. _____

c. _____

d. _____

SAMPLE OF TURNING MOVEMENT SURVEY DATA SHEET TRAFFIC COUNTS AT INTERSECTIONS.

VEHICLE MOVEMENT

Intersection studies: _____

Approach observed: _____

Sheet No: _____ of _____ Date _____

Weather: _____ day _____

Hours: _____ to _____

(Simply mark 1 for each vehicle in the appropriate colums)

| Hours | | | | | sub-Total |
|---|---|---|---|---|---|
| --.00 | | | | | |
| --.05 | | | | | |
| --.10 | | | | | |
| .15 | | | | | |
| --.20 | | | | | |
| --:25 | | | | | |
| --:30 | | | | | |
| --:35 | | | | | |
| --.40 | | | | | |
| --.45 | | | | | |
| --.50 | | | | | |
| --.55 | | | | | |
| Totals | | | | | |

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# APPENDIX V

Table Sample of Cordon Traffic Count Sheet

Cordon Traffic count Survey form

Observation _____Station: _____Date _____ day

_____Synboss

Mark 1 in Colum for each vehicle. the fifth marl crossing the four marks as

Sheet Number :_____of_____Weather _____

Traffic flow direction: _____Bound

(Please sketch location on back of sheet number 1)

| Hours | Passenger cars including taxis and minibus | Motor cycles | Pick-Up trucks & Delivery vans | Large Buses | Two(2) Axle Trucks & Lorries | Multiples Axles Trucks Lorries | Bicycles |
|---|---|---|---|---|---|---|---|
| -.00 to -.15 | | | | | | | |
| -.15 to -.30 | | | | | | | |
| -.30 to -.45 | | | | | | | |
| -. 45 to -.00 | | | | | | | |
| Total | | | | | | | |