MODAL SPLIT OF WORK TRIPS UNDERTAKEN BY PUBLIC SERVANTS IN MINNA, NIGER STATE, NIGERIA.

BY

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DEDICATION

This work is dedicated to my parents, Alh. Mamman Kolo & Hajiya Amina Muhammad, My loving and caring wife, Mrs. Jamila Adamu and my children Mohammed Salim Kolo and Abdul-Jalil A. Kolo.

DECLARATION

I hereby declare that this thesis has been composed by me and that it is a record of my own research. It has not been accepted in any previous application for a degree anywhere. However, as it is required by research laws and ethics, all sources of information are specifically acknowledged by means of references.

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ABDULLAHI KOLO
JULY, 2011

CERTIFICATION

This project thesis titled "Modal Split of Work Trips Undertaken By Public Servants In Minna, Niger State, Nigeria" meets the requirement governing the award of the degree of Master of Science (Civil Engineering) of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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ABSTRACT

The use of multinomial logit models for predicting mode- choice decisions for urban travels has gained prominence in recent years. The prime advantage of this model lies in their ability to allocate travel demand among many modes at the same time, as opposed to the traditional binary mode-choice models developed in the early sixties. Journey to work is vital in any aspect of land use and transport planning. Transport remains a vital component of the urban economy that enables the populace to move freely between their homes and place of work. This study examines the factors that influence modes of travel of civil servants in Minna. Questionnaire administrations are used in establishing the modes of travel and factors influencing them were evaluated. The survey results showed that a large split of the workers (25.4%) use taxis as the dominant mode of transport to work. Statistical regression analysis using SPSS was used to derive the utility function and multinomial logit model was used to calculate the probability of occurrence of each particular mode.

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CHAPTER ONE

INTRODUCTION

1.1 Background

Modal split can be defined as the proportionate division of the total number of person trips between different modes of travel. Modal split model predicts how people choose different modes of travel for different trip purposes. Built environment influence the utility of travel both directly and indirectly but the utility gains are different for different group of travellers, for different trip purposes and different modes (Reilly and Landis, 2003). A widely adopted approach for modal split analysis is the logit model (Ben- Akiva and Lerman, 1985). Recent experiment using logit models /spatial interaction models in order to map out the freight transport in Europe has been carried out by Tavasszy (1999), who showed the sustainability of logit models also for the goods transport sector. Transportation modes include walking, bicycling, transit, and using a vehicle (either as a driver or passenger).Modal split can be expressed numerically as a fraction, ratio or percentage of the total number of trips. Many different procedures have been developed to derive this split in the transportation planning process, all based on the assumptions that, of a given total travel demand the proportion carried by bus, tube, surface railway or private motor car will depend on the standing of each mode of transport in relation to its competitors.

Modal split model is the third step of travel demand analysis, it forms an integral part of the transport development strategy of any surveyed district. The identification of the factors which influence modal split provides the basis for modal split modelling. The volume of daily travel as a result of journey to work makes a critical contribution to the overall volume of movement in towns and cities. Horton *et al*. (1969) indicated that among all the traffic generated from the home in urban areas, journey to work normally dominates, both in importance and relative numbers. The uneven distribution of work trips during the day often contributes to the unpleasant phenomenon of congestion experienced during the peak hours.

Many metropolitan areas are plagued by a continuing increase in traffic congestion resulting in

- Motorist frustration rate.
- Longer travel times
- Increase freight transportation cost.
- Increase accidents and automobile insurance rates
- More fuel consumption and
- Deterioration in air quality.

These problems have been aggravated by the prevailing economic predicament. The inconsistent rise in the prices of vehicles and spare parts has made urban travels costly, time consuming and frustrating. In Nigeria, the substantial increase of petroleum products in recent years has brought about high increase in transport fares. In urban areas, however; the effect of modal split is quite significant and greatly influenced by transport policy decision, socio-economic characteristics of workers as well as the service characteristics of the various existing modes of transport (Black, 1981).

Modal choice, which is the focus of this research, involves procedures for allocating trips among various competing travel modes. Some of the methods that have been used in modal choice analysis include

- Discriminant Analysis (Lisinge, 1996)
- Probit (Banister and Hall, 1981)
- Logit model (Pundo and Fraser, 2006).
- Behavioural Models (Owolabi, 2009)

The behavioural model is quite robust in the variability of time, cost, flexibility and convenience etc.

1.2 Types of Modal split Models

There are two types of mode split models namely Trip - End and Trip - Interchange Models

1. Trip - End Models: These models are applied before trips are distributed, and predict transit shares as a function of independent variables such as

   i. Auto ownership in the zone
   ii. Residential density
   iii. Distance from Central Business District (CBD)
   iv. Income level

They are suitable for small urban areas where transit is basically a "social service" or in developing countries where mode choice is almost completely determined by income and auto ownership.

2. Trip - Interchange Models: These models are applied after trip distribution, and predict transit shares as a function of

   i. Relative travel time between competing modes
   ii. Relative travel cost
   iii. Economic status of trip makers
   iv. Relative service

1.3 Aim and Objectives

1.3.1 Aim

The aim of this research is to examine the characteristics of work trips undertaken by civil servants within Minna metropolis with a view to identifying the associated problems and proffer solutions to them.

1.3.2 Objectives

The objectives of this research are

- To appraise the modal split of work trips in the study area.
- To develop models for the trips' evaluation.
- To proffer solution to the problems of work trips' mode accessibility in the study area.

1.4 Justification for the Study

It is well recognized that one of the most important tasks in urban transport planning is to device a frame work that will enable each mode play its role. This can be done only if the common purpose of all modes is acknowledged. The present economic recession has made it difficult for the low and middle income groups to commute to work. Unfortunately, too, the existing public transport system [motorcycle, buses, and cars] are inadequate in their coverage and level of service. They charge very high fares and their services do not permit trips. This makes it necessary for workers to change mode several times before reaching their workplace. These multiple change of mode translates to high cost and long travel times.

Journey to work should be as short and precise as possible. It should also be free of any obstacle. Transport authorities can only assist to achieve this if the character of these movements can be identified. Extensive works have been reported by Daniel's and Mogridge (1981). Maunder and Mbara (1993, 1995a, and 1995b) have on their part carried out extensive studies on the urban bus sector in Harare (Zimbabwe). Amongst others, they investigated the effect of ownership on the performance of stage bus services, the effects of introducing commuter omnibus services in Harare and the effects of regular fare increases on stage bus patronage.

Results of their first work indicated that public sector ownership does not necessarily lead to decline productivity and operational performance. However, improvement in level of service under public sector ownership appeared to have been achieved at a cost, since most of the buses were acquired through borrowing hence while level of service improved, the financial performance deteriorated.

On the introduction of commuter omnibuses, the following conclusions were, made;

i. Supply and capacity of public transport system in Harare increased

ii. The level of service improved as shown by a reduction in passenger waiting time

iii. Fares tended to rise especially during peak hours and congestion at major locations in the city centre increased.

Finally, the third project showed that regular fare increases result in a decrease in bus patronage, with most of the passenger's resistance to fare increase being for short distance route or journeys. However, most of the research has been carried out in developed countries. There is, therefore the need for studies to examine the factors that influence work trips characteristics in developing countries of the world- Africa in particular. This will provide basis for comparing work trip characteristics of different areas and also provide transportation policy makers information to base different transport decision.

1.5 Scope of the Study

The scope of this study is limited to the major workplaces in Minna town. The activities of informal sectors i.e. hawkers and service oriented workers with highly mobile employment and whose work location covers a large area are not considered. This is because their journey to work is erratic and cannot be determined easily.

1.6 Description of the Study Area

The study area is Minna metropolis in Niger State. Minna is the capital of Niger State which was created on 3rd February, 1976 from what used to be called North-West State during the military regime of General Murtala Ramat Mohammed. The state is located between latitudes 3.20^0 east and longitudes $11.30^{\mathbf{0}}$ north. Niger State is located in the middle belt of Nigeria and bordered in the North by Zamfara, to the Northwest by Kebbi, to the South by Kogi. Kaduna and (FCT) Abuja border the State to the Northeast and Southeast respectively. Furthermore, the State shares a common international boundary with the Republic of Benin. Minna - Niger State has a land mass of $76{,}000km^2$ about 9% of Nigeria's total land area. This makes the state one of the largest in the country. It is called the "power state" and earned the nickname because of the Kainji dam which supplies electricity to Nigeria and most part of West Africa. Other dams are the Shiroro and Jebba dam which are also located in Niger State. Niger State has a beautiful landscape with various rocky hills around with some towns built in the valley like Suleja. The natives are mostly farmers and the land is very fertile with good harvest. Niger state played an important role in the history of Nigeria; indeed it is in this state, Zungeru, to be precise that the capital of Northern Nigeria sat between 1902 -1916. It was in Zungeru in Niger State that Northern and Southern Nigeria was amalgamated by Fredrick Lugard in 1914. It was also in Zungeru that the first president of Nigeria Dr. Nnamdi Azikiwe was born.

Fig 1.1 shows the map of Niger state while Fig 1.2 shows the Minna street guide map (the study area) depicting some major streets, Level crossing, Bridge, Hospital , Residential areas, Ministries e.t.c.

Fig 1.1 Map of Niger State-Nigeria

Fig 1.2 Minna Street Guide Map (the study area) Niger State- Nigeria

CHAPTER TWO

LITERATURE REVIEW

2.1 Mode Choice

The choice of transport mode is probably one of the most important classic models in transport planning. This is because of the key role played by public transport sector in policy making. Public transport modes make use of road space more efficiently in Nigeria than private transport. Also they have more social benefits like if more people begin to use public transport, there will be less congestion on the roads and the accidents rate will be less. Again in public transport, one can travel with low cost. In addition, the fuel is used more efficiently. Main characteristics of public transport are that they will have some particular schedules, frequency e.t.c**.** On the other hand, private transport is highly flexible. It provides a more comfortable and convenient means of travel. It has better accessibility also. The issue of mode choice, therefore, is probably the single most important element in transport planning and policy making. It affects the general efficiency with which one can travel in urban areas. It is important then to develop and use models which are sensitive to those travel attributes that influence individual choices of mode. Travel arises because someone has to move from one place to another for one reason or the other. Therefore for each trip there must be the origin and destination. In the process of achieving origin and destination, sometimes people only use one vehicle (unimodal). This is usually used as personal vehicles. But there are also many people that use more than one mode (multimodal) to travel by using the public transport system. The travellers that use several modes usually need longer journey time and more cost, so many people switch to personal vehicles. Travellers can be classified into two groups: choice riders and captive riders. Choice riders have two travel modes to select: public transport or private transport (car or motorcycle) whereas captive riders have only one travel mode option to select i.e. public transport.

2.1.1 Factors Influencing the Choice of Mode

The factors may be listed under three groups

1. Characteristics of the trip makers: The following features are found to be important

    a) Car availability and /or ownership

b) Possession of a driving license

c) Household structures (young couple, couples with children, retired people etc)

d) Income

e) Decision made elsewhere, for example the need to use a car at work, take children to school etc

f) Residential density

2. Characteristics of the journey: Mode choice is strongly influenced by

   a) The trip purpose: for example, the journey to work is normally easier to undertake by public transport than other journey because of its regularity and the adjustment possible in the long run.

   b) Time of the day when journey is undertaken

   c) Late trips are more difficult to accommodate by public transport.

3. Characteristics of the transport facility: There are two types of factors. One is quantitative and the other is qualitative.

   Quantitative factors are

   a) Relative travel time: in - vehicle, waiting and walking times by each mode

   b) Relative monetary cost (fares, fuel and direct costs)

   c) Availability and cost of parking

Qualitative factors which are a bit difficult to measure are

d) Comfort and convenience

e) Reliability and regularity

f) Protection, security.

2.2 Factors Affecting Mode Choice Decision

Very little work has been done on the demand for passenger travel in developing countries. But understanding and predicting urban travel demand is crucial to transport planning and design of urban areas, especially in the rapidly growing developing countries. Mode choice is perhaps the most policy -oriented element in the whole process of analyzing and forecasting demand for urban travel. In particular, the analysis of workers choice of modes is intended to provide information about the effects of various policies , like fare structures, taxes on petrol, adding buses, planning routes, improving roads, etc. The information can be used along with other information in deciding which policies are to be implemented and which are likely to be more effective. More recently, mode choice models incorporating parking spaces are being estimated in developed countries. The effects of incentives designed to promote ride-sharing (car -pooling and van -pooling) on work trips to reduce congestion and pollution are estimated using data on workers commuting behaviour [(Feeney, 1989); Willson and Shoup (1990); Hwang and Giuliano (1990); Stevens (1990)].

Thobani (1984) studies in the city of Karachi is the most well known. He estimated a probabilistic joint mode choice and auto ownership model. He estimate demand elasticity for time (access and in - vehicle) and travel costs. The author applied the nested logit maximum likelihood technique to a sample of 400 travellers in the city of Karachi. The study revealed that the decision to own a car is made simultaneously with the decision about which mode to take to work. The results of the study suggested that

i. Heads of household have greater utility from the use of the car.

ii. Car travel time is less onerous than bus travel time.

iii. Suburban dwellers have lower values for time than urban dwellers (supporting train's results).

iv. The elasticity with respect to out-of-vehicle time is high and

v. Cross elasticity between bus and minibus, which are close substitutes, are low.

Watson (1974) considered the effects of income on the mode-choice decision. Results of the work indicated that income strongly influenced mode -choice decision. Lomax and Dowues (1974) also carried out a study of travel pattern to schools and work places in the town of Reading. They found out that work places which are located near the town centre drew trips uniformly from all parts of the survey area, that trips to work places in the outer area were shorter than those to central area, and finally, that a large proportion of trips to the outer area were on foot and cycle, and a smaller proportion by bus.

Highlights of the work of Daniels (1979) include:

- That location and availability of car parking and the level of service provided by public transport influence the modal-split work trips and indirectly affects the spatial and temporal distribution of work trips.
- That distance and travel times for a journey to work varied according to the mode of transport used and that public transport was extensively used over short distance but the duration of travel time was usually higher than for journeys of equivalent distance by car. Daniels (1979) further did a comparative study of journey to work of five urban areas of various distances from London. Some of the findings include:
- That the majority of journeys to work by car drivers in all the centres are made by office staff while most car passengers journey are made by females.
- That there is a moderate association between car ownership and travel mode choice from all five centres studied. Between half and one-third of journeys to work by bus or on foot are generally by office workers from households which do not own or have access to a car.

Ojumu (1975), base his study on selected low income earners in Lagos, Nigeria and had the following conclusions:

Low income earners tend to walk when commuting distances that are within one kilometre, use bicycles as a means of transport for distance of one to four kilometre whereas they use motorcycle, taxi or bus when distances are beyond four kilometres. In a related study, Sani (1982), in his M.Sc thesis, examined the factors influencing mode choice of Kaduna State civil servants using discriminant analysis to administered questionnaires, he reported

- That the most important variable in distinguishing between various mode users is personal income.
- That the non-inclusion at any level of service factors other than transport fare in discriminate analysis implicitly confirmed that the studied workers were captive mode users.
- That the positions in household as well as the number of cars possessed in a family are important factors influencing mode-choice decision.

  Lisinge (1996), in his M.Sc thesis, examined the effect on the mode choice of the devaluation of the Franc (CFA) and the liquidation of government operated urban bus service, (SOTUC) using discriminant analysis. These were found to have jointly resulted in:

- An increase in the use of taxis
- An increase in the number of civil servants who travel to work as car passengers
- An increase in the number of those who walk to work and
- A reduction in the use of private vehicles to work.

2.3 Theoretical Development in Mode Choice Models

Development in modelling travel demand has also received a great deal of scrutiny and research based mainly in the Netherlands has been extensively reported by Jansen et al (1976). The use of discriminate analysis, utility maximization model, as well as Probit and Logit model has also been reviewed by Banister and Hall (1981). The Logit program is widely used in aggregate forecasting work. The reason for this is that the Logit formula is easy to use, and can readily be extended to cover choices from more than two modes, although statistical estimation of the parameters of the model remains a problem.

2.4 Transport Policies and Mode choice Decision

Over the past decades, transportation has increased dramatically in the European Union (EU) (CEC 2002). Growth rates vary significantly between prevailing transportation modes. Roads usage increased exponentially, while the use of inland waterways and rail decreased (CEC 2001a). Average traffic speed has decreased by ten (10) percent over the last ten (10) years in major OECD cities (OECD 1995). Six percent of fuel is consumed in traffic jams and delays (CEC 2001a), reflecting an economic loss of two percent GDP (CEC2001c).

Plowden (1980), in his own contribution argued that transport problems, like traffic jams and long bus queues resulted from the lack of a suitable framework of institution.

An important trend in transportation studies, which is now gaining grounds, is the assessment of transport policy decision. Black (1981) illustrated how behavioural travel demand models may be applied in examining the implications of different urban transport policies. Multinomial logit probability models was calibrated using data obtained in Camberra (Australia) to examine changes of modal split stimulated by different transport policies and to trace the effects on different groups within the community. Some of the major findings of the work include:

- That reduction in bus travel times to reflect the introduction of bus priority measures would have a negligible impact on altering model choice.
- That the mode-choice for all journey purpose was insensitive to bus fare.
- That the introduction of parking charges increase bus patronage, reduce the number of car drivers travelling alone and increase the number of car passengers.

However, all the above studies were undertaken shortly after the implementation of the policy changes that were being investigated. Such short period of time is not sufficient to make any definite conclusions.

2.5 Urban Travel Patterns

Urban travel demand patterns were classified by Hutchinson (1974), into the broad categories shown in Fig. 2.1 and described as follows:

Type 1 is travel along corridors focused on the Central Business District (CBD). It is characterized by high intensity along definite corridors with concentrated peak movements. This needs high capacity system to provide the service (Khanna, 1988).

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

Type 3 is travel within residential areas. This type of travels might be between local activities or longer trips within an urban area. This calls for careful attention to safety and environmental quality (Khanna, 1988).

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

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

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

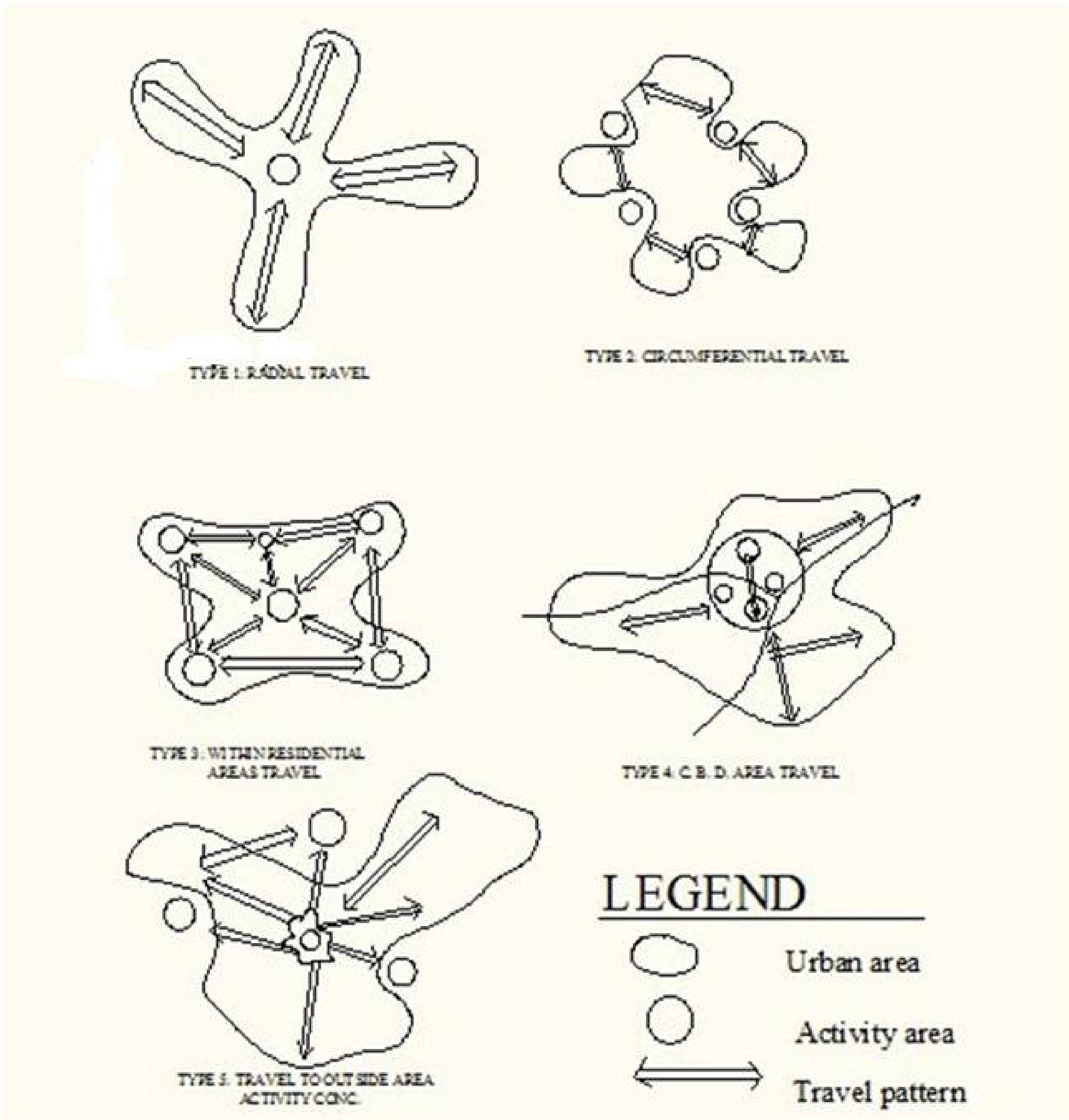


Fig.2.1 Urban Travel Demand Patterns

Source: KHANNA (1988)

2.6 Approaches and Strategies used in Planning for Journey to Work

The problems of journey to work are derived largely from the distributions of the residences and workplaces or employment centres. Studies in Karachi (Pakistan) indicated on a smaller scale how planned community growth can minimize local transportation problems. There, a growth, plan financed through the United Nations Development Programme (UNDP) recommended the creation of a series of “metrovilles” or compact communities of 40,000 to 50,000 people focusing on self help housing and public housing programmes and of street systems, close by schools, clinics, markets and bus depots and light industry capable of employing large volumes of local labour (Owen, 1978). The growth strategy was developed to create an orderly growth process designed to conserve resources, avoiding unnecessary transportation and reduce the distance between homes and workplaces.

Joint land use and transportation planning approach could be used to great advantage since different land use generate and attract different and variable traffic flow. The fundamental aim of planning should be to provide most people with the opportunity to live reasonably close to their places of work in the interest of personal convenience and economy and in order to relieve urban congestion (Keeble, 1969). There will always be cases of people living in one zone and working in another zone. Another approach which has been proposed is to study and plan the transportation modes of the town. Attention would be paid to the types of mass transit systems to include a family of modes of different characteristics and compatibility. Such modes would offer a spectrum of transport services ranging from the highly flexible taxis and motorcycles services to a rigid fixed route, fixed schedule services of rail and rapid transit systems.

Among strategies so far proposed for minimizing traffic congestions during the journey to work in urban centres include the following.

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

b. The application of constraints to the use of private cars by imposing charges (parking, tolls etc) on the use of car rather than on “Ownership” .The proceeds may be used to build up mass transit fund with which to subsidize mass transit users.

c. Banning of automobile traffic in limited areas of the city and the dedication of the streets to pedestrians and transit vehicles. There are also the avoidance systems, such as designing urban activity system that reduced the need for vehicle movement (Thompson, 1972).

d. The use of urban freeways as in Lagos, Nigeria to provide rapid flow of traffic and reduced congestion.

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

f. Catering for public transport vehicles, the needs of pedestrians and cyclists.

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

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

i. By introducing modern traffic management schemes.

2.7 Factors Affecting the Attractiveness of Transportation Modes

Modal choice is generally driven by a company's desire to remain competitive by serving their customers both effectively and efficiently. Three factors determine the attractiveness of containerized transportation offers to a large extent: Cost, time in transit, and reliability of transit time (Cullinane et al., 2000; Mc Ginnis et al., 1981). Several studies indicate that the reliability of promise regarding transit time is more important than the duration of the transit itself (Murphy et al., 1997; Premeaux, 2002; Semeijin et al., 1995).

2.7.1 Costs

Transportation costs are mainly determined by fuel prices, efficiency of the transportation mode and taxes. An important recent change in the attitude of European policy makers is the idea that transportation cost should reflect the time cost to environment and society. Based on this idea, a policy framework is developed to be implemented by 2005, (Commission of the European Communities, CEC 2001b). Environmental impacts of transportation not only include the consumption of energy but also the emission of Carbon Monoxide (CO), Carbon Dioxide (CO_2), Sulphur Dioxide (SO_2), Nitrogen Oxide (NO_x) and hydrocarbons. SO_2 and NO_x are two known causes of acid rain. Nitrogen Oxides indirectly contribute to the green house effect and directly to smog (Stanners *et al*., 1995). The environment is substantially burdened by the side effects of transportation, but the effects tend to vary per transportation mode. Compared to transportation via rail and inland water ways, road transportation produced about four times the Nitrogen Oxide, Sulphur and Carbon Dioxide emissions per ton -km (Van Ierland et al., 2000). Transportation cost to society includes noise and light pollution, as well as accidents.

2.7.2 Speed and Reliability

Speed and reliability are determined by the characteristics of each mode, and capacity limitations of the existing infrastructure. Since the deregulation of the EU motor carrier industry in 1993, the establishment of Pan –European Corridors (PAN) has been encouraged by the EC (Lewis et al., 2001-2002). Increased liberalization has led to a more efficient transport system by, for instance, allowing sabotage. However, deregulation has not led to a measurable reduction in transportation rates in Europe (Gentry *et al*., 1995), as was the case in USA and Canada (Bardi et al., 1989). Operating expenses have been steadily increasing due to high fuel prices and road charges, more than offsetting any rate cuts. Severe and chronic congestion currently affect average speed and reliability of the road transportation network. Australia and Switzerland have imposed restrictions on motor carrier movement in their countries. Germany and France –among other EU countries-restrict weekend traffic of trucks (Lewis *et al*., 2001-2002), further decreasing the attractiveness of road haulage. The operational part of the European railway network has decreased in length by about 10% over the past three decades (CEC 2002). Bottlenecks are also formed by bridges, passes across mountains and tunnels (CEC 2001a). Varying levels of railway privatization across EU countries reflect another weakness; Public owned systems are generally less efficient (Gentry *et al*. 1995). A focus on national priorities often impedes cross border traffic. Unlike information systems for passenger rolling stock, the system for freight transportation are not integrated and standardized across the EU. The lack of integration and standardization creates many difficulties including long border delays. The opening of all markets by EU legislation, in force since March 15, 2003, is expected to bring about some changes.

2.8 Factors that Affect Journey to Work

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

2.8.1 Transport cost and residential location

It is generally believed that work trips characteristics are determined by residential choice among workers. Caroll (1952) suggested that the costs incurred in journey to work are major determinants of residential location and therefore, most workers attempt to minimize the length of their journey to work. Carroll's studies of some factory workers concluded that most of the workers live close to work and that beyond two or three kilometres, the population of workers decreases as the distance from the factory increases and attributed this pattern to tendency by reducing travel time, cost and the location of residential houses.

This relationship between transport cost and residential location has been illustrated by Schreiber (1976) to fit the pattern drawn in Fig 2.2. The wage curve is horizontal (wage do not vary with distance). The cost of transportation to work is upwards sloping as distance from the core increases. The compensating savings in cost residing further from the core (otherwise the houses of workers would have been clustered near the core) is that the price of land decreases with distance from the core, workers would pay more for housing if closer to the core, so they trade off reduced housing cost with increased transport cost in their choice of residence.

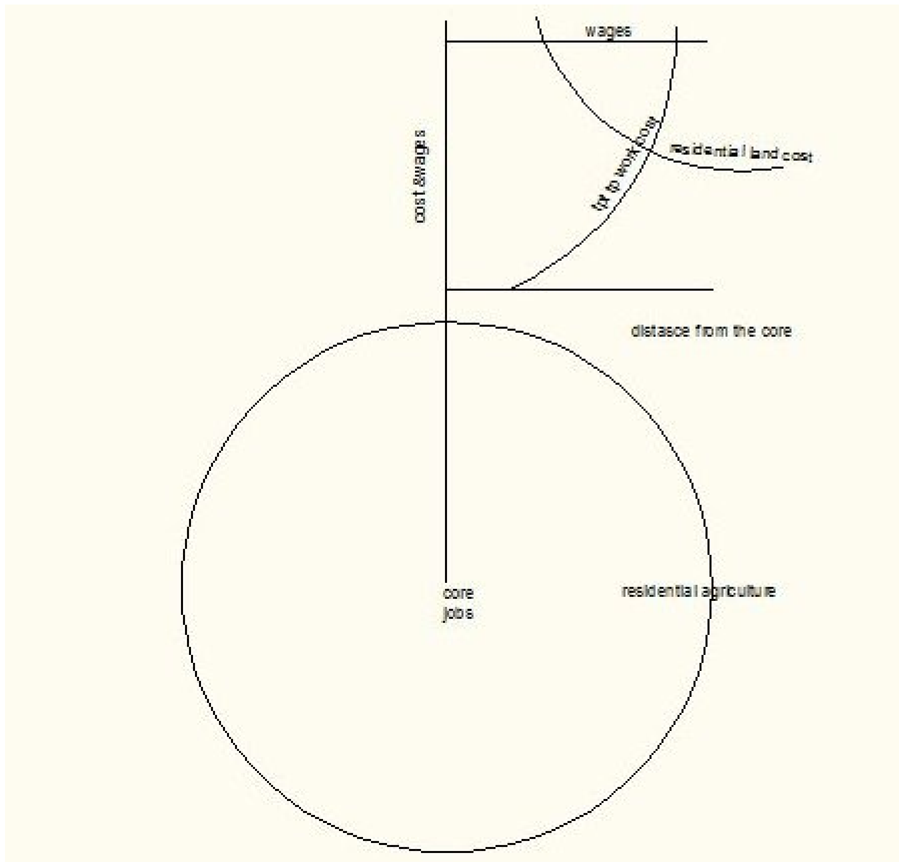


Fig: 2.2 Distances and Cost in a Core Dominated City Source: Sschreiber, 1976.

This model is based on the character of the United States housing market. The model assumes a mono-centric city where workplaces are concentrated at the centre. The situation is likely to be more complicated where there are multiple workplaces. Nevertheless, the model gives an idea that residential choice of workers is influenced by journey to work.

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

In other related studies, Beesly et al. (1974) analyzed the 1951 and 1961 commuter census data for central London and found that socio-economic status strongly influenced the residential distributions relative to workplace and that this influence does not decline much with time. One shortcoming of the study was that they failed to account for the influence of availability and non- availability of vacant residence.

Guest (1976b) investigated the influence of metropolitan population, size and age on work trip patterns and found that metropolitan population, size and age do not exert strong effects on work trip patterns of metropolitan area and that workplace exerted a strong, though not profound effect on the location of residence. He further found that work trips from sub urban areas to central city were increasing whereas those within the central city were decreasing.

2.8.2 Modal choice

The cost of the workers final choice of mode in time, comfort, convenience and money will depend on how much residential space he consumes and the level as well as types of transit services available (Meyer, 1965). The mode of travel by employees for daily journey to work affects the characteristics of trip time and trip length (Daniels, 1973). Trips by private transport, with the exception of trips on foot, are generally faster per unit of distance than public transport because of waiting and stopping times at loading points. Given the diversity of transportation modes that are available to the users of a large transportation network, a predicting traffic model cannot be designed without taking into account modal choice decision. Modelling these decisions means predicting a distribution of different journeys which are split according to available transportation modes (car, bus, Metro, walking etc). More precisely, the total number of trips from a zone i to a zone j can be view as a transportation demand. If more than one transport mode is available for commuting from i to j, the alternative mode compete in order to fulfil that demand. Hence, deciding on a modal choice is a matter of preferences and human choice faced with a market of competitive offers. A modal choice then needs to focus on characteristics of the alternative as well as on personal characteristics of the individual making these choices. Indeed the preference of an individual for a specific transportation mode seems to be influenced.

2.8.3 Socio-economic status of workers

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

Several authors have tested the hypothesis that commuting distance increases as occupational status rises but the results of these studies range from acceptance through no meaningful relationship to inverse relationship (Wheeler, 1967). These mixed findings have led more than one investigator to conclude that work trips behavioural are individualistic and varies with the time and palace (Peterson, 1961).

The effects of travel costs and level of service on mode choice patterns were investigated by Ben Akiva *et al*., (1976). They found that out of pocket travel costs have no significant influences on mode choice. This is contrary to general beliefs. The authors concluded that the probability of any one choosing a given mode is determined largely by factors other than level of service effect offered by the mode.

2.9 Survey Area

"Journey to work" is a term used to describe data collected as part of a census that describes aspects of commuting behaviour .It is the most regular trip made by workers and constitutes a major part of the traffic in the streets of towns and cities. A substantial number of workers employed in Minna are from Government Ministries.

As a result of the fact that these Ministries are grouped together, a high volume of traffic is generated in this area especially during the morning and evening rush hours. Government Ministries are therefore the target of this survey. The grouping of the Ministries also makes the data collection easier.

2.10 Selection of Variables

Behavioural choice models attempt to appraise the driving force that affects choices about travel. Individual subjectively weigh differently such factors as; driving and parking versus transit charges, congestion, time consumed including walking, waiting as well as schedule delays, comfort and cleanliness of vehicles, privacy and flexibility, accidents or other personal safety considerations, dependability and the opportunity to carry out such activities as conversing, listening to car radio or working or reading.

In making these decisions, travellers are influenced by their occupation, level of education, income and trip purpose. Other influences for example those within household also affect choices.

Models presently used do not attempt to incorporate all these factors. A model that considers all these factors would be very complex and cumbersome. Besides, very lengthy questionnaires would be required to capture them and this will increase the non-response rate in addition to being less economical.

For the purpose of this study, the following variables were therefore used.

1. Level of Service variables
   - (a) IVTT: In - vehicle travel time (min)
   - (b) OVTT: Out - of vehicle travel time (min)

     OVTT could be further broken into

     - (i) POVTT: Park out- of -vehicle travel time-applicable to all modes except walking
     - (ii) WOVTT: walk time-specific to walk trips
     - (iii) WOTT: walk time, to station or taxi-specific to buses and taxis
     - (iv) SOVTT: waiting and transfer time-specific to buses and taxis
2. Socio-economic variables
   - (a) Income level
   - (b) Car ownership
   - (c) Number of vehicles in household
   - (d) Occupation
   - (e) Position in household
   - (f) Age

The following travel choices were defined.

(a) Private car (owner)-users of official vehicles with assigned drivers are included in this category.

(b) Private car (lift) –Assigned drivers of officials' vehicle are included in this category (car passenger mode)

(c) Taxis

(d) Bus

(e) Motorcycle

(f) Bicycle

(g) Walking

2.11 Discrete Choice Model

Discrete choice models are widely used in economics, marketing, transportation and other fields to represent the choice of one among a set of mutually exclusive alternatives. Discrete choice models are statistical procedures that model choices made by people among a finite set of alternatives. The models have been used to examine, e.g. the choice of which car to buy, where to go to college, which mode of transport (car, bus, rail) to take to work among numerous other applications. Discrete choice models are also used to examine choices by organizations, such as firms or government agencies. They statistically relate the choice made by each person to the attributes of the person and the attributes of the alternatives available to the person e.g. the choice of which car a person buys is statistically related to the person's income and age as well as to price, fuel efficiency, size and other attributes of each available car. The models estimate probability that a person chooses a particular alternative. Discrete choice model are often used to forecast how people choice will change under changes in demographics and attributes of the alternative. Most discrete choice models are based on random utility maximization hypothesis. The development of discrete choice models represents a significant advance in the analysis of individual choice behaviour. Multinomial Logit model is the most popular form of discrete choice model in practical applications. It is based on several simplifying assumptions such as independently and Identically Gumbel Distribution (IID) of random components of the utilities and the absence of heteroscedasticity and autocorrelation in the model. Some of these assumptions do not appear unrealistic, but taken together it is often unrealistic to imagine any real world situations where all the conditions are satisfied. It has been shown that these simplifying assumptions limit the ability of the model to represent the true structure of the choice process. Recent research works points to the development of closed form models which relax the assumption of the multinomial Logit model to provide a more realistic representation of choice probabilities within a closed form framework.

Mixed Logit and Generalized Extreme Value (GEV) models are examples of these alternative model structures (Bhat, 2002).

2.12 Multinomial Logit Model (MNL)

The Logit model is a choice model between two or more alternatives. It belongs to the disaggregated choice models of consumer research. Multinomial Logit models are used in applications in marketing that have several distinct outcomes and are widely used in transport research, economics, marketing and operations management literature, among many other fields, see Anderson et al. (2001), Ben- Akiva and Lerman (1993) ,Talluri and van Ryzin(2005)

Multinomial Logit models are simple and easy to understand in terms of both statistical inference and computation and are particularly attractive in many modelling scenarios due to their link in decision - making process via maximizing or minimizing the utility (travel cost). One common application is to predict what product or brand a customer is going to choose. Another application is to predict purchase when the consumer may have more than two options, e.g. pay a loan instalment, pay off and close the loan or default. Multinomial logit model is similar to the binary logit model except that the dependent variable in this case will have multiple discrete outcomes instead of just 2. e.g. a model predicting consumer choice (choose 1 out of 5 brands) models predicting market share ranks e.t.c. The estimation technique is very similar to the binary logit model except that instead of predicting odds of 1 or 0, it predicts the odds of the different outcomes against a baseline.

CHAPTER THREE

METHODOLOGY

3.1 Survey Design

A carefully designed questionnaire was administered to acquire inputs to the discrete choice model that was developed in this work. The multinomial logit model was used to calculate the probability of occurrence of each particular mode of travel. A procedure which some authors (Kish, 1965) refer to as "experts choice "was used. This is a purposive or judgment sampling method used to pick typical or representative samples. In the case of this survey, workers who had an insight of their co-workers were chosen in each of the ministries. These are people who could easily separate their co-workers into different income groups.

Questionnaires were administered to these selected workers who now distribute them proportionately to the respondents (civil servants). Burgers (1982), Hughes and Preski (1997) refers to these selected individuals as "key informants".

3.2 Derivation of Multinomial Logit Model

Commencing from the model with only two alternatives. Suppose, the consumer will make his choice based on the utility maximization rule (Ben-Akiva and Lerman, 1985). According to this rule, the consumer *i* chooses the alternatives, which maximizes his utility U_i . The two alternatives *j* and *k* creates the choice set *C* with $C = \{ j, k \}$. The probability that consumer *i* chooses alternatives *j* is

$$P_i(j) = P(U_{ij} \geq U_{ik}) \qquad 3.1$$

Assuming now, the utility function U_{ij} from equation (3.1) can be separated into two parts

$U_{ij} = V_{ij} + \varepsilon_{ij}$, V_{ij} being a systematic utility component and εij a stochastic component (Guadagni and Little, 1983). In the simplest case, the stochastic components are assumed to be independently and identically Gumbel distribution (iid) and extreme value distributed. For other choice models e .g the probit model, another distribution for the error term is assumed (Ben-Akiva and Lerman, 1985). The systematic utility component is typically specified by a linear function.

$$V_{ij} = {}^{T}x_{ij} \qquad 3.2$$

Where is a vector of parameters to be estimated and x_{ik} the vector of explanatory variables. Equation (4.2) can now be rewritten as

$$P_i(j) = P(U_{ij} \geq U_{ik}) = P(V_{ij} + \varepsilon_{ij} \geq V_{ik} + \varepsilon_{ik})$$

$$= P(\varepsilon_{ik} - \varepsilon_{ij} \leq V_{ij} - V_{ik}) \qquad 3.3$$

Assuming that $\varepsilon_{ik} - \varepsilon_{ij}$ has a logistic distribution, the probability from Equation (3.3) can be written as

$$P_i(j) = \frac{1}{1 + \exp\{-(V_{ij} - V_{ik})\}} = \frac{\exp(V_{ij})}{\exp(V_{ij}) + \exp(V_{ik})}$$

$$= \frac{\exp(\ ^T x_{ij})}{\exp(\ ^T x_{ij}) + \exp(\ ^T x_{ik})} \qquad 3.4$$

The coefficients in are typically estimated by maximum likelihood (Ben-Akiva and Lerman, 1985). The absolute values (if all variables are on the same scale) and the signs of the estimated *a*re of great interest. In particular, if the sign is positive, an increase in the explanatory variable results in an increase of the response variable. For a negative sign this effect turns to the opposite. The absolute values give information about the strength of the connection between the explanatory and the response variable.

The binary Logit model from equation (3.4) can be generalized to a case with *J* alternatives in a straight forward way. Utility maximization is again the basic decision rule here. The choice set *C contains J* alternatives. Each consumer chooses the alternatives that give him maximal utility. With this decision rule, the multinomial case can be reduced to the binary model. This is possible, because the maximal utility is taken against the other alternatives, and these other alternatives can be grouped as one possible 'rest choice'. Formally this can be written as

$$P_i(j) = P(U_{ij} = \max_{k \in C} U_{ik}) = P(U_{ij} \geq U_{ik} \text{ for all } k \in C$$

$$= P(\varepsilon_{ik} - \varepsilon_{ij} \leq V_{ij} - V_{ik}) \text{ for all } k \in C \qquad 3.5$$

In this framework, the systematic utility component is typically specified by the linear function

$$V_{ij} = \ ^T x_{ij} = \beta^T z_{ij} + \gamma_j^T \omega_i \qquad 3.6$$

Where x_{ij} is split into $x_{ij} = [\, z_{ij} , \omega_i \,]$ with z_{ij} denoting alternative specific part and ω_i the individual specific part of the explanatory variables, ω_i does not vary over the alternatives, because the household size or the number of children is independent of the purchase. With Equation 3.5 and the assumption about the iid and logistic distribution error differences $\varepsilon_{ik} - \varepsilon_{ij}$, the probability of the *i-th* consumer to purchase alternative *j* is

$$Pi\,(j) = \frac{\exp\,(V_{ij})}{\sum_{k \in C} \exp\,(V_{ik})} = \frac{\exp\,(\beta^T z_{ij} + \gamma^T{}_j\,\omega_i)}{\sum_{k \in C} \{\exp\,(\beta^T z_{ik} + \gamma^T{}_k\,\omega_i)\}} \qquad 3.7$$

This model is the most general case of a multinomial Logit model. The parameter values in β and $\gamma_{j,}\ j \in C$ can again be estimated by maximum likelihood.

If only product specified variables z_{ij} are used as explanatory variables, the probability $P_i\,(j)$ is given by

$$P_i\,(j) = \frac{\exp\,(\beta^T z_{ij})}{\sum_{k \in c} \exp\,(\beta^T z_{ik})} \qquad 3.8$$

In this case, the model is called the conditional Logit model. Multinomial Logit models have some obvious deficiencies. One problem is the assumption of the logistic distribution of the error differences. Another structural problem lies in the linear assumption for the systematic part of the utility function, which is a very strong restriction. There is no need for the data to follow this linear modelling, also all other types for modelling the explanatory variables should be allowed. These weak points are the reasons for the various approaches to improve the model (e.g. Ben- Akiva *et al*., 1997) or Horowitz *et al*., (1994). But all these new models are given without testing the multinomial Logit model against an alternative. This substantial gap should be filled by this article.

3.2.1 Modelling the logit

In the Multinomial logit model the log - odds of each response is assume to follow a linear model

$$h_{ij} = log\, p_{ij} / p_{ij} = a_j + X_i\, b_j \qquad 3.9$$

Where a_j is a constant and b_j is a vector of regression coefficients, for j= 1, 2...J - 1. Note that by written the constant explicitly, it will assume henceforth that the model matrix X does not include a column of ones. The model is analogous to a logistic regression model, except that the probability distribution of the response is Multinomial instead of binomial and these results to J-1 equations instead of one. The J-1 multinomial logit equation contrasts each of categories 1, 2, J-1 with category J, whereas the single logistic regression equation is a contrast between successes and failures. If J = 2 the multinomial logit model reduces to the usual logistic regression model. Note that only J-1 equations will describe a variable with J response category and that it really makes no difference which category is picked as the reference cell, because one can always convert from one formulation to another. In our example with J = 3 categories, it contrast categories 1 versus 3 and 2 versus 3. The missing contrast between categories 1 and 2 can easily be obtained in terms of the other two. Since log (P_{i1}/P_{i2}) = log (P_{i1}/P_{i3}) - log (P_{i2}/P_{i3}). Since logit is a quadratic function of age, the model can be entertained

$$h_{ij} = a_j + b_j a_i + g_j a_i^2 \qquad 3.10$$

Where a_i is the midpoint of i-th age group and j = 1, 2 for sterilization and other method, respectively.

3.2.2 Modelling the probabilities

The Multinomial logit model may also be written in terms of the original probabilities P_{ij} rather than the log - odds. Starting from equation (3.9) and adopting the convention that $h_{iJ} = 0$, we can write

$$P_{ij} = \underset{k=1}{J} \exp\{h_{ij}\} / \exp\{h_{ik}\} \qquad 3.11$$

For j =1, J. To verify this result exponentiate equation (3.9) to obtain $P_{ij} = P_{iJ} \exp\{h_{ij}\}$, and note that the convention $h_{Ij} = 0$ makes this formula valid for all j. Next sum over j and use the fact that $P_{ij} = 1$ to obtained $P_j = 1/j \exp\{h_{ij}\}$. Finally, use this result in equation (3.11).

Note that equation (3.11) will automatically yield probabilities that add up to one for each i.

3.3 Statistical Package for the Social Sciences (SPSS)

SPSS is a computer package that offers broad range of capabilities for understanding and analyzing data. One of the many statistical procedures which the SPSS contains is multinomial Logit model. With SPSS it is possible to generate decision – making information quickly using statistics that have rigor and power and effectively present results with high quality graphical group. SPSS technology has made difficult analytical task easier through advance in usability and data access, enabling more people to benefit from the use of qualitative techniques in making decision.

3.4 Utility Function

Utility function measures the degree of satisfaction that people derive from their choices. A disutility function represents the generalized cost that is associated with each choice. In the case of modal choice the characteristics of trip e.g. trip purpose bears a relationship to the utility with a particular mode of travel. The utility (disutility) function is typically expressed as a linear weighted sum of the independent variables of their transformation.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Sample Size and Response Rates

A total of 2,000 questionnaires were administered for the field work, out of which 1,467 were returned and used for the analysis. This gives a response rate of 73.4%.

Table 4.1 – 4.7 illustrates the descriptive frequency distribution of respondent by Age, Position in household, Income level, and Mode of travel, Travel time, Car ownership and Sex respectively.

Table 4.1: Frequency Distribution of Respondents by Age.

Age Group	Frequency	Percent	Cumulative %
18 - 24 years	83	5.7	5.7
25 – 31	392	26.7	32.4
32 – 38	842	57.4	89.8
39 and above	150	10.2	100
Total	1,467	100	

Source: Field work 2011

Table 4.1 indicates that 57.4% of the respondents are within the age group of 32 – 38 years, while 5.7% represents the age group of 18 – 24 years.

Table 4.2: Frequency Distribution of Respondents by position in Household

Position in household	Frequency	Percent	Cumulative%
Husband	691	47.1	47.1
Wife	367	25	72.1
Son	157	10.7	82.8
Daughter	168	11.5	94.3
Relation	84	5.7	100
Total	1,467	100	

Source: Field work 2011

As expected in table 4.2, male workers outweigh the females with 57.8% as against 42.2%.

Table 4.3: Frequency Distribution of Respondents by Income

Estimated monthly income	Frequency	Percent	Cumulative%
□5,000- 15,000	716	48.8	48.8
□16,000 – 30,000	354	24.1	72.9
□31,000 - 45,000	177	12.2	85.1

□ 46,000-60,000	121	8.2	93.3
Greater than □61,000	99	6.7	100
Total	1,467	100	

Source: Field work 2011

In Table 4.3, majority of the respondent reported an income level of □5,000 – 15,000 with a response rate 48.8%. Respondent who reported income level greater than □61,000 are the least with response rate of 6.7%.

Out of the 2,000 questionnaires administered for the survey, 533 were either not returned or were returned uncompleted.

Table 4.4: Frequency Distribution of Travel Time to Work by Respondents

Travel Time	Frequency	Percent	Cumulative %
< 5min	10	0.7	0.7
6-10min	38	2.6	3.3
11-15min	160	10.9	14.2
16-20min	176	12	26.2
21-25min	307	20.9	47.1
>26min	776	52.9	100
Total	1,467	100	

Source: Field work 2011

Table 4.4 indicates that 52.9% of the respondents travel for more than 26 minutes before getting to work, while 0.7% travels less than 5 minutes to work.

Table 4.5: Frequency Distribution of Mode of Travel to Work by Respondents

Mode of Travel	Frequency	Percent	Cumulative %
Bus	142	9.7	9.7
Taxi	648	44.2	53.9
Passenger car	314	21.4	75.3
Personal car	183	12.5	87.8
Motor cycle	160	10.9	98.7
Bicycle	12	0.8	99.5
Walking	8	0.5	100
Total	1,467	100	

Source: Field work 2011

Table 4.5 shows that civil servants in Minna use taxi as the dominant mode of transport to work with a response rate of 44.2%. This is followed by the users of passenger car with response rate of 21.4%. Walking mode has the least reported on with response rate of 0.5%.

Table 4.6: Non – Response Rate by Sex

Sex	Number of Questionnaire		Response Rate in percent
	Distributed	Returned	
Male	1,100	848	57.8
Female	900	619	42.2
Total	2,000	1,467	100

Source: Field work 2011

This indicates 42.2% response rate for female workers compared to their male counterpart with 57.8%.

Table 4.7: Frequency Distribution of Respondent by Car Ownership

Car Ownership	Frequency	Percent	Cumulative%
Yes	183	12.5	12.5
No	1,284	87.5	100
Total	1,467	100	

Source: Field work, 2011

Table 4.7 shows that 12.5% of workers in Minna own cars, while 87.5% of the respondents are non car owners.

4.2 Cross Tabulation Results

This section discusses results of the field data obtained using SPSS and analyzed in the following areas; the influence of personal income on modal choice, the influence of position in household on modal choice, the influence of travel time on modal choice and the effect of home location on travel mode.

4.2.1 The influence of personal income on mode choice.

Income normally should play an important role in the choice of travel mode to work. Table 4.8 illustrates the significance of income level on mode choice decision in the area studied. In table 4.8, none of the respondents who go to work by private car reported an income level of between □5,000- 15,000. However, 62.5% of those who walk to work reported an income level of between □5,000- 15,000, 25% reported an income level of between □16,000- 30,000 and 12.5% reported an income level of between □31,000- 45,000 .while none reported an income level greater than □61,000. Evidently, economic conditions must have force people into choosing walking mode. Results from table 4.8 also shows that 78.8% of respondent with reported salaries of greater than □61,000 travel to work by personal car, while none of the respondents in this group walk, use bicycle or motorcycle to work. Similarly, 52.1% of those who reported an income level of between □46,000-

60,000 use private cars to work with no reported case of walking or bicycling. Those of them who do not own cars would rather use taxi bus or car passenger mode since they are the three modes which are used by workers of all income levels. Figures 4.1- 4.2 represents bar and pie charts of income level in relation to mode of transport to work.

Table 4.8: Income level by Travel Mode.

Mode / Income level (□)		Bus	Taxi	Car passenger (lift)	Personal car	Bicycle	Motorcycle	Walking	Row Total
□5,000-15000	Count	84	372	152	0	7	96	5	716
	Row %	11.7	52	21.2	0	1	13.4	0.7	48.8
	Column%	59.2	57.4	48.3	0	58.3	60	62.5	
□16,000-30,000	Count	32	175	94	12	3	36	2	354
	Row %	9	49.4	26	3.4	0.8	10.2	0.6	24.1
	Column %	22.5	27	29.9	6.6	25	22.5	25	
□31,000-45,000	Count	15	65	46	30	2	18	1	177
	Row %	8.5	36.7	26	16.9	1.1	10.2	0.6	12.2
	Column %	10.6	10	14.6	16.4	16.7	11.3	12.5	
□46,000-60,000	Count	8	24	16	63	0	10	0	121
	Row %	6.6	19.8	13.2	52.1	0	8.3	0	8.2
	Column %	5.6	3.7	5.1	34.4	0	6.3	0	
>□61,000	Count	3	12	6	78	0	0	0	99
	Row %	3	12.1	6.1	78.8	0	0	0	6.7
	Column %	2.1	1.9	1.9	42.6	0	0	0	
Column Total		142 9.7	648 44.2	314 21.4	183 12.5	12 0.8	160 10.9	8 0.5	1,467 100

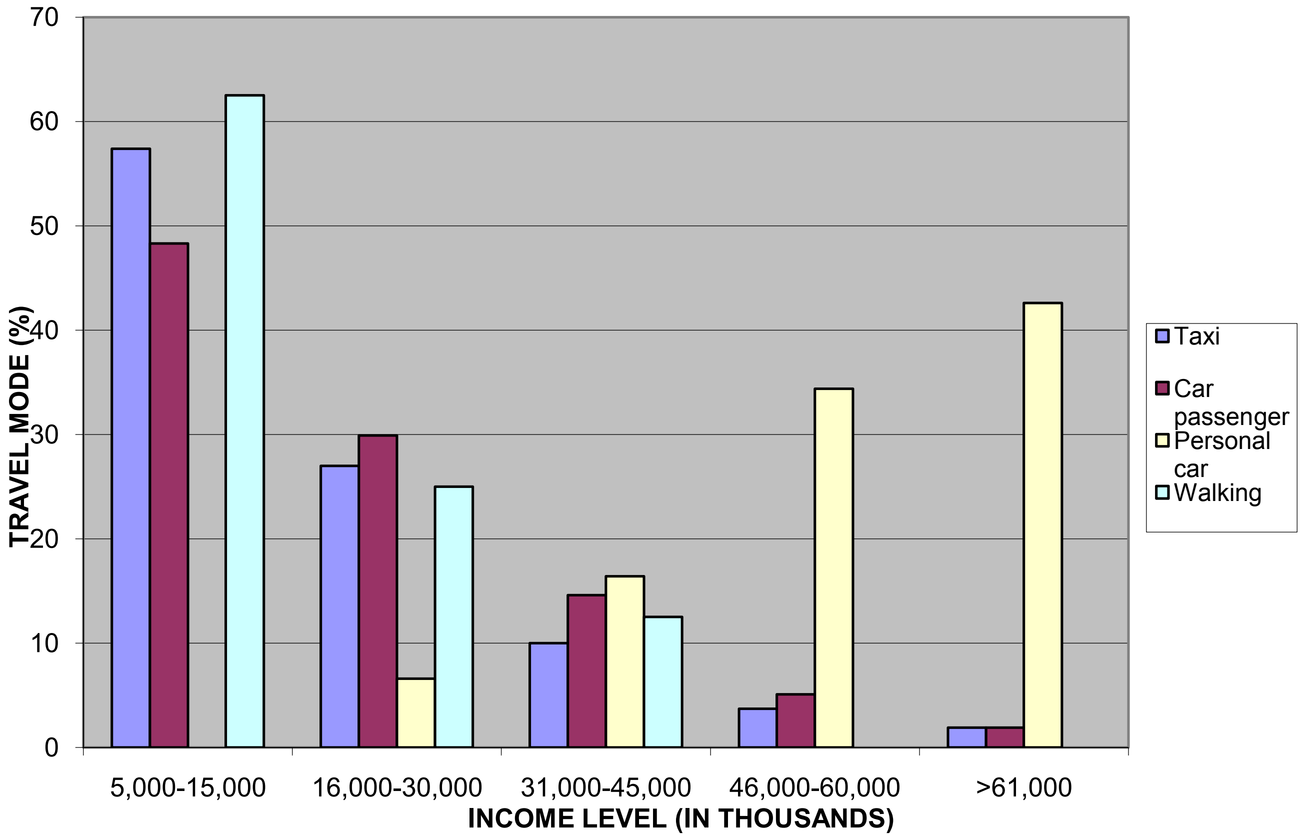


Fig. 4.1: Estimated income by Travel Mode

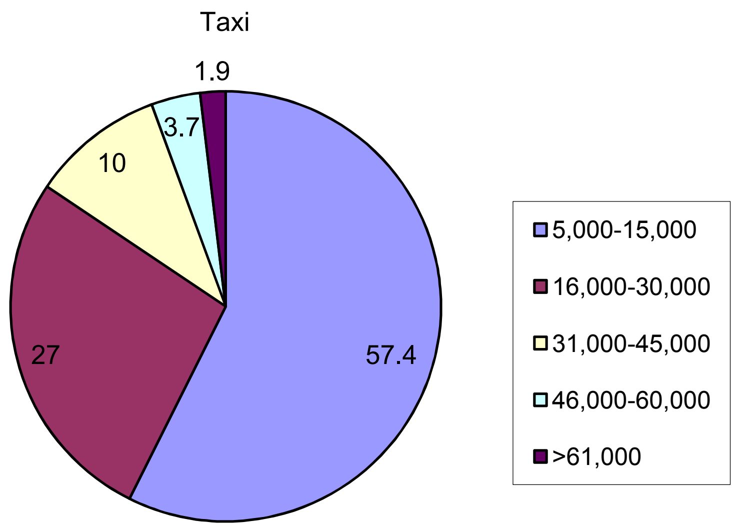


Fig. 4.2a Income level (in thousands) by Travel Mode

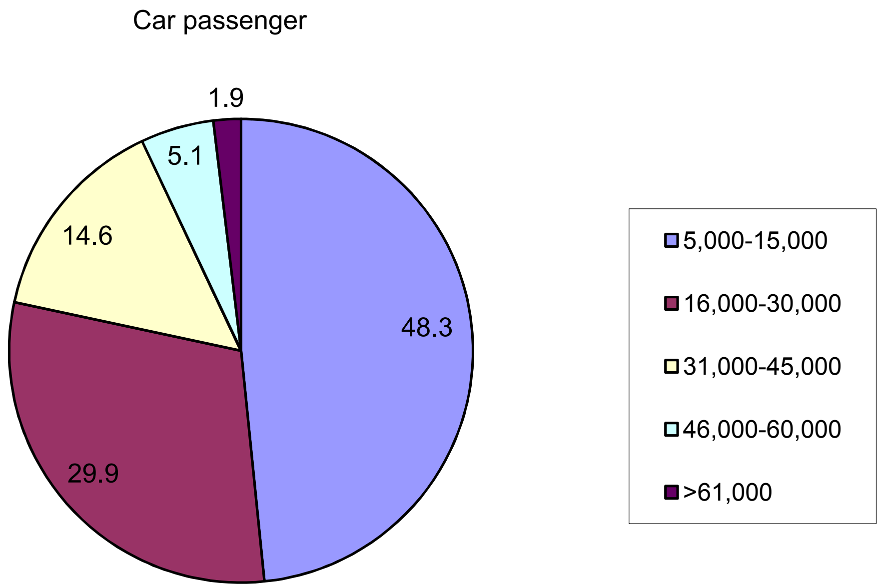


Fig. 4.2b Income Level (in thousands) by Travel Mode

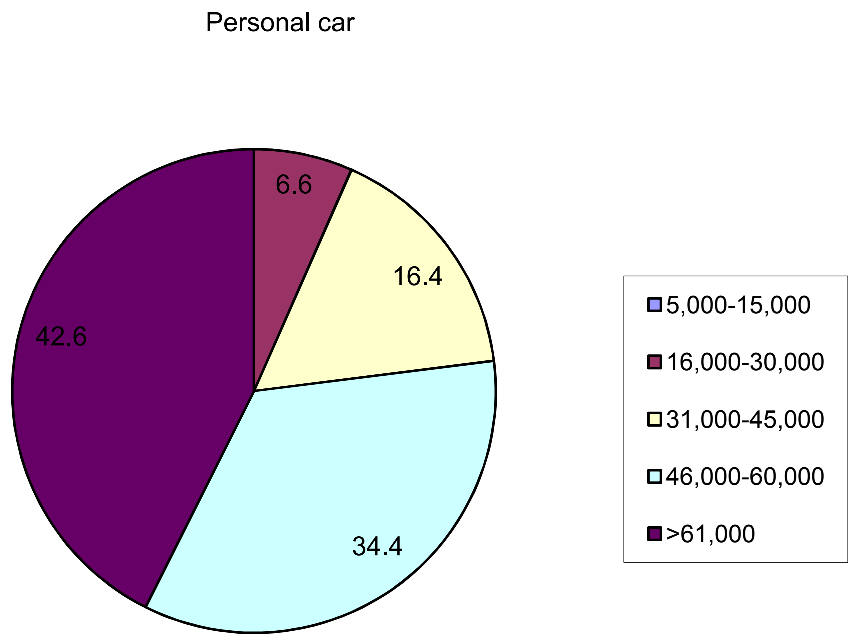


Fig. 4.2c Income Level (in thousands) by Travel Mode

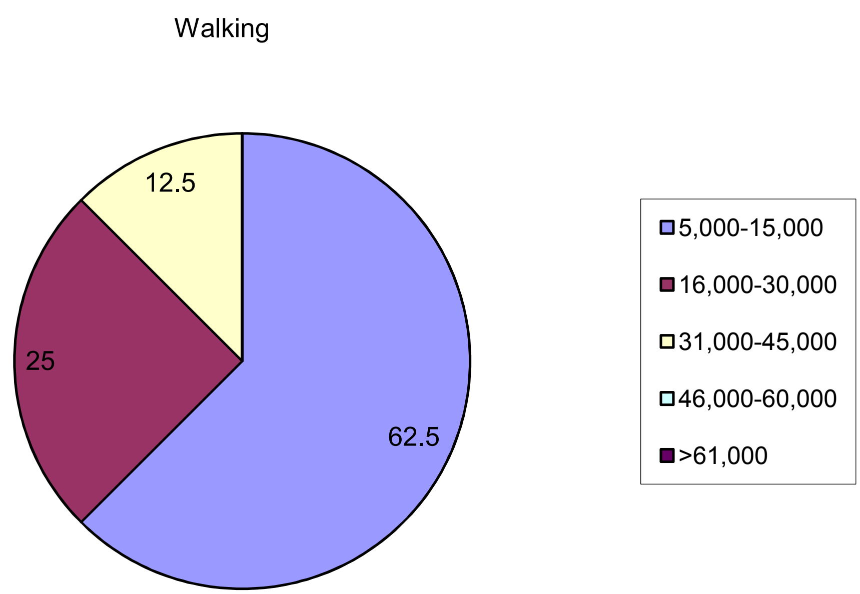


Fig. 4.2d Income Level (in thousands) by Travel Mode

4.2.2 Influence of Workers Position in Household on Mode Choice.

Table 4.9 shows how position in household affects the choice of mode to work. The table shows that 0.4%, 0.3%, 1.9% and 0.6% of husbands, wives, sons and daughters respectively walk to work.

Taxi appears to be the most common mode of travel to work with 44.2% of workers depending on it. Results also indicate that 12.5% of the workers travel to work by personal cars. Husbands dominate the use of this mode with 79.8% of all those involved. This is closely followed by wives with 13.1% of those who use personal cars to work. Sons and Daughters respectively use 4.4% and 2.7% of personal car to work.

Table 4.9: Position in Household by Mode of Travel to Work.

Mode / Position in household		Bus	Taxi	Car pass. (lift)	Personal car	Bicycle	Motorcycle	Walking	Row Total
Husband	Count	53	336	120	146	10	23	3	691
	Row %	7.7	48.6	17.4	21.1	1.4	3.3	0.4	47.1
	Column %	37.3	51.9	38.3	79.8	83.3	14.4	37.5	
Wife	Count	36	158	64	24	0	84	1	367
	Row %	9.8	43.1	17.4	65.4	0	22.9	0.3	25
	Column %	25.3	24.4	20.4	13.1	0	52.5	12.5	
Son	Count	28	71	36	8	2	9	3	157
	Row %	17.8	45.2	22.9	5.1	1.3	5.7	1.9	10.7
	Column%	19.7	11	11.5	4.4	16.7	5.6	37.5	
Daughter	Count	18	58	54	5	0	32	1	168
	Row %	10.7	34.5	32.1	3	0	19	0.6	11.5
	Column %	12.7	9	17.2	2.7	0	20	12.5	
Relation	Count	7	25	40	0	0	12	0	84
	Row %	8.3	29.8	47.6	0	0	14.3	0	5.7
	Column %	4.9	3.9	12.7	0	0	7.5	0	
Column Total		142	648	314	183	12	160	8	1,467
		9.7	44.2	21.4	12.5	0.8	10.9	0.5	100

4.2.3 Influence of travel time on mode choice

There is a relationship between total travel time to work and travel mode. Figures 4.3 and 4.5 represents bar and pie charts distribution of travel times for different travel mode while figure 4.4 represents cumulative frequency curve .In table 4.10, 54.6% of sampled private car users reported a total travel time of between 11-20mins. Only 2.7% of the respondent in this category spent less than 5 mins while 14.2% spent more than 26 mins. However, the situation is different from those who use taxis to work. In this category of workers 60% of the respondents reported a total travel times greater than 26 mins.

The reason for the longer travel times for taxi as compared to private car is fairly obvious. Those who use taxis have to walk from their homes to pick up points, wait for taxis going to their way of various offices, and walk to their offices from drop off points comparatively, the time spent by car owners to enter into their cars from home, plus that spent for parking and walking to their offices is shorter. Another reason for increased travel time for taxis is that taxis have to stop along their route either to pick up or drop off others passengers.

No regular pattern of travel time was observed for the car-passenger mode. For example, 30.7% of the respondents in this category reported travel times of between 16-20mins. 30.6% reported 21-25mins while 17.8% reported travel times greater than 26 mins. This indicates that some car passengers are driven from their homes directly to their destinations while others have to walk between their homes and pick up points as well as between their drop off points and actual destinations. The former experience shorter travel times while the later record longer travel times.

Results from table 4.10 also indicated that 62.5% of those who walk to work spend more than 26 mins on their way. The long time spent walking is most likely as a result of the fact that few residential buildings are located around office blocks and so those who depend on walking have to cover reasonable distance to work.

Table 4.10: Travel Time by Travel Mode.

Mode / Travel Time (mins)		Bus	Taxi	Car passenger (lift)	Personal car	Bicycle	Motorcycle	Walking	Row Total
<5	Count	0	2	3	5	0	0	0	10
	Row %	0	20	30	50	0	0	0	0.7
	Column %	0	0.3	1	2.7	0	0	0	
6-10	Count	0	4	7	9	0	18	0	38
	Row %	0	10.5	18.4	23.7	0	47.4	0	2.6
	Column %	0	0.6	2.2	4.9	0	11.3	0	
11-15	Count	10	60	18	63	1	8	0	160
	Row %	6.3	37.5	11.3	39.4	0.6	5	0	10.9
	Column%	7	9.3	5.7	34.4	8.3	5	0	
16-20	Count	3	74	54	37	0	6	2	176
	Row %	1.7	42	30.7	21	0	3.4	1.1	12
	Column %	2.1	11.4	17.2	20.2	0	3.8	25	
21-25	Count	7	120	94	43	0	42	1	307
	Row %	2.3	39.1	30.6	14	0	13.7	0.3	20.9
	Column %	4.9	18.5	29.9	23.5	0	26.3	12.5	
>26	Count	122	388	138	26	11	86	5	776
	Row %	15.7	50	17.8	3.4	1.4	11.1	0.6	52.9
	Column %	85.9	60	43.9	14.2	91.7	53.8	62.5	
Column Total		142	648	314	183	12	160	8	1,467
		9.7	44.2	21.4	12.5	0.8	10.9	0.5	100

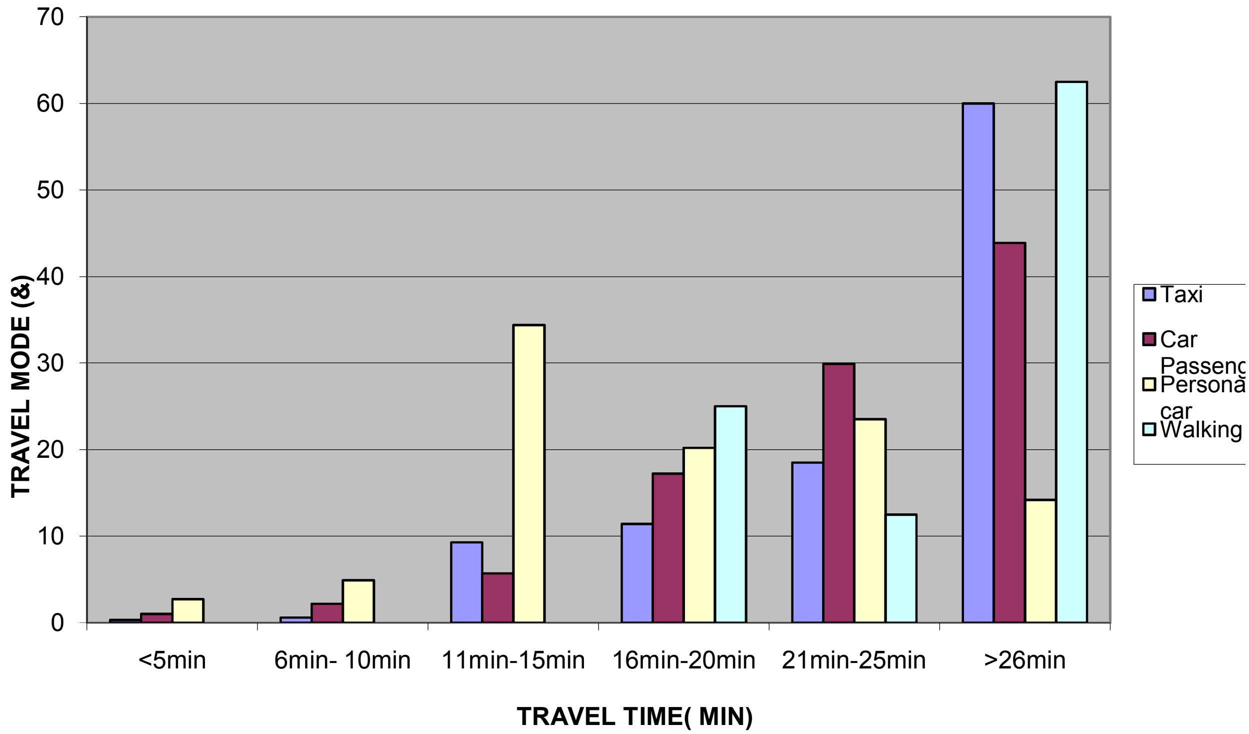


Fig: 4.3 Travel Time by Travel Mode.

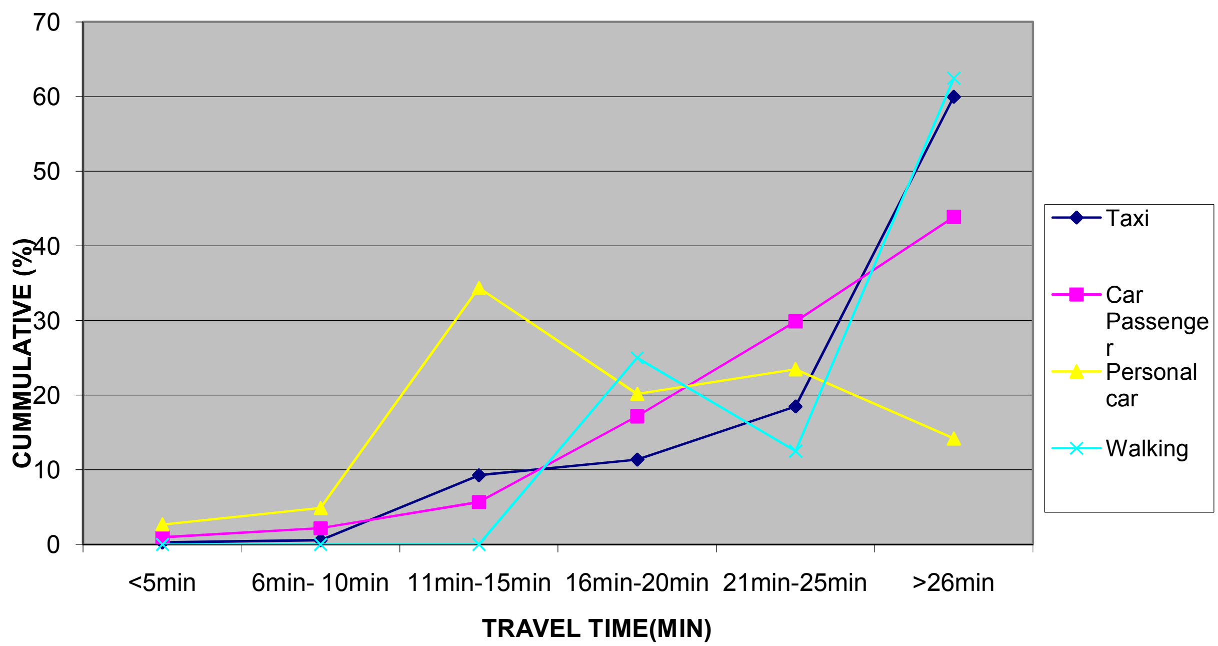
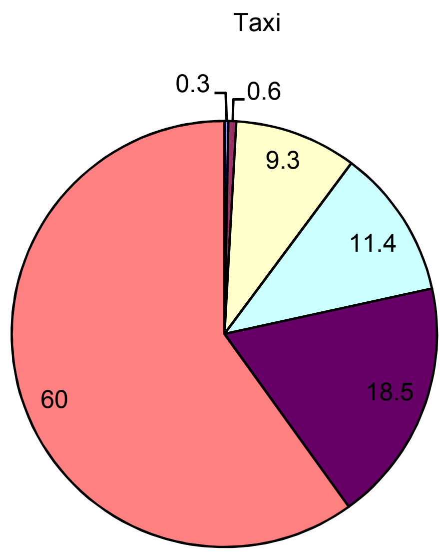


Fig 4.4Travel Time by Travel Mode



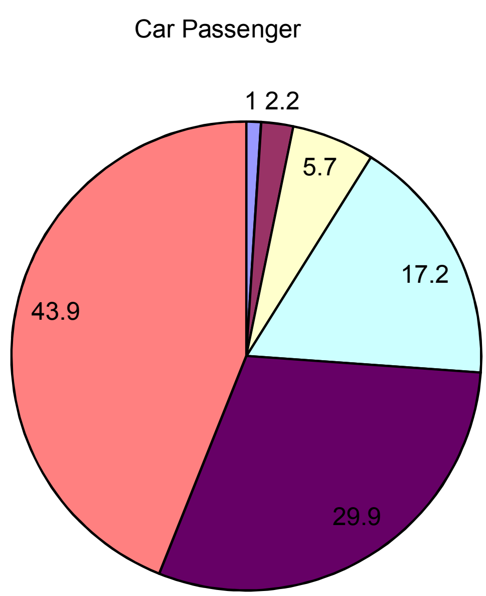
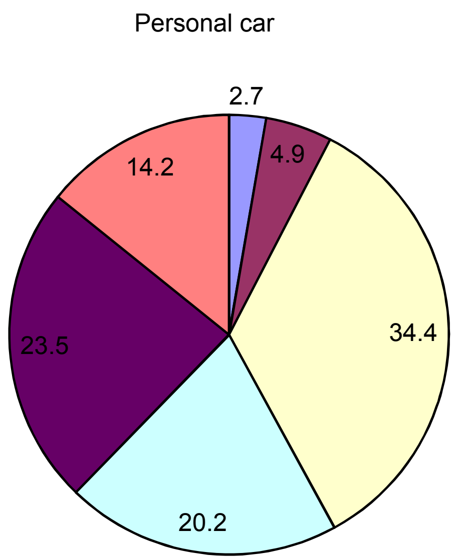


Fig: 4.5a and 4.5b Travel time (min) by Travel mode



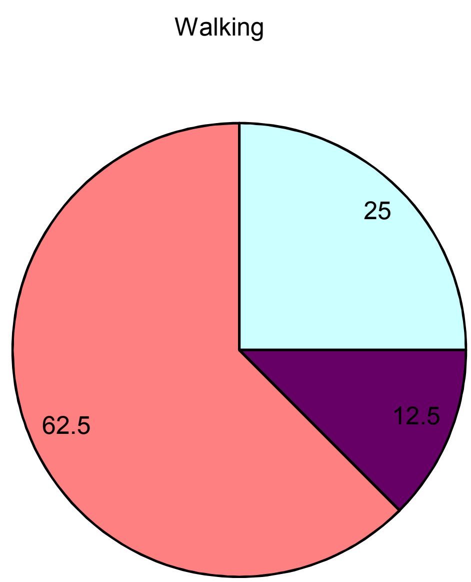


Fig: 4.5c and 4.5d Travel Time (min) by Travel Mode cont.

4.2.4 Effect of home location on travel mode

Of all the variables used in the questionnaire, addresses of respondents was the least reported on. Out of 1,467 respondents, only 87 indicated their home addresses which represent 5.9% while 94.1% refused to provide their addresses as required in the questionnaires. The respondents who gave their addresses only provided the names of their residential areas without indicating the street names or house numbers. As such it was difficult to estimate the distance from home to workplace especially for those who reside in the new developed areas.

Due to lack of enough information on the addresses of workers, it was difficult to deduce any conclusive statement on the relationship between home location and travel time. However, only high income earners (workers) can afford to stay in certain exclusive quarters with high house rent. Since income level also affects mode choice as discussed earlier, residence of such expensive areas are expected to be car owners.

The development of new prestigious quarters mostly in the out skirt of the city has further complicated the task of relating work trips and address.

(Sani, 1982 and Lisinge, 1996) also reported an irregular pattern of residential distribution amongst civil servants, citing the lack of easily available residential accommodation, and the practice of employers providing quarters for their staff as the main reasons.

Researchers in developed countries like Beesley et al (1974), and Guest (1976) have however come up with relationship between choice of residence and location of work place.

4.3 Regression Analysis using SPSS

These was obtained by entering data into SPSS (Statistical Package for the Social Science) to obtain the regression table as shown below.

Table 4.11 Regression Analysis

Variables	Coefficient (B)	Standard error (S.E)	Significant t
Age	0.062	0.011	0.000
Income level	0.040	0.160	0.000
Position in h/hold	0.020	0.070	0.004

Sex	0.124	0.139	0.371
Occupation	0.192	0.122	0.117
No. of cars	1.308	0.141	0.000
Constant	- 3.952	0.487	0.000

Source: Field work 2011

The utility equation is given by

$$U= \beta_o+ \beta_1 X_1+ \beta_2x_2+ \beta_3X_3+\ldots+ \beta_rX_r$$

Where X_1, X_2 and X_3 are called the attributes. β_0 is the constant, while β_1, $\beta_{2,}$ and β_3 are the regression coefficients of X_1, X_2 and X_3.

By substituting the coefficients in the equation above, the utility equation is derived as

$$U_x = -3.952 -0.040X_{IL} - 0.020X_{PH} -0.487$$

Where X_{IL} = Income level

X_{PH} = Position in household.

and E= Error = 0.487

The utility function for Bus can be calculated as follows

$$U_B = -3.952 - 0.04X_{IL} - 0.02X_{PH} - 0.487$$

$$= -3.952 - 0.04(9.7) -0.089(9.7)-0.487$$

$$= - 5.021$$

Similarly, utility functions for Taxi (T), Car passenger (CP), Personal car (PC), Bicycle (BC),Motor cycle (MC), and Walking (W) is given as follows

$U_T = - 7.091$

$U_{CP} = - 5.723$

$U_{PC} = - 5.189$

$U_{BC} = - 4.487$

$U_{MC} = - 5.093$

$U_W = - 4.469$

The multinomial logit model in equation 3.8 is used to calculate the probability of occurrence of each mode of transport. The model is given by

$$P_i(j) = \frac{\exp(\beta^T z_{ij})}{\sum_{k \square c} \exp(\beta^T z_{ik})}$$

For Private Car (PC), the probability is calculated as follows

$$= \frac{}{\quad + \quad + \quad + \quad + \quad +}$$

But = · = 0.011254356

Similarly, for = 0.000832564

= 0. 00326989

= 0.00557758

= 0.00659793

= 0.00613957

= 0.011458768

$$= \frac{0.00557758}{0.00326989 + 0.00659793 + 0.00613957 + 0.000832564 + 0.00557758 + 0.011254356 + 0.011458768}$$

$$= 0.123587384 \qquad 12.4\%$$

Similarly, probability for bus, taxi, bicycle, motorcycle, car passenger and walking are given below

= 14.6%, = 25.4%, = 25%, = 7.2%, = 1.8% and = 13.6% respectively.

The results of the probability indicated that Taxi and Car passenger mode are the most frequent mode of transportation in Minna with 25% each of the civil servants using it. Walking mode has the least with an occurrence of 1.8%.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, as expected civil service in Minna is dominated by male workers and taxi appears to be the dominant mode of transport in Minna with 25.4% of workers depending on it. Respondents who earn □45,000- 60,000 and those who earn above □61,000 never indicated walk as means of transport to work. Bus, taxi and car passenger are the frequent modes of transport use by workers of all income levels.

5.2 Recommendations

This work focused on work trips which constitutes 80% of trips making in an urban area. However, for completeness, further studies in the following areas should be done.

Recreational trips e.g.

i. Journey to mosque

ii. Church

iii. Shopping and

iv. Tourist etc

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.

APPENDIX

JOURNEY TO WORK SURVEY

Department of Civil Engineering

Ahmadu Bello University, Zaria.

Dear Sir/Madam,

This is part of an MS.c. research work on 'Journey to work' characteristics of workers in Minna – Niger State.

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

The answers you provide will be treated as strictly confidential.

Thanks for your co-operation.

Instruction: Please tick in the appropriate box.

General Section: To be completed by everyone

1. Home Address: …………………………………………………………………….

2. Sex: Male [ ][1], Female [ ][2]

3. Age: 18-24 years [ ][1], 25-31 years [ ][2], 32- 40 years [ ][3], 41and above [ ][4],

4. Marital Status: Married [ ][1], Single [ ][2], Widowed [ ][3], Divorced [ ][4],Separated[ ][5]

5. Religion: Islam [ ][1], Christianity [ ][2], Traditional [ ][3]

6. What is your position in your house hold?

   Husband [ ][1], wife [ ][2], Son [ ][3], Daughter [ ][4], Relation [ ][5]

7. Do you personally own a vehicle?

Yes [ ][1], No [ ][2]

8. How many cars are owned by your house hold?

Non [ ][1], One [ ][2], Two [ ][3], 3 or more[ ][4].

9. How did you go to work today?

Bus [ ][1], Taxi [ ][2], Private car lift [ ][3], Private car (owner/driver) [ ][4,] Motorcycle [ ][5,] Bicycle [ ][6], Walking [ ][7].

10. What is your occupation?

Administrative staff (secretaries, clerks, typists, messenger, etc) [ ][1], Professional (lawyer, Doctor, Teacher, etc) [ ][2], Skilled worker (Technical staff, plumber , carpenter, etc) [ ][3].

11. Is the method you use to come to work today your normal means of transport to work?

Yes [ ][1], No [ ][2].

12. What was your regular means of going to work?

Bus [ ][1], Taxi [ ][2], Private car lift [ ][3], Private car (owner/driver) [ ][4,] Motorcycle [ ][5,] Bicycle [ ][6], Walking [ ][7].

13. Please estimate your personal monthly income

₦5,000-15,000 [ ][1], ₦16,000- 30,000[ ][2],₦31,000- 45,000[ ][3], □46,000-60,000[ ][4] Above ₦61,000 [ ][5]

To be completed by person who go to work in their cars

14. How many minutes did you use going to work? (I.e. from your house to your office)

Less than 5 minutes[ ][1], 6 – 10 mins[ ][2],11- 15 mins[ ][3],16- 20 mins[ ][4],21- 25 mins[ ][5] More than 26mins [ ][6]

15. How many minutes did you spend in the vehicle?

Less than 5 minutes[ ][1], 6 – 10 mins[ ][2],11- 15 mins[ ][3],16- 20 mins[ ][4],21- 25 mins[ ][5] More than 26 mins [ ][6]

16. How many minutes did you spend out of your vehicle? (i.e. from your house to your vehicle and from your vehicle to your office).

Less than 5 minutes[ ][1], 6 – 10 mins[ ][2],11- 15 mins[ ][3],16- 20 mins[ ][4],21- 25 mins[ ][5] More than 26 mins [ ][6]

For Non Car Owners

17. Which of the following do you own?

Motorcycle [ ][1], Bicycle [ ][2], Non [ ][3]

18. How many minutes did you spend inside your mode of transport? (i.e Taxi, bus, motorcycle or bicycle)

Less than 5 minutes[ ][1], 6 – 10 mins[ ][2],11- 15 mins[ ][3],16- 20 mins[ ][4],21- 25 mins[ ][5] More than 26 mins [ ][6]

19. How many minutes did you spend inside your mode of transport?

Less than 5 minutes[ ][1], 6 – 10 mins[ ][2],11- 15 mins[ ][3],16- 20 mins[ ][4],21- 25 mins[ ][5] More than 26 mins [ ][6]

20. How many minutes did you spend outside your mode of transport? (i.e from when you left your house to when you entered the mode and from when you dropped from the mode of transport to your office?

Less than 5 minutes[ ][1],6 – 10 mins[ ][2],11- 15 mins[ ][3],16- 20 mins[ ][4],21- 25 mins[ ][5] More than 26 mins [ ][6]

21.(a) Is the method you used today your usual means of transport to work?

Yes [ ][1], No [ ][2]

(b) If your answer is No, which of the following is your usual means?

Bus [ ][1], Taxi [ ][2], Bicycle [ ][3],Walking [ ][4].Private car (lift), [ ][5]

LIST OF FIGURES