UNIVERSITY OF CAPE COAST

DETERMINANTS OF THE CHOICE OF MODE OF TRANSPORT OF INTRA-CITY SPARE PARTS DEALERS IN ACCRA

BY

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere.

Candidate's Signature: ..... Date: .....

Name: .....

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature: ..... Date: .....

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ABSTRACT

In contemporary times, there has been a clarion call from transport experts and researchers suggesting the need to discourage the number of trips made on private cars during peak hours. Some studies suggest the use of toll differentials, whereby private cars are charged higher than others to ensure diversion from private cars to public transport. This thesis explored the determinants of the choice of mode of transport of intra-city spare parts dealers, and estimated the specific and overall predictions of the discriminant model.

Using a non probability sampling technique, two hundred spare parts dealers in Accra, were sampled for this study. Discriminant model was employed to classify the spare parts dealers into their appropriate mode choice to ascertain factors determining their choice of mode of transport.

The key findings from the study showed that individual characteristics and mode choice attributes determined the choice of mode of transport of spare parts dealers. In terms of prediction, the study showed that, more than two-third of the original private car users were predicted. The model also predicted over three-quarters of the original bus users. Moreover, the model over predicted the original trotro users, while almost all the original taxi users were predicted. Overall, the discriminant model was successful in correctly classifying about two-third of all original spare parts dealers in the study area. The study concluded with the recommendations that efforts should be made to encourage business private car owners to patronise public transport in their journey to work in Accra.

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DEDICATION

I dedicate this work to my late father Hyde, my mother Elizabeth and my beloved Nathaniel.

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LIST OF ACRONYMS

ACA	Adaptive Conjoint Analysis
AIC	Akaike Information Criterion
AMA	Accra Metropolitan Assembly
BIC	Bayesian Information Criterion
BRT	Bus Rapid Transit
CBD	Central Business District
CES	City Express Services
C-MMACS	Centre for Mathematical Modeling and Computer Simulation
DA	Discriminant Analysis
DDA	Descriptive Discriminant Analysis
DoUR	Department of Urban Road
GDP	Gross Domestic Product
GIS	Geographic Information System
GPRS	Ghana Poverty Reduction Strategy
GPRTU	Ghana Private Road Transport Union
GSS	Ghana Statistical Service
HOT	High Occupancy Toll
LDA	Linear Discriminant Analysis of Variance
LDF	Linear discriminant Function

MANOVA	Multivariate Analysis of Variance
MMT	Metro Mass Transit
MoT	Ministry of Transportation
MPO	Metropolitan Planning Organisation
NTP	National Transport policy
O-D	Origin-Destination
OSA	Omnibus Service Authority
PDA	Predictive Discriminant Analysis
QD	Quadratic Discriminant
QDA	Quadratic Discriminant Analysis
SAR	Statistical and Analytical Research
SPD	Spare parts dealers
SPSS	Statistical Product and Service Solution
STC	State Transport Company
TDC	Transport Data Centre
UCC	University of Cape Coast
UR	Urban Road
US$	United State Dollar
UTS	Urban Transport Survey
VLTP	Volta Lake Transportation Project

CHAPTER ONE

INTRODUCTION

Background to the Study

Transport is one of the most important catalysts for sustainable development. In the developed countries, the transport sector contributes to the GDP by about 10 percent, and its services are a precondition for economic activities as well as leisure activities. In most developing countries, for example, the last 40 years have been characterised by a dramatic increase in urban populations and auto-centric lifestyle of the citizenry. Growing demands for passenger transport are visible manifestations of an increase in urban population. There is a high demand for motor vehicles, with ownership and use growing at a rate even faster than the population growth rate in most developing countries. Evidence suggests that motor vehicle ownership growth rates of 15 percent to 20 percent per year are common in developing countries (World Bank, 1996).

There is a connection between number of cars, especially in most urban cities of developing countries and global warming and environmental pollution (Hughes & Whitelegg, 1993). This is due to emission of greenhouse gases by cars into the atmosphere through the combustion of fossil fuels, leading to the depletion of the ozone layer and in turn contributing to the global warming. There

is an economic cost of using private cars over public transport as was discussed extensively by Peirson, Skinner & Vickerman (1996). In their view, Private cars were less efficient in bulk carriage of passengers and goods as compared to public transport. Research has shown that on short distance journeys, the private car engine is cold and runs least efficiently (Potter & Hughes, 1990). Other evidence also suggests that most intra-urban journeys are of short duration of about 5 minutes (Ullrich, 1990), and this implies that most private cars operate inefficiently in terms of their energy consumption.

Therefore, many urban transport experts advocate the incorporation of transport policies, such as car pooling, cycling and mass transport into transport management policies. These are to reduce private car use and to help mitigate congestion during peak periods and enhance the sustainability of the transport system in metropolitan areas. Over the years, transport experts in many developing economies sought to adopt various innovative alternative strategies, in an attempt to deal with the growing demands for transport, and their impacts on human health as well as urban transportation. Some experts suggest expansion of existing transport infrastructures to improve intermodal transportation.

A notable development in this area is the proposed establishment of an intermodal framework in Ghana where road, rail, inland, water and pipeline transport and logistics services will coexist and complement each other to provide a broader range of options to shippers and users (Ghana Ministry of Transportation [GMoT], 2005). Nevertheless, the addition of new infrastructures and expansion of existing ones in order to deal with growing demands will be

undesirable and sometimes difficult because of socio-economic and environmental constraints.

Other experts were also of the opinion that efforts should be made towards the use of a better demand management strategy in order to make efficient use of existing infrastructures. Prominent among these opinions is the modal diversion from private car to public transport by ensuring that the efficiency of the alternative substitutes is enhanced. Another option experts maintain is the differential pricing system, whereby different toll rates for different types of vehicles at different times of the day are used. The implications of these are to help mitigate traffic congestion during the peak periods in metropolitan areas to ensure efficiency and sustainability of the sector.

However, studies have revealed that efficiency and sustainability of road transportation, depends on policy interventions and planning strategies. These strategies are to develop and strengthen the appropriate legal, institutional and regulatory framework to regulate all modes of transport to ensure an efficient transportation system (Ghana Statistical Service [GSS], 2000-2007). Newman and Kenworthy (1999) argued that policy interventions and planning strategies have been adopted by North America as alternatives to road expansion due to the evidence that road expansion alone cannot ensure sustainability of the transport system. Governments in some countries are involved in programmes to improve and restructure their public transport system, with the emphasis on the type and quality of service.

In Costa Rica, government was involved in a programme to improve and restructure the public transportation system, emphasising the type and quality of service provided. The aim of that programme is to achieve a reduction in the level of congestion and pollution originating from urban transportation (Alpizar, Carlsson & Martinsson, 2001). Ghana launched the gateway project to take advantage of her political and economic stability within the sub-region to market herself to her landlocked neighbours. This project, among others, is to develop and maintain transport services and infrastructure, re-organise and rationalise port and customs procedures to facilitate access to landlocked countries. The project has already achieved some monumental results. It has rapidly increased both transit freight traffic and trade with the neighbouring countries of Burkina Faso, Niger and Mali (Ghana Shippers' Council, 2003).

Governments of Ghana over the periods have also made some efforts to improve rail and inland water transportation infrastructure, through the Volta Lake Transportation Project (VLTP). The aims are to divert some truck movements from the transport corridors of Ghana, reduce overloading on the roads, and to reduce traffic congestion and road maintenance costs. But these efforts are yet to yield any significant effects on road traffic congestion and road maintenance cost. Government's expenditure on minor rehabilitation, for instance, was US$29.53 million representing 98 percent over the expenditure on maintenance in 2006 (Ghana Statistical Service [GSS], 2007).

As a developing economy, Ghana has a population, which has been increasing since independence. The present figure stands at about 23 million

people with an estimated growth rate of 1.97 percent (GSS, 2007). The regional capitals, which epitomise the level of socio-economic development in the country, are characterised by an increasing rate of population growth (3%–6% per annum), substantial suburban expansion and a relative rise in the growth of industry, commerce, housing, health and educational establishments (Abane, 1994). Accra has a population of about 1,658,937 people (GSS, 2000).

National economic development has shown an accelerating upward trend in recent years. The rate of increase in Gross Domestic Product (GDP) was 4 percent in 1995 and increased to about 7.3 percent in 2008 (Department of Urban Road [DoUR], 2005). Traffic demand is closely related to the rate of economic growth. This is expected to continue at the current rate of 5 percent. Vehicle ownership rates have also shown a dramatic increase in recent years. This rate is expected to continue, and the combined impact of population growth and increasing rate of private car ownership will be an increase in the number of cars in Accra Metropolitan Assembly (AMA) from 181,000 in 2004 to over 1 million in 2023 (DoUR,2005). This means that, the urban transportation system will be under severe pressure and, therefore, needs special attention.

National Transport Policy on urban transport recognises rapid growth of vehicles in recent years as a key contributor to congestion, especially, in urban areas. Therefore, as a policy objective, government has prioritised mass transportation in urban areas to move at least 80 percent of passengers through the implementation of Urban Transport Projects (Ministry of Transportation, 2009). The projects among others include Bus Rapid Transit (BRT) systems. The BRT

systems are to enhance the efficiency and quality of bus operations in the country. Specifically, the BRT are to provide high quality service to the users; minimise the time buses are stopped for boarding and alighting by passengers; maximise the vehicle cruise speed; facilitate transfers and enhance the reliability of bus operations in Ghana.

The government of Ghana has formalised its commitment to the implementation of the project, by engaging a consultant to undertake feasibility study in 2005 to identify the daily commuting patterns across the pilot region in morning and evening peak hours. Current transport demand and demand levels projected for 2013 for public transport modes such as taxi, trotro and bus were analysed. The study was based on a conservative assumption that mode shift to the BRT would come exclusively from trotro and taxi users. Consequently, the analysis excluded the demand characteristics of private car users (GMoT, 2005). Considering the sustained and pervasive popularity of the private car, not only in Accra, but in most major cities of Ghana, any policy that excludes the analysis of the characteristics of private car presents a challenge.

Hanson and Hanson (1980) noted that men travel on bus to lesser extent than women. Alpizar, Carlson and Martinsson (2001) discovered that travel time and travel cost were the most important determinants of choice of mode. Mathies, Kuhn and Klockner (2002) found in Germany, Switzerland and Australia that women use public transport more than men and reversibly use cars less frequently. Corpuz, McCabe and Ryszawa (2006) also found that, car users were concerned with speed, comfort and convenience associated with shorter travel

time and the flexibility of the trip-making. Mintesnot and Takano (2007) posited that Peripheral zone residents, who were public or private company employees and had a larger family size, had a higher probability of choosing bus over taxi. Eno (2007) maintained that women who had unrestricted access to private car persistently preferred the private car mode to public transport. Bill (2008) argued that there was no connection between affluence and car usage.

Statement of the Problem

Research has shown that the number of private cars operating in Ghana had noticeably increased from 20564 to 22523 between 2003 and 2005, whiles the number of public buses in operation within the same period increased from 914 to 2192 (GMoT, 2005). Evidence has further shown that private car accounts for 34 percent of all average weekday daily traffic generated in Accra. The bus accounts for three percent, with the trotro, taxis and freight vehicles accounting for 25 percent, 20 percent and 18 percent respectively (DoUR, 2005). In the morning peak hour, the story is the same with public bus share decreasing compared to the share of private car.

In terms of daily passenger flows in Accra, 56 percent of daily trips are made by trotro, 15 percent of daily trips are made by taxi, with 13 percent by bus and 11 percent of commuters use private car. The rest (5%) of the daily trips are accounted for by other modes (GMoT, 2005). Several questions can be asked about why a commuter will prefer one mode over the other. It is difficult to tell whether the reasons are personal specific or mode choice attributes. In the view of

Verplanken, Aarts and Van (1994), making exactly the same journey to work under the same circumstances on the same way every morning, is not guided by deliberate decision, but is habitual. This means that the individuals who frequently travel by car in similar situations may develop a stronger car habit than individuals who sometimes travel by car and another time by public transport.

Whichever way one considers the issues, the need to classify intra-city spare parts dealers into their appropriate mode choice groups and to examine factors that determine their choice of mode of transport becomes palpable. Now the questions to be answered are: What makes people use or prefer the private car more to other modes of transport? What are the factors that will be important in discriminating between the choices of mode of transport of intra-city spare parts dealers? What is the probability of choosing a mode of transport given other modes and personal specific characteristics and mode choice attributes?

It is against this background that in this study, a typical probabilistic model (discriminant function analysis) is employed to classify and predict the choice of mode of transport of intra-city spare parts dealers and to examine the relevant personal specific characteristics and mode choice attributes that determine the choice of mode of transport in Accra.

Objectives of the Study

Based on the need to appreciate the determinants of the choice of mode of transport, the study seeks to classify intra-city spare parts dealers into their appropriate mode choice groups and to examine the relevant personal specific

characteristics and mode choice attributes that determine the choice of mode of transport in the Accra Metropolitan Area because Accra is the capital city and main administrative and business centre of Ghana.

Specifically, the following research objectives were developed to:

i. Identify the personal specific and mode choice characteristics that determine the choice of mode of transport of intra-city spare parts dealers.
ii. Empirically examine which characteristics are the best predictors of the choice of mode of transport of intra-city spare parts dealers.
iii. Determine which characteristics are relevant in discriminating between the mode choice groups.
iv. Examine spare parts dealers' perceptions of other factors that influence their choice of mode of transport.
v. Estimate the specific and overall predictions of the discriminant model.
vi. Make policy recommendations based on personal specific and mode choice characteristics that determine the choice of mode of transport.

Research Hypotheses

The researcher tested the following hypotheses to guide the study:

i. The number of children per family has no influence on the choice of mode of transport of spare parts dealers.
ii. Residential zone has no influence on the choice of mode of transport of spare parts dealers.

iii. Average monthly income has no influence on the choice of mode of transport of spare parts dealers.

iv. Sex has no influence on the choice of mode of transport of spare parts dealers.

v. Average in-vehicle travel time has no influence on the choice of mode of transport of spare parts dealers.

vi. Age has no influence on the choice of mode of transport of spare parts dealers.

Scope of the Study

The study sought to use a typical probabilistic model (discriminant function analysis) to classify and predict the choice of mode of transport of intra-city Spare parts dealers and to examine the relevant personal specific characteristics and mode choice attributes that determine the choice of mode of transport in Accra.

Significance of the Study

For sustainable transportation, there is the need for policy interventions and planning strategies to ease mobility of people. Therefore, successful completion of this thesis will help transport policy makers in Accra to establish the factors that determine the choice of mode of transport of spare parts dealers. The study will also identify the number of people who currently use a particular mode of transport. This will guide policy makers to design strategies to move commuters from one mode to the other. The study will provide information on the

specific mode choice variables, which will be relevant in predicting spare parts dealers who will discard their private car for any other mode of transport.

Theoretical and empirical literature in the area of choice analysis is inadequate in Ghana. As a result, information about the personal specific characteristics of people and attributes of transport, which determine the choice of one mode over the other, is minimal. To this end, this study will help contribute to literature in the area. Further, the study will provide information for both state and municipal policy makers, transport operators, researchers and other relevant bodies in the country, on the importance of perceptions in the choice of mode of transport. This will allow them to come out with policies that promote the welfare of commuters and also ensure efficiency and reliability of transport services delivery in the country.

It will also help policy makers to know the relationship between transportation and access to health care. A few studies that have examined the impacts of transportation on access to health care, to varying degrees elsewhere, were reviewed (see Lia-Hoagberg, Rode, Skovholt, Oberg, Berg, Mullett, et al.,1990; Melnikow & Alemagno, 1993). It is therefore believed that this literature will serve as reference documents for policy makers. Moreover, this study will be a precursor for the development of other models for the promotion of a more sustainable transport system Ghana.

Organisation of the Study

This study is organised as follows: It starts with Chapter One, which discusses the background and issues related to mobility in developed and developing countries and focuses on transport mode choice. It considers the statement of the problem and the objectives of the study and connects that with the research hypotheses. The chapter continuous with the scope of the study and touches on the significance of the choice of mode of transport for a unique group of spare parts dealers, and finally concludes on the organisation of the study.

Chapter Two provides a review of related literature. The objective of this chapter is to provide a theoretical background to the research. The chapter begins with the write up on the overview of the public road transport sector in Ghana. It considers the conceptualisation and definition of decision and choice, discusses previous mode choice research and the utility decision rule. The chapter also highlights the methods used in choice models and finally discusses an overview of discriminant function analysis, which was use in this study to determine the personal specific characteristics and the mode choice attributes that influence the choice of mode of transport of intra-city spare parts dealers in Accra.

Chapter Three provides a description of the methodology and model specification as well as the plan of analyses employed in this study. It resumes with a brief introduction to the methodology, followed by detailed description of all the methods and steps that were taken in arriving at the conclusions of this study. The chapter also includes the map of the study area together with the study design and the instruments used. It documents the sample size and sampling

procedures. The chapter also presents the specification of the model, identification of variables and their operational definition, and concludes with sources of data and the techniques for data analysis.

Chapter Four presents the results and discussion from the analyses of the data. The chapter ends with the discussion of the results of the discriminant analysis (DA). Chapter Five provides a discussion on the summary, conclusions and recommendations of the study. It also suggests future policy initiatives that could cause modal shift and improve the sustainability of the sector. Also considered in the chapter is a discussion of the limitations of the study. The chapter ends with suggested directions for future research as well as the contributions made to understanding transportation and efficient transport services delivery in Ghana.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Introduction

The objective of this section is to provide a theoretical background to the research. The chapter begins with the write up on the over view of the public road transport sector in Ghana. The chapter continuous with the conceptualisation and definition of decision and choice, discusses previous mode choice research and the utility decision rule. It also highlights the methods used in travel demand models. The final section discusses an overview of discriminant function analysis, which is proposed in this study to determine the personal specific characteristics and the mode choice attributes that influence the choice of mode of transport of intra-city spare parts dealers (SPD) in Accra.

Overview of the Public Road Transport Sector

This is the section in which the write up on public road transport in Ghana is considered. Under this section, some of the operational challenges pertaining to the public road transport sector in the Accra Metropolitan Area are highlighted, and finally the discussion of the effects of population growth and increasing demand for motor vehicles on urban transport in the study area has been done.

Public Road Transport

Road transport is by far the leading carrier of freight and passengers in Ghana's land transport system. It carries over 95 percent of all passenger and freight traffic and gets to most communities in Ghana. Ghana's road network was about 38,000 kilometers in 2000. This has increased rapidly to 60,000 kilometers by the end of 2005. The road sub sector has seen gradual improvements. For example, the road condition in 2004 was 36 percent good, 36 percent fair, and 28 percent poor as compared to the desired condition of 70 percent good, 20 percent fair, and not more than 10 percent poor (GMoT, 2009).

Road maintenance is critical to achieving desired accessibility, affordability, reliability and safety. However, since 1961 it increasingly became difficult to provide adequate funding from the consolidated fund to maintain the road network. A first generated road fund was established in 1985 to solve this problem. In 1997 the Road Fund Act (Act 536) was promulgated to offer a legal framework for road maintenance. This has resulted in great improvements in funding of road maintenance. The current level of the road fund is about 68% of the projected level of maintenance costs (GMoT, 2005).

Public road transport services in Accra Metropolitan Assembly (AMA), as is the case for the entire country, are provided by the private sector, which operates a mix of fleets such as buses, trotro and taxis. In 1927, the Accra Town Council operated bus services in Accra, Kumasi, Sekondi-Takoradi and Obuasi. Prominent among the transport operators in this sector in the 1980s was King of Kings Ltd. Its bus operation, which was heavily patronised, was concentrated

mainly on the Odorkor-Accra corridor. The company's operations could not survive the difficult and ruthless environmental conditions of the industry thus it wound up in the late 1980s.

Governments over the years have also established bus service companies such as the Omnibus Services Authority (OSA), State Transport Company (STC), City Express Services (CES) amid others. Similarly, operators like STC, CES and OSA in the formal sector have not fared well either, and this compelled the government to divest STC and CES and to liquidate OSA in the 1990s. The Government has quite recently established Metro Mass Transit (MMT) limited for various reasons including government social obligations, environmental factors, energy considerations and the promotion of efficient public transportation to increase productivity and economic growth. It is also in fulfillment of the government's promise to bus at least about 80 percent of passengers in Ghana, through mass transport (GMoT, 2009). Other projects including Bus Rapid Transit (BRT) systems, School Busing Schemes and Rail Based Mass Transport Systems have also been given due consideration.

A number of buses have been imported and are operating in Accra and elsewhere under the management of Metro Mass Transit (MMT) Limited. The Company's bus Fleet as of December 2007 was 779. As of December 2007, MMT was operating in all 10 regions in the country. At the end of the year 2007, the number of buses that were in good condition for operation was 400 (51%) countrywide out of the total of 779 buses with 379 (49%) bus fleet at workshop (GMoT, 2009).

The control over the operation of public transport by government is limited to an extent. The private operations are strictly controlled by trade unions of which the most powerful is the Ghana Private Road Transport Union (GPRTU). These unions charge membership fees and member drivers are obliged to register with and pay a daily fee to a local branch, which controls a terminal. The unions also collect user charges on behalf of the Metropolitan or District Assemblies, who own the terminals. As part of their rules, unions require a vehicle to be full before it can depart. This practice is inimical to the interest of passengers who often cannot board vehicles between terminals and must wait for long periods until the vehicles are full.

Generally, quality of services provided by public road transport is poor. This is because most vehicles are old and maintenance standards are to the extreme very low. Sky-rocket vehicle maintenance costs arising from poor road surfaces and limitations imposed on earnings by the acute congestion on the urban roads constrain the operators to invest in new vehicles. The consequence is limited number of low capacities vehicles and the resultant long queues during the morning and evening rush hours at most terminals in the country (GMoT, 2005)

The public transport and freight terminals, known in the local parlance as lorry parks, serve all forms of vehicles from private commercial cars and taxis to multiple axle trucks. A few of these parks are paved and there is no clear demarcation between access roads, parking space, and passenger waiting areas. Overall, lorry parks have sprung up near markets and at major intersections. Lorry parks' development has been ad-hoc, with little account taken of the impact of the

vehicle and pedestrian traffic they attract. Lack of their planning has also resulted in vehicles following long and meandering city routes and passengers having to change vehicles most time before reaching their destinations.

Problems of Public Road Transport in Accra

The Department of Urban Roads (DoUR) in 2005 conducted a survey with public transport operators, who classified their concerns as terminal, route, operational or financial problems. According to DoUR, lack of toilets and poor sanitation is clearly the most common problem faced by transport operators at terminals in AMA. From the perspective of the operators, lack of shelters, congestion at access points and congestion within the terminal are also significant problems. Amongst the route problems, congestion (56%), with associated long travel time and high operating cost was the most common problem, the survey indicated. Along routes, insufficient provision of lay byes and bus stops is one of the most frequently identified problems cited by the operators. One third of the survey respondents mentioned conflict with hawkers and pedestrians, inadequate traffic control at junctions and police harassment among others as problems.

Furthermore, 28 percent of the operators interviewed claimed poor road signs and absent or faded road markings were problems for them. Driver indiscipline and old vehicles were the only two significant operational problems noted by the survey respondents. These two issues were listed by 50 percent and 44 percent of the survey sample respectively. Financially, high cost of maintenance and spare parts was the major problem identified in the survey. This

was closely followed by high taxes. Low fares and high vehicle replacement costs were the remaining financial problems identified by over 25 percent of respondents.

Urban Transport in Accra

Accra, which is the capital city and main administrative and business centre of Ghana, had a population of approximately 1,659,000 in 2000. It is estimated that by 2013 the combined effect of growth and migration will increase the population of AMA to slightly less than 4 million. It is also expected that the Population growth and increasing rates of car ownership will increase the number of cars in AMA from 181,000 in 2004 to over 1 million in 2023, and this is likely to aggravate the already chronic traffic congestion in the cities. Currently, the highest traffic volumes are found in the Winneba Road and Liberation Road corridors, which have volumes over 50,000 vehicles per day at certain points (DoUR, 2005).

About 10,000 vehicles also enter the central area of Accra within the Ring Road in the morning peak hour and on a typical weekday, 270,000 vehicle trips are made into, or out of, the Accra central area. In the morning peak hour, higher volumes of about 16,000 inbound vehicle trips and 300,000 daily vehicles trips in both directions cross into the area inside the motorway extension. These vehicle trips consist of 50,000 inbound passenger trips into the Accra central area and 85,000 trips into the area inside the motorway extension in the morning peak hour. Approximately 1.3 million passenger trips per day are estimated to enter or

leave the area within the Accra Ring Road and 1.6 million passenger trips into or out of the area within the motorway extension (DoUR, 2005).

Eighty four percent of these passenger trips, according to Urban Road, are made by public transport. Over half (56%) of daily passengers are carried by trotros, and a further 15 percent by taxi. About 1 million passenger trips are made each day into and out of the central area of Accra using trotros and taxis. In Accra the average number of passengers carries by trotros and taxis per trip is 13 and 2.3 respectively. The implication of this is that these vehicles are inefficient in terms of congestion caused and the amount of road space used to transport each passenger. In a situation where the intra-urban journey is short, most of these vehicles also experience inefficiency in terms of high energy consumption per time as well as per passenger.

Congestion is a major problem on arterial routes in Accra, and this leads to 70 percent of major roads operating at unacceptable level of service at some time during the day (less than 20 km/h). Although considerable scope exists to improve the efficiency of people movement through a shift from low capacity public transport vehicles to large and double-decker or articulated buses with the potential to carry over 100 passengers, the concern is whether this will really work given the nature of roads and the volume of daily traffic congestion on all the corridors in the cities. Any attempt to shift from one mode to the other is also likely to face some challenge due to pervasive popularity of private cars in Accra and the country as a whole.

Theoretical Literature Review

The theory of decision analysis depends on the need to consider and evaluate complex decisions amongst alternatives that differ significantly. Formal analysis of a decision, or a set of decisions, typically becomes necessary when a problem has a large number of factors or involves multiple decision makers or uncertainty. This type of analysis is not only common in business, social science, and operations research, but in transportation. Decision analysis is used regularly in transportation planning to model a traveler‘s choice of destination, choice of mode and choice of route (Rhoulac, 2003).

Perlmutter and Monte (1979) defined choice as experience when the self is the agent who decides which of the two or more options will be accepted. Choice occurs when volition takes place under condition such that the reactor is conscious that he might have followed either one of two or more courses (Monroe, 1968). Carroll and Johnson (1990) argued that choice involves comparison among alternatives and together with judgment forms a different kind of decision-making. It depends on the availability and the desirability of options, and people experience choice when they seem to control the decision-making process. However, such control over the decision-making process does not guarantee a positive outcome. According to Carroll and Johnson (1990), to decide is one thing and to cause the decision to bear fruit is another.

There are three kinds of choice. These are evaluative choice, discriminative choice and autonomous choice. Evaluative choice pertains to people who evaluate their best alternatives. This means that people making this

choice decision, before making their choice, carefully look at the available alternatives in terms of their attributes. That, people do not experience choice unless at least one of their available options is at least as desirable as their comparison set, where a comparison set refers to the values attached to the attributes of each alternative. Variety of choice is experienced when the best available option exceeds the comparison level (Perlmutter & Monte, 19 79).

Discriminative choice occurs when people find two or more alternatives at least as attractive as their comparison level. In this case, they will compare one variable with another to maximise their benefits. The third kind of choice is the autonomous choice, which occurs when two alternatives are complex (contains more than one positive attribute) and differ in several dimensions. In this situation, it is not immediately clear which alternative will provide better options. When an individual is faced with this kind of choice, his individual preference guides his evaluation process and the individual himself determines the decision rather than the obvious quality of the options. In this case, the individual decision maker is perceived as autonomous and the experience to choose is called autonomous choice.

It can be deduced that the preference of the subjects in this study will guide them in their evaluation process as they decide on whether to use other modes of transport at the expense of their private car. The decision to make trips using either private car as a means of transport or otherwise is complex as the alternatives available contain more than one positive attribute and differ in

dimensions. In this case, the subjects of focus in this study can be said to be making autonomous choice.

Mode Choice Decision

In order to evaluate the potential impact of different National Transport Policies on the choice of mode of transport of commuters, information regarding their preferences for the attributes of the transport system is needed. Since some of the attributes of interest do not exist, it is not possible to rely only on revealed preference data for that purpose. Therefore, a mode choice research was conducted to determine traveler preferences for different attributes of different mode of transport. The basic idea behind this was to create a hypothetical situation and elicit the preferences of commuters (in this case spare parts dealers) for different attributes, through their choice of mode of transport in each of those situations (Rhoulac, 2003).

The roots of choice experiments can be traced back to Lancaster's (1966) microeconomic theory of demand for characteristics of goods, and the Random Utility theory (Thurstone, 1927).Transport mode choice researches have a long history in transport economics. They have been developed as a complement to revealed preference studies, because of the possibilities of analysing preferences for new levels of attributes (Polak & Jones, 1997). When conducting any choice researches, there are four fundamental issues that should be considered: the characteristics of the decision maker, the available alternatives, the attributes of

the alternatives, and the decision rules that will be used in the analysis (Ben-Akiva & Lerman, 1985).

Specifically, the attributes are those complex characteristics of each alternative that differ greatly and affect choice. The list of alternatives may consist of the universal set of alternatives for the decision being analysed or the reduced set of alternatives available to a particular individual or group. Such alternatives cause the decision maker whether or not to approach goal objects about which he is truly ambivalent (Hill, 1979). The situation that arises from such an act is that, the more the decision maker approaches a particular alternative because of the desirable attributes associated with that alternative, the more aware they become of its negative features. The opposite, however, is also true. The more the decision maker avoids an alternative, the more salient its positive attributes become. The decision maker can be an individual or a group as in the case of intrapersonal or interpersonal decisions.

Associated with this study is the scenario that the intra-city commuter finds, for example, a particular mode desirable. As their decision leans towards choosing this attribute, they find that the closer they get to prefer this mode, the more revealed are features that might impede their positive transport mode choice. In this situation, the decision maker is both pushed and pulled by the forces active within him and if these forces are equal in intensity, the decision maker will experience the greatest conflict among opposing alternatives. Consequently, the decision maker employs certain standards to select an alternative (Rhoulac, 2003).

Decision Rule in Mode Choice

The decision rule in mode choice is based on the theory of utility. The starting point is the hypothesis that each individual will choose that option out of the set available to him, which gives him the greatest utility or the least disutility. Utility, used as a decision rule to analyse mode choice, provides a numeric measure of attractiveness (Hunt, 1990).It is generally assumed that people prefer to make journeys that cause them least loss of money or time or least discomfort. Therefore, it is easier to talk in terms of disutility than of utility. Disutility depends on three primary considerations: out-of-pocket costs, travel time and convenience, which are measured by a variety of factors and together make up the relative attractiveness of modal alternatives (Ball & Edward, 1990).

Literature revealed that it is costly to make a decision. It is not costly only because decision is an activity that some people find unpleasant, but because it is a behaviour which requires information which has to be analysed. In transport mode choice, cost is seen in terms of payment that an individual has to make for using a particular mode. This payment, which is also known as out-of-pocket cost, is measured in terms of fare for using public transport. The out-of-pocket costs for private car usage include consumable items such as fuel, tires and maintenance, which are entirely different from average costs. Average costs for a particular mode include the fixed costs of purchase, licensing, registration and insurance payments (Wright, 1992).

Owners of private cars rarely, if ever, consider the fixed costs of owning cars when making the decision of whether or not to drive one. It can also be

argued that socioeconomic factors, for example, money income, also influence mode choice decision of commuters as out-of-pocket payment is a function of income. Particularly, these factors directly affect the category of public transport users known as “captives” or dependents. These are persons who do not own or have access to a car and, therefore, are not considered riders of private car (Rhoulac, 2003).

The other component of disutility is travel time, which consists of two parts: in-vehicle and out-of-vehicle time. In-vehicle time is the time spent inside the vehicle of choice in route to a destination. Out-of-vehicle time is one, which includes time to walk to and from parking places, waiting time and transfer time (Beimborn, 1995). Without exclusive right-of-ways, both Private and public modes of transport are subjected to delays and rising in-vehicle time, as a result of traffic congestion and other occurrences on the highway system. In addition, the stops that a public transport makes to onboard or alight passengers cause increase in in-vehicle travel time and a less desire for it (Rhoulac, 2003).

Convenience as a Measure of Modal Utility

Convenience is also one of the contributing factors to modal utility. It is the most difficult component to be incorporated in the model because convenience is highly judgmental. What one person finds to be convenient will likely differ from what another person considers convenient. The value of privacy, peer selection, personal environment control, flexibility of scheduling, and ease of carrying things affect overall convenience and, therefore, can be used

as proxies for convenience. Privacy, for instance, is the ability to keep others from invading one's personal air space. The personal private car promotes privacy and peer selection, which is the ability of a person to choose traveling companions that are judged compatible or at least tolerable in terms of values and standards of behaviour (Wright, 1992).

Differing preferences of musical genres keep music from being played on most public transport. Portable music listening devices, like a Walkman or Discman, however, allow a traveler to be more in control of their personal environment on public transport. Moreover, there are no technologies that allow for personal control of noise level or temperature control in public transport as it is the case in private mode of transport. Flexibility in scheduling is another measure of convenience. Infrequent bus arrivals, characterised by systems with long headways, are not convenient for commuters. In terms of private car, departure times are under the full control of those who choose it as a means of travel (Ball & Edward, 1990)

Utility Function Development

Human behaviour is generally seen as a product of chance decisions governed by random variables that are not usually amenable to deterministic modeling. Therefore, the utility function on which an individual's choice of mode is based is made up of a deterministic portion and a probabilistic or random portion. The deterministic part of the utility function describes the attractiveness of mode choice *i* for individual *n*, and the random error part of the utility function

adjusts the deterministic part with regard to uncertainty accounts for by incomplete or unavailable information about the observed modes and individuals, together with model measurement errors, and the assumptions that the trip maker has perfect discriminatory capability (Ben-Akiva & Bierlaire, 1999).

The deterministic function is a linear combination of variables that expresses the relative utility of a mode. These variables are constraints that govern an individual's choice of mode based on which the individual maximises their preferences. These variables may include travel impedance factors, personal specific factors and mode attraction factors. Impedance factors are a measure of accessibility or of spatial separation between zones such as travel time, travel distance, and travel cost. Personal factors are observed characteristics of the trip maker including gender, employment type, household size (persons per household), household income, etc. In addition to the above, Mode attraction factors are the observed characteristic specifics such as the availability of services and infrastructure such as transport (Ben-Akiva & Lerman, 1985).

The value of the variables determines the "tipping point" in the distribution of preferences where commuters would switch from one mode choice to another. In other words, value of the variables determines the cut-off point where individual(s) will decide to shift from one mode to another. Utility functions can be mode specific or mode abstract. An abstract model is a single equation used to estimate the utility of several modes by altering the values of the independent variables. Mode specific models use a unique equation for a mode

being analysed so that different weights can be assigned to the same attribute (Papacostas & Prevedouros, 2001).

In general, it is assumed that individuals with similar characteristics will have similar preferences that can be represented by utility function. These Preferences are based on the Random Utility Maximization (RUM) theorem. The RUM theory states that a choice maker will make decisions to maximise their well-being. This theory is based on the assumption that choice makers are essentially rational decision-makers who seek to make choices that maximise their utility. The assertion above is predicated on consumer theory. The consumer theory states that a choice maker makes rational decisions that are consistent and transitive. Transitive in the sense that if a consumer chooses an alternative "A" over "B" and chooses "B" over "C" then they will choose an alternative "A" over "C" (Hal, 1993).

In order to determine the choice of mode for transport, the utility function is specified base on the premise that individuals' preferences are influenced by utility, and that utility depends mainly on the attributes selected to describe those alternatives, and that an individual i will choose to go by a mode j if and only if

$$U=u(X, Y) \qquad (2.1)$$

Where, X and Y are private and public mode of transport respectively. Given attributes of the mode as (P); socio-demographic characteristics of the individual as (Z) and income of the individual as (M), and solving the optimization problem subject to the individual characteristics and mode attributes constraints, we derive the indirect utility function,

$$V(P, M) = \text{Max}\ \{u(X, Y, Z) / P_x X + P_y Y + P_z Z = M\} \quad (2.2)$$

Note that p is a vector of K attributes (including cost) of the profile of alternative modes i. So then, using Roy's identity, we derive the quantity chosen as

$$y(P,M) = \frac{\frac{\partial v(P,M)}{\partial Py}}{\frac{\partial v(P,M)}{\partial M}} \quad (2.3)$$

Thus, equation (2.3) is the theoretical demand (choice) model for transport mode.

Limitations of the Deterministic Utility Model

Deterministic utility functions, like any mathematical model, have some limitations. Firstly, deterministic utility functions result in the same value for utility, given the same input parameters, meaning that a user will always choose to maximise utility or minimise disutility. Behaviour is probabilistic, however, and sometimes choices are made that cannot be expressed numerically by a quantified utility. This introduces the probabilistic portion of utility theory, the random error term. This term is added to the deterministic portion of a utility model, acknowledging that aggregate behaviours are not fully estimable.

A second limitation of the utility model is that some factors that individuals consider in choosing a mode of travel are not quantifiable and must be represented by a single constant, the mode specific bias term. This mode bias term, found by fitting the model to actual travel behaviour, accounts for the difference between what has been included in a model and what may need to be included based on observed travel behaviour (Beimborn, 1995).

Overview of Mode Choice Models

The logit and discriminant models are more often than not employed in the analysis of mode choice behaviour of commuters. Human behaviour is generally seen as a product of chance decisions governed by random variables that are not usually amenable to deterministic modeling. Consequently, human actions and behaviour are typically analysed using probabilistic or stochastic models. The multinomial or binary logit models and the discriminant models are typical probabilistic models that have found wide application in mode choice analysis.

The tendency for an individual to forgo a particular mode of transport for another is a transportation version of decision making involving a choice of a particular mode in relation to other alternatives. Consequently, a mode choice model is concerned with the trip maker's behaviour regarding the selection of travel mode. Modal split modeling is thus the transportation adaptation of the general model of human choice that explains how people select between competing alternatives (Kanafani, 1983). Uncertainty is a part of every decision that an individual makes and when uncertainty is present in choice making, the model used to link alternatives to their consequences upon which decisions are based involves an assessment of probability.

Probability models attempt to estimate the probability that a given mode will be used by an individual with certain characteristics and preferences, expressed by the utility function. This study focused on individuals because their decisions determine aggregate behaviours, which are generally of interest in transportation modeling (Ben-Akiva & Lerman, 1985).Measures of aggregate

travel behaviour, such as bus ridership, are obtained by adding up the choices of individuals (Horowitz, Frank & Steven, 1986).

Probability Mode Choice Models

There are numerous types of probability mode choice models. These depend on choice probabilities and include: binary (dichotomous), multinomial (polychotomous), linear, probit and logit. A probability model is named by a description of the outcome variable or the random error distribution. Linear, probit, and logit models are the most common probability models, each describing a different distribution of the random error term. Any assumption about the distribution of error will lead to a choice model (Ben-Akiva & Lerman, 1985).

Binary (dichotomous) models, for instance, have two possible outcomes, whereas multinomial (polychotomous) models involve three or more choices. The polychotomous and dichotomous models are widely used in analysing modal choice pattern. They are used to determine the proportion of trips in a specific mode (say mode i) according to equations, which involve the exponential transformation of utilities (Papacostas & Prevedouros, 2001).

The linear probability model assumes that the error term is zero and the probability that an individual will choose a specific mode is based solely on a linear combination of variables expressing utility. In the binary case, where the two available modes are identified as “0” and “1”, the linear combination of variables estimates the probability that a mode will be used. A limitation of the linear probability model is that values, which are negative and greater than one,

can be calculated. Extreme value limits can be implemented since probabilities can range between zero and one or the negative and greater-than-one values can be used with the other individual values to estimate the statistics of interest.

The probit model assumes a normal distribution error term. The logit model is an extension of the probit model with a logistic-distributed random error. Logit and probit are the two most commonly used alternatives to the linear specification of the probability model (Aldrich & Nelson, 1984). Logistic model is the type used mostly in predicting mode choice. The logit model is characterised as probit-like. It is more convenient analytically because it has a closed form and does not involve the multiple integrals that are encountered in formulating a multinomial probit model (Ben-Akiva & Lerman, 1985).

The basic difference between probit and a logit model is the scale of their coefficient estimates. Logit coefficients are typically 1.8 times the probit coefficients. The theoretical basis for both models is essentially identical but the distributions of their respective tails are different (Aldrich & Nelson, 1984).These models calculate the proportion of persons using each of the available modes based on the relative utility of the available modes. For binary logit, the difference in utility is necessary for modeling, as opposed to a unique utility function for each available mode. Interpretation of linear probability models is mostly simple, but can be limited when a continuous dependent variable is not involved. Non-linear probability models do not have this limitation and are therefore widely used in social science analyses, where the attitudes, behaviours, characteristics,

decisions, and events being studied are measured in non-continuous ways (Liao, 1994).

The general form of a logit model is:

$$p_i = \frac{e^{u_i}}{\sum_{i=1}^{n} e^{u_i}} \tag{2.4}$$

Where p_i is the proportion of users selecting mode i, U_i is the utility of mode i (Equation 2.4) and n is the total number of available modes.

The general form of a probit model is:

$$P_i = \phi(\mu_i) \tag{2.5}$$

Where ϕ denotes the standardized cumulative normal distribution.

The linear probability model offers the advantage of relatively easy interpretation, but this interpretation can be limited. The logit model offers a non-linear specification of a probability model, which is proven to work well when modeling attitudes and behaviours. Therefore, the discrete choice models that have been in use so far have been logit models for the most part. However, depending on the nature of data available and the primary purpose of the study, some other classification models can be deemed appropriate. Less common classification models among them are: Linear Discriminant Analysis (LDA), Quadratic Discriminant Analysis (QDA) and Classification Trees for mode choice modeling.

Overview of Discriminant Function Analysis

Discriminant analysis explains how individuals make a choice of mode in the face of competing alternative modes of city transport. It makes it possible to classify members of a population into their appropriate groups using a set of independent variables. In practical terms, discriminant analysis can be used to analyse a number of variables and use the result to determine members of a given population that should be allocated to some pre-determined sub-groups. For example, discriminant analysis can be used to allocate commuters to say, private mode or public mode of intra-city transport. In other words, discriminant analysis is a statistical technique that focuses on the prediction of group membership. The function is a linear combination of some variables and the resultant coefficients are usually presented in both standardised and unstandardised forms.

Originally involved in applications in biology and medicine, the discriminant analysis now has wide applicability in a number of disciplines, including the social sciences. Computationally, there is a similarity between discriminant function analysis and analysis of variance (ANOVA). The discriminant analysis is applicable when there is one dependent variable with multiple independent or predictor variables, similar to the ANOVA and ordinary least squares regression. However, there is a basic difference between the ANOVA and ordinary least squares regression. ANOVA requires the dependent variable to be interval or ratio scale (Huberty, 1994). The same can be said for the discriminant function, too.

The discriminant analysis has two primary purposes in research: predictive analysis and descriptive analysis. In predictive discriminant analysis (PDA), the multiple variables (the independent variables) play the role of predictor variables. In descriptive discriminant analysis (DDA), the multiple variables are viewed as outcome or criterion variables and the grouping variables are then viewed as the explanatory variable or independent variable (Newacheck, Stoddard, Hughes & Pearl, 1998). Essentially, the roles of the variables in PDA are reversed in DDA. PDA is most closely aligned with ordinary least squares regression analysis while DDA is most closely aligned with ANOVA or multivariate analysis of variance (MANOVA) (Huberty, 1994).

The researcher was mostly interested in classifying spare part dealers and analysing the factors that influence their choice of mode of transport. The study also sought to determine the probability of choosing a particular mode given the respondent's personal specific characteristics and mode choice attributes. It is therefore believed that discriminant function analysis technique is most appropriate for this study. Thus, as part of the objective of the study, how accurately the discriminant function could allocate spare parts dealers to private car mode, public bus mode, trotro mode and taxi mode of intra-city transport in our study area was sought.

It is pertinent to note that logistic regression could also be used to predict outcome. However, due to the nature of the data and the primary purpose of conducting this research, a less common probability models such as the discriminant analysis (DA) was used for the study. This model has been chosen

because of its successful application to classification problems in fields like Medicine and Business.

While the models are different, discriminant function analysis and logistic regression, both can arrive at predicting the same outcome although in different ways. Each method has its strengths and weaknesses. The discriminant analysis technique can be used to verify the logistic regression model and vice versa (SPSS Inc, 2003). As a general rule, logistic regression is preferred when the population is not normal and discriminant analysis is preferred when the population is normal. However, even when the homogeneity of variances assumption is not met, discriminant function analysis is still robust, provided the data do not contain important outliers.

Discriminant analysis is also preferred when the assumptions of linear regression are met since it has more statistical power than logistic regression (less chance of type 2 errors - accepting false null hypothesis). This means that the resultant significant test would still be trustworthy even if the data failed the normality test. The logistic regression also has other advantages, such as averting the need for a contingency table. The model creates a logistic or log-linear relationship table that replaces the contingency table, which can be confusing. Contingency table has large number of cells that often contain too few observations per cell to be valid when using multiple variables in the equation (Press & Wilson, 1978).

Empirical Literature Review

Empirical literature in the area of choice analysis is inadequate in Ghana. As a result, information about personal specific characteristics of people and attributes of transport, which determine the choice of one mode over the other, is minimal. Ortuzar and Willumsen (2005) provided a useful list of factors known to influence the choice of mode in three main groups: Attributes of the traveler, attributes of the journey and characteristics of the transport facility. The empirical literature review under this section elaborates on these factors drawing relevant lessons from studies from other countries.

Middendorf, Jelavich and Ellis (1982) argued that the use of trip generation and distribution models was reasonably well developed in freight forecasting. However, the modeling of mode choice had been the most difficult step for most practitioners and the research into this step was still too elementary to be included in the freight forecasting models (Transportation Research Board, 1996). Several other studies have reported a failure or difficulties in developing mode choice models. The researchers claimed that some of the difficulties in developing mode choice models were obscurity in the identification of mode choice decision maker(s); lack of proper understanding of the mode choice decision process and lack of availability of reliable disaggregate data.

Disaggregate demand models have been generally used for mode choice modeling (Winston, 1983). These models have been classified as behavioural models and inventory models. In behavioural models like logit and probit the theory of utility maximization in which the mode with the maximum utility is

chosen by the shipper. Inventory based models take the perspective of a firm's inventory manager and attempt to link the mode choice and production decisions of a firm. However, the need for detailed firm level data makes the implementation of inventory models impractical for planning purposes.

Abdelwahab and Sargious (1992) developed a switching simultaneous equation model that estimates the mode choice and shipment size simultaneously. They argued that using a single equation model for estimating the mode choice introduces a potential bias. Moreover, in reality most firms do not simultaneously determine the mode choice and shipment size. The mode choice decision is usually a long term decision as the contracts between shippers and carriers last between three to five years. The shipment size is a short term decision process which can be a daily decision for some of the firms (Vidya & Michael, 2004).

Since the availability of reliable freight data at a disaggregate level is difficult, the use of some unconventional methods for mode choice modeling has been explored in the recent past. Bhat (2000) used the Delphi Technique for mode choice analysis. The expert panel that participated in this study consisted of Metropolitan Planning Organization (MPO) planners, state planners and port, truck and rail representatives. However, the views of other researchers that an expert panel that consists of logistics managers from shipping firms, who are the actual decision makers, would have been more representative for this kind of study could not be discounted. Another innovative approach being used in freight mode choice analysis is the use of stated preference data.

Alpizar, Carlsson and Martinsson (2001) studied policies that were aimed at increasing the attractiveness of the only available substitute, the bus, to discourage the use of private transport during peak hours in Costa Rica. In order to evaluate the potential impact of the policies on the substitution between the two alternatives, the researchers conducted a mode choice experiment evaluating traveler preferences for different attributes of both private and public transport. They assumed that the utility or otherwise the satisfaction derived from each of the two alternatives available, car and bus, depended mainly on the attributes selected to describe those alternatives.

The objective of their study was to obtain estimates of the coefficients for all the relevant attributes, based on the trade-offs made by the commuters when faced with successive hypothetical situations. Therefore, the researchers adopted a general type of model called Random Parameter Models, where taste variation among individuals was explicitly treated (Bhat, 2000). A total of 602 individual workers who had access to a car, and who were living and working in the metropolitan area of San Jose in Costa Rica were interviewed. The reason for limiting the data to that category was to ensure that the respondents could actually make a choice between private and public transport.

Their findings revealed that travel time for both modes and travel cost for car were the most important determinants of mode choice. Their estimates for the average elasticities and marginal effects were rather small. However, it was in line with other studies, and was also partly due to their short run perspective. Since the aim was to determine which characteristics were more relevant to achieving a

switch from private to public modes of transport, the researchers rather concentrated on the relative importance of each attribute. They, therefore, concluded that a programme aimed at reducing congestion during peak hours should focus on increasing the cost of private transport and providing faster and more reliable public transport.

Li (2001) demonstrated the effectiveness of logistic regression for modeling categorical variables in transportation related issues in California. Li applied logistic regression to model factors that contribute to a person's likelihood to use the HOT (high occupancy toll) lanes on State Route 91 in California. In that study, riders on the HOT lane were stopped and surveyed for a variety of household and trip characteristics. These included household income, trip purpose, vehicle occupancy, and other related characteristics.

To perform the logistic regression, Li assigned a categorical classification scheme to each variable, and the scheme was applied to each variable to discretise the data. The dependent variable tested in the model was a dummy variable stating whether or not the person used the HOT lane on their most recent trip that occurred during peak periods. The logistic regression analysis showed that household income, vehicle occupancy and age were significant factors that contributed to a person's likelihood to use HOT lanes. It was also shown that gender, trip length, trip frequency and other household characteristics played little or no role in determining whether or not a person was likely to use the HOT lanes.

Fadare and Morenkeji (2001) studied the gender bias in intra-urban trip pattern in Niger state, Nigeria and concluded that there was a remarkable difference in the travel behaviour of men and women. Other researchers observed

travel behaviour of individuals and concluded that the differences observed in travel behaviour of individual were due to gender (Matalon, 1992).

Labuschagne (2003) employed a quantitative analysis to investigate the relative contribution of influential decision factors, as indentified by previous research, in the choice students made when they chose between print-based and on-line modalities in South Africa. The study argued in favour of the distance education student as being a decision-maker and scrutinised his choice criteria against the open education background. The study used a survey data of 23 participants in two modules at the University of South Africa.

The results from the study showed that, influential decision factors were transferable to choice between print or on-line instructional content, but their effects were less significant. Differences pertaining to previous experience with their delivery mode were apparent between students who selected the print-based option and students who selected the on-line option. The results also confirmed that of other resea.rch that a significant relationship exists between self concept and optimal decision-making and self-concept and social environment.

In North Carolina, Rhoulac (2003) developed mode choice models based on factors exhibiting statistical significance in estimating the choice of automobile or school bus for the morning and afternoon school trips of children in kindergarten, through eighth grade in the Wake County public school system. The objective was to calibrate a school transportation mode choice model for a selected North Carolina school district. The study used survey of 1250 respondents. It was observed that, variable expressing the convenience of the

school bus service for a household, based on parent work schedules and perceived problem was the most influential. In terms of model transferability tests, the results from the study suggested that the models can be used state-wide in schools or school districts where actual automobile usage ranges from about 30 to 55 percent of all school trips in the morning and 15 to 40 percent in the afternoon.

Vidya and Michael (2005) investigated the applicability of a supply chain based modeling methodology to regional freight transportation planning. The focus of their study was to relate the supply chain practices of individual firms to public sector transportation planning. A two-step methodology that makes use of some of the supply chain characteristics was proposed for their study. The first step was to obtain the Origin-Destination (O-D) flows by tracing the supply chains of major business units in a region. The second step was to model the choice of mode for freight shipments. Vidya and Michael (2005) asserted that logistical needs and constraints of a shipper determine the choice of mode. Therefore, a model that accounts for the logistical variables should be used in modeling the choice of mode.

The researchers identified a list of supply chain variables that have the potential to influence the choice of mode. Vidya and Mihael developed a mode choice model using aggregate data from transearch database supplemented with data from a survey of shippers. The researchers also collected data pertaining to relative weights among potential attributes that affect the choice of mode for three different categories of shippers. They used four different classification methods,

namely: Binary logit model, linear discriminant analysis, quadratic discriminant analysis and tree classification to develop their mode choice model.

Danielis, Marcucci and Rotaris (2005) used the stated preference data collected from logistics managers to model the choice of mode. Adaptive Conjoint Analysis (ACA) software was used in this study to collect the preferences among freight service attributes from the logistics managers. Some of the advantages in using stated preference data are: 1) It is relatively easier to obtain stated preference data as it need not be confidential 2) It allows the modeler to control the variability in attributes 3) It provides the ability to model future scenarios. The disadvantage with the use of stated preference data is that the choices are hypothetical (Louviere, Hensher, & Swait 2005).

In the work of Corpuz, McCabe and Ryszawa (2006), an empirical data from the Household Travel Survey in Sydney was analysed, using a simple univariate and qualitative approach. The focus of the study was to (a) identify factors that affect mode choice, (b) describe the impacts, and (c) determine which variables analysed will exhibit high potential for policy intervention. The analysis indicated that public transport use was most viable in the following situations: (1) where parking capacity or arrangements were problematic for car use, (2) where the vehicle was not available, (3) where the public transport was cheaper. Other aspects such as travel time, convenience and accessibility were important but appeared to be less significant compared to the first three factors. Environmental reasons were not as significant as other factors in the choice of public transport but it is an emerging area that presents timely opportunities.

Corpuz et al. (2006) argued that car users were primarily concerned with speed as well as with the comfort and convenience associated with shorter travel time and the flexibility of the trip-making. According to the researchers, when these factors did not exist or diminished during peak periods, public transport gained a foothold. But even then, there remain the issues about public transport accessibility and frequency, which together are important to car users. These aspects need to be addressed to complete the shift to public transport (Corpuz et al., 2006). Despite the simpler univariate approach applied in the study, the conclusions were consistent with the results from TDC's Scenario Modeling Project, which used more complex multi-modal modeling techniques.

Mintesnot and Takano (2007) used an ordered logit model to examine citizens' perceptions of the bus condition in Addis Ababa. The objective of the research was to determine factors that affect the choice of bus transport, and to develop a binary logit model to analyse traveler choice behaviour. The researchers undertook a diagnostic analysis to examine the relationship of independent variables in the two models. They found that citizens' perceptions of the three chosen bus condition aspects (fare, convenience, and frequency) had a significant influence on public transport mode choice. Their study further revealed that peripheral zone residents, who were public or private company employees and had a larger family size, had a higher tendency of choosing bus over taxi.

The distance variable also had positive sign, which was consistent with the choice of bus for long trips. For the bus fare aspect, elderly females who were unemployed (or housewives) and had a low monthly income as well as large

family size, perceived the existing bus transport as costly. When the convenience aspect was considered, Mintesnot and Takano found that the same group perceived bus as an inconvenient mode of public transport except for the monthly income parameter. According to the study, those with higher monthly income perceived bus as an inconvenient mode of public transport.

In addition, their outcome shown that shorter waiting times, and cheaper bus prices increased the probability of choosing the bus and enhance the perception of bus convenience. Low bus frequency (long waiting time) and high fares increase the probability of perceiving the bus as costly. Based on the results and further analysis and considerations, Mintesnot and Takano argued that a strategic plan, policy interventions and physical solutions could be drawn as an effort to improve the existing public transport services. The researchers, therefore, recommended that spatial expansion of bus service, improving bus frequency conditions, and strengthening the bus linkage with respect to the land use should be the policy intervention areas.

Eno (2007) explored the propensity of female car owners in Akure, Nigeria, to patronise public transport. Discriminant model was employed to classify the respondents into their appropriate mode choice category. The model predicted a marginal increase of three in the number of women who preferred to discard their private cars for a public transport mode in Akure. The independent variables used in the model were willingness to use public transport for subsequent work trip, access to private car and number of cars in the family

among others. The report showed that women who had unrestricted access to private car at home persistently preferred the private car mode to public transport.

Asiyanbola (2007) examined the effects of urban transport infrastructure condition and intra-urban travel on the psychological well-being of women and men in Nigeria, using Ibadan as a case study. Cross-sectional survey of 721 households was used for the study. The following null hypotheses were tested: (a) there is no significant effect of urban transport infrastructure condition and intra-urban travel on women's and men's psychological distress and (b) there is no gender difference in the effects of urban transport infrastructure condition and intra-urban travel on the psychological distress of women and men.

The variables used in the analysis included urban transport infrastructure condition indicators such as: Neighbourhood road quality; neigbourhood public transport condition; neighbourhood street light condition; neighbourhood state of security; neighbourhood crime level and neighbourhood drainage system; intra-urban travel indicators (weekly trips made for each of the following purposes secular work, children school, childcare, recreation, shopping, religion, fetching water, getting rid of household waste) and psychological distress information.

Their regression analysis showed that urban transport infrastructure condition and intra-urban travel has significant effects on the psychological well-being of women and men. Gender difference was also found in the effects of urban transport infrastructure condition and intra-urban travel on women and men's psychological well-being. The effects were, however, found to be more on working and nursing mothers compared to men. According to Asiyanbola's

findings, urban transport infrastructure condition and intra-urban travel constitute a major threat to psychological well-being of women and men and the effect was more on the psychological well-being of women than of men due to gender differences in the socially prescribed roles.

Based on the outcome of their analysis, the researchers recommended that intra-urban transportation should not only be made accessible, safe, affordable and appropriate, but also gender sensitive. This could be achieved by developing transportation planning models that capture gender differences in trip purpose, frequency and distance travel, mode of transportation use and complexity of trip making, among others.

Bill (2008) explored the factors that contribute to primary school pupils' travel choices in New Zealand. This was to identify travel choice patterns which might, in turn, be useful in developing policies and planning initiatives, which could contribute to achieving an efficient and sustainable transport system. A case study involving the pupils of twenty two Christchurch primary schools was carried out. Pupils and their parents were surveyed to establish their mode choices and the factors influencing those choices. The study showed that between 55 percent and 60 percent of the pupils surveyed traveled to and from school by car, 30 percent to 35 percent walked and five percent to seven percent cycled. This was compared with 34 percent that travelled by car in the late 1980s.

The results of their study also suggested that school travel plans, when combined with energy and commitment to implement them could have a significant effect on school travel choices. As part of the study, parents were

asked to rank the importance of a number of factors, which could influence choices regarding their children's school travel. The responses from parents identified safety concerns, regarding both road and personal safety, as the major factors behind decisions regarding their children's travel choices. Time constraints coupled with the complexity of travel requirements of many families were identified as significant factors.

Multinomial Logit Models for both mode choice and pupils travel independence were then produced for both the journey to and from school. These models were based on the results of the case study. The models produced indicated that, at a school level, there was a correlation between increasing school roll and an increasing proportion of pupils travelling by car. A slight negative correlation between school decile and car usage was also indicated. This was contrary to the normally accepted understanding that in most transport situations there is a positive correlation between increasing affluence and car usage. At a family level, the researchers observed that there was a strong positive correlation between distance from school, age of the pupils, and the number of major roads between school and home and car usage. It was therefore recommended that a model using decile, average age and school roll variables be used to estimate mode choices at an individual school level.

In India, there was a study of a passenger transport sector in an attempt to address an interesting and increasingly apparent phenomenon of travel behaviour, namely intermodal choice and modal substitution. This study was premised on an earlier work done by a research team at the Centre for Mathematical Modeling

and Computer Simulation (C-MMACS), NAL. A general methodology to describe the growth of the transport sector in India was developed in terms of appropriate mathematical models.

The primary objective of the subsequent study was to develop and evaluate a set of econometric models that could adequately measure the extent of intermodal substitution in passenger transport on short-haul routes (inter-city travel) and, critically evaluate the factors that affect travel choice in a multimodal environment. To that end, the researchers used the traditional logit framework to estimate choice probabilities based on user perceptions about factors affecting their mode choices. It was found that users attached considerable importance to comfort and convenience, including time of travel, while making travel choices ("Growth of transport centre and CMMACS," n.d.).

The literature review suggests that the key determinants of choice of mode include: Time and travel cost (Alpizar, Carlsson and Martinsson, 2001; Bill, 2008); Residential zone (Mintesnot and Takano, 2007); Comfort and convenience (Corpuz et al., 2006); Gender (Asiyanbola, 2007; Li, 2001; Fadare and Morenkeji, 2001) and Accessibility of transport (Eno, 2007).

CHAPTER THREE

METHODOLOGY

Introduction

First of all, this chapter presents the methodology of this study. This is followed by detailed description of all the methods and steps used in arriving at the conclusion of this study. It contains a description of the subjects, considers the map of the study area, study design and the instruments used. It also documents the sample size and sampling procedures. The chapter concludes with the specification of the model, sources of data and techniques of data analysis.

Study Area

Abossey Okai is the study area. It is situated in the Accra Metropolitan Area (AMA) of Ghana. The AMA is one of the largest assemblies in the country. AMA, as shown in Figure 1, is bordered in the North, West and East by other Municipal and District Assemblies, and South by the Gulf of Guinea. Accra is the capital as well as the largest urban centre in Ghana. It is located on the coast of the Greater Accra Region (Fig 1), and epitomises the level of socio-economic development in the country. Accra has a population of 1,659,000 according to 2000 population census.

There is a substantial suburban expansion and a relative rise in the growth

of industry, commerce, housing, health and educational establishments since independence. The labour force in Accra was estimated at 300,000-400,000 in the 1990s (GSS, 2007). These resulted in high demand for motorised transportation. It is not surprising that there is a large volume of traffic on the Winneba and liberation Road corridors with the volumes of over 50,000 vehicles per day (DoUR, 2005). Approximately one million vehicles are expected in AMA in 2023 according to the Department of Urban Road.

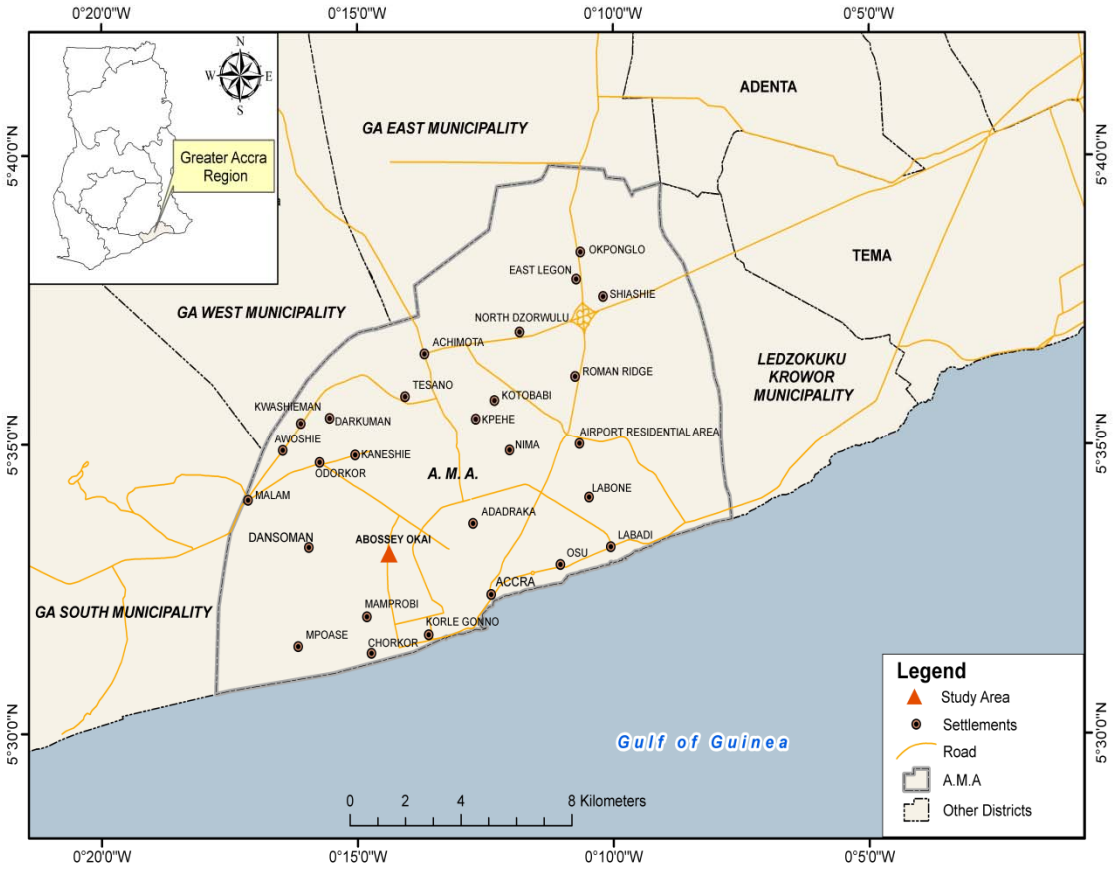

Figure 1: Greater Accra Region

Source: GIS, UCC-2009

For the purposes of this study, the study area was divided into two zones. These are inner zone and peripheral zone. The inner zone residents are spare parts dealers who live in and around the Central Business District (CBD) of Accra. The peripheral zone residents are those who live in the urban edges of the study area.These zones are largely inhabited by all manner of persons but the dominant languages spoken are Akan, Ga and English. Each zone is made up of settlements (as shown in figure 1). The inhabitants, most of whom are spare parts dealers, engage in various activities such as banking, commerce and other administrative duties. Nonetheless, of all the activities engage in at Abossey Okai, spare parts dealing is the dominant one.

Study Design

This study adopted the ex post facto survey design to determine the personal specific characteristics and mode choice attributes that influence the choice of mode of transport by individual spare parts dealers in Accra. According to Johnson (2001), the major strength of the ex post facto design is that it enables researchers to scrutinise existing conditions and collect data to explore a possible relationship between factors and ensuing characteristics or behaviours. The design has independent and dependent variables. It involves no direct manipulation of the independent variables and supposes that, the presumed cause of an event has already taken place.

However, this design is limited in that it does not permit firm conclusions about the cause and effect of an occurrence. Control for confounding variables

that may offer alternative explanations for any group differences that may have been observed also remains tentative. The ex post facto design was appropriate for this study because it examined spare parts dealers using transport mode. The composite independent variables were the individual personal characteristics and mode choice attributes (Ortuzar and Willumsen, 2005). The dependent variable was mode of transport. Data about individual spare part dealers were collected to serve the purpose of the study.

Study Population

The target population was made up of individual spare parts dealers, who qualified to drive and at the same time could make choice decision. The data was limited to spare parts dealers to ensure homogeneity of data necessary for discriminant analysis. Literature revealed that to use discriminant function analysis, the data should be homogeneous in nature (Hurberty and Olejinik, 2006). Spare parts dealers were occupationally homogeneous. The study population did not also include non-transport users. Therefore, the data for this study was homogeneous in nature. There were 3,500 spare part dealers at the time of the study. Preliminary investigation also revealed that spare part dealers faced similar constraint in terms of road traffic congestion. So what is responsible for the mode choice behaviour of this group of spare parts dealers? This is the focus of this study.

Sampling Procedures

In order to ensure the best coverage of the target population in the study area, the non-probability sampling technique called purposive or judgmental sampling was used. Thus, the selection of respondents was based on personal judgment about which of them to choose and picked only those who best met the purpose of the study. This sampling technique was used because, the target respondents were concentrated at one location and the fact that it was also impossible to get the list of all spare parts dealers to enable the construction of a meaningful sampling frame for random sampling. This was done having in mind the need not to disrupt the activities and incomes of respondents as their incomes are a function largely of their daily sales.

Sample Size Determination

In order to draw inference from a sample that will accurately reflect the population, careful attention was paid in determining the needed sample size. The sample size was based on a maximum acceptable error. This was done using Krejcie and Morgan's (1970) formula. The formula is specified below as:

$$S = \chi_p^2 NP(1-P)/\delta^2(N-1) + \chi_p^2(1-P) \qquad (3.6)$$

Where S is the required sample size, χ_p^2 is the table value of chi-square for one (1) degree of freedom at the desire confidence level (3.841), N is the population size, P is the population proportion set at 10 percent and **δ** is the degree of accuracy set at 5 percent.

Given a total population of 3,500 spare parts dealers, the determined sample size was 211. As the determined sample size was not rounded and also due to logistical and time constraints, it was reduced to experimentally acceptable sample size of 200 spare parts dealers. The assumption also was that, large samples would not guarantee high degree of precision and validity in research. This is because the quality of the outcome of the research depends on several factors and the sample size is only one of them (Sarantakos, 1993).

Instruments for Data Collection

The structured interview schedule was employed to collect the data for this study. This was because of the low costs involved and its possibility to give response rate representative of an entire population. It also made it possible to generate both qualitative and quantitative data from respondents. The data were collected to mirror the exact objectives of the study. The interview schedule was designed to incorporate the demographic characteristics (sex, age, educational level, income and marital status) of spare part dealers and mode specific attributes. The structure of questions in the instruments was a combination of open-ended and close-ended questions.

Data Collection Procedures

The survey was done in September, 2009. The fieldwork spanned across four weeks. Two hundred questionnaires were administered. All interviews were personal where the questions were read aloud to the respondents in English and

vernacular (Akan & Ga). The respondents were visited at their offices or shops during working hours. If the person at the office or shop could not make a choice decision, the person at the next office or shop next door was surveyed.

Model Specification

The empirical discrete choice models have been used by researchers to model choice of transport over the past four decades. This is because of their high accuracy and sensitivity to policy measures. However, discrete choice models are more data intensive. Discrete choice models are useful for transportation planners for two important reasons. The models help in obtaining a modal split in the four step planning process for travel demand forecasting. The second reason of discrete choice models is in policy analysis. The models are useful tools in analysing policy measures like the potential impacts of imposing tolls and calculating the potential benefits due to proposed improvements in transportation infrastructure among others.

These policy measures can be used to affect modal shifts in order to improve the overall efficiency of the transport system. The discrete choice models that have been in use so far for the most part have been logit models. However, depending on the nature of data available and the primary purpose of developing the model, some other classification models might be more appropriate. Therefore, a less common model like discriminant analysis was employed in this study. This model had been chosen because of its successful application to

classification problems in the fields of Medicine and Business (see Borders, 2006). Three of the less common discriminant models are considered as follows:

Theoretical Framework

In case of two choice modeling, Linear Discriminant Analysis attempts to find a hyper plane that separates the p-dimensional space into two halves (www.statsoft.com). Here the p-dimensions represent each of the explanatory variables that affect the choice of mode. The points that lie on one side of the plane represent the mode i and the points that lie on the opposite side represent the other mode. LDA is a special case of the general discriminant problem that assumes that covariance matrices of all the classes are equal. If observations are represented for the choices as classes 'k' and 'l', the linear discriminant function for class 'k' can be theoretically represented by:

$$\lambda_k(x) = x^T \Sigma^{-1} \mu_k - \tfrac{1}{2} \mu_k^T \Sigma^{-1} \mu_k + \log \pi_k \tag{3.7}$$

The decision boundary between the classes 'k' and 'l' is described by:

G(x) =argmax$_k$ $\lambda_k(x)$. This can be denoted by the following linear equation:

$$\log \tfrac{\pi_k}{\pi_l} - \tfrac{1}{2}(\mu_k + \mu_l)^T \Sigma^{-1}(\mu_k - \mu_l) + x^T \Sigma^{-1}(\mu_k - \mu_l) = 0 \tag{3.8}$$

If the value of the above expression is greater than zero, the observation is classified as mode i and if it is less than zero the observation is classified as otherwise. Here *x* represents an observation written as a vector of p explanatory variables, π_k and π_l represent the proportion of observations in classes k and l,

μ_k and μ_l represent the class mean vectors and Σ represents the common covariance matrix for all classes. The above parameters can be estimated as:

$\ddot{\pi}_k = \frac{N_k}{N}$, where N_k is the number of class-k observations.

$$\vec{\mu}_k = \Sigma_{g_i=k} x_i / N_k$$

$$\vec{\Sigma} = \Sigma_{k=1} \Sigma_{g_{i=k}} (x_i - \mu_k)(x_i - \mu_k)^T / (N - K)$$

The above parameters can be estimated using R and the coefficients of the explanatory variables interpreted.

Quadratic Discriminant (Qd) Model

Quadratic discriminant analysis is one of the classification models. QDA uses a quadratic discriminant surface to separate the p-dimension space into two halves. QDA arises when the assumption of the equality of covariance matrices among all the classes is relaxed. The following equation represents a quadratic discriminant function for class 'k':

$$\lambda_k(x) = -\frac{1}{2} \log|\Sigma_k| - \frac{1}{2}(x - \mu_k)^T \Sigma_k^{-1} (x - \mu_k) + \log \pi_k \quad (3.9)$$

The decision boundary between the classes k and l is represented by the quadratic equation: $\{x: \lambda_k(x) = \lambda_l(x)\}$ (3.10)

The Tree Based Model

Classification Trees are simple but powerful tools used in modeling choices. A tree consists of a series of nodes which hierarchically classify the observations into groups. At each node, the observations are split into two groups based on a threshold value of a particular explanatory variable. These groups are hierarchically further split into groups; two groups at a time based on threshold values of other explanatory variables. At the final set of nodes referred to as the terminal nodes; the observations are classified as belonging to one of the choices. The calibration of a tree involves developing a full tree that gives the best possible classification on the data set and pruning the tree to a reasonable level to avoid over fitting. Tree pruning is analogous to eliminating some of the insignificantly contributing variables in regression modeling. Trees can be pruned using statistical procedures like Cross-validation, Akaike Information Criterion (AIC) or Bayesian Information Criterion (BIC) (Hastie, Tibshirani, & Friedman, 2001).

Empirical Model Specification

For empirical estimation purposes, the linear discriminant functions for multiple groups was adopted to estimate the likelihood of an individual spare parts dealer choosing a particular transport modality with the grouping or dependent variable being the mode of transport, which was grouped into private car, public bus, public trotro and public taxi. This is of great importance because it will help policy makers to know which personal specific characteristics and

mode choice attributes influence transport mode choice decision by spare part dealers in Accra.

The standard linear discriminant model is specified as follows:

$$F_K = \lambda_0 + \lambda_1 X_1 + \lambda_2 X_2 + .. \lambda_P X_P \quad (3.11)$$

Where F_k is the score on the function K, the λ_i s are the discriminant coefficients, and the X_i s are the independent or response variables. The maximum number of functions K that can be derived is equal to the minimum number of predictors (p) or the number of groups less one (SPSS Inc., 2003). In this study, four groups were used. Therefore, four minus one maximum functions was use in the analysis.

Like other general linear model techniques, discriminant analysis has many of the same conditions. First of all, the predictor or independent variables must be measured either with interval or ratio scale. Ordinal variables measured on a likert scale must be treated as interval variables. Nominal variables may be included in the model if they are given dummy coding. A second assumption of discriminant analysis is that the distribution of the sample must be normal. However, this assumption can be violated as the sample size rises. A third assumption of the discriminant analysis is that the variables that are used to discriminate between groups must not be completely redundant (Hurberty, 1994).

Thus, the variance or covariance matrix of the variables should be inverted in the model. If any of the variables is completely redundant with other variables, then the matrix is said to be ill-conditioned, and it cannot be inverted. For example, if a variable is the sum of three other variables that are also in the model, then the matrix is said to be ill-conditioned. In order to guard against

matrix ill-conditioning, there is the need to constantly check the so-called tolerance value for each variable. The tolerance value is computed as 1 minus R-square of the respective variable with all other variables included in the current model (Hurberty & Olejinik, 2006). Thus, it is the proportion of variance that is unique to the respective variable. In general, when a variable is almost completely redundant, the tolerance value for that variable approaches zero.

Identification of Variables and their Operational Definition

Different groups of people have different characteristics and consequently the factors that influence their choice of mode of transport are different. This section identifies the important mode choice variables or characteristics that affect the choice of mode of transport and attempts to find the relative importance of these variables for determining the choice of mode of transport. Ortuzar and Willumsen (2005) provided a useful list of factors known to influence the choice of mode in three main groups: attributes of the traveler, attributes of the journey and characteristics of the transport facility. The analyses in this thesis examined characteristics falling under these three groups, focusing largely on those that could be tested using data available from the Survey.

Transport mode choice and usage was discussed in relation to the following variables or characteristics: Sex, respondent's marital status, age of respondent, family size, average monthly income, risk specific issues (accident, missing appointment, robbery and breakdown), respondent's level of education, respondent's accessibility to transport, residential zone, in-vehicle travel time,

average distance travel from home to work and habits. These variables were chosen because several studies have shown their effect on travel mode choice.

Habits represent the number of times the respondent used a particular mode from home to work in the last week preceding the survey. It is believed to have an effect on behaviour in this context. Triandis (1980) argued that habit could be measured by the frequency of occurrence of behavior. A habit is a composite variable which was measured with likert scale. It received the value of 7 for the highest number of times respondents used a particular mode for the past week preceding the survey and 0 for minimum number of time.

Accessibility is how respondents perceived their access to a particular mode of transport. It was coded 1= very easy, 2= easy, 3= not easy at all. Because this variable has more than two response categories, it was contrast coded (also known as dummy coding) to represent and compare subgroups on the variables. This was very necessary because the process enabled the use of a single equation to represent multiple groups. It was also to fulfill one of the basic requirements for the discriminant model. In order to know how accessibility affects transport mode choice, response three or "not easy at all" was used as a reference category. The reference category was then used in the discriminant function modeling as a way of redefining categorical variables as a series of dichotomous variables.

For example, the covariate, accessibility, has three values and by assigning "not easy at all" as the reference category, each of the other three variables was treated as a dichotomous variable against "not easy at all". In other words, the three-way category became two simpler dichotomous variables – very easy (1) vs.

not easy at all (0) and easy (1) vs. not easy at all (0). Therefore, for any independent categorical value with *n* categories, the use of contrast coding converts the independent variable to a series of *n*-1 dichotomous variables (see Borders, 2006 for more explanation on contrast coding).This approach was applied to all the categorical variables in the discriminant models.

In-vehicle travel time is the average time per minutes a commuter has to endure in a particular mode of transport. It is a generic variable (sometimes referred to as level-of-service attributes in mode choice in transportation) and varied across alternative mode. In-vehicle travel time is a continuous variable that was measured in minutes per second. Family size is a continuous variable based on the number of children responsible to the respondent .It ranges between one to six children; age is also a continuous variable measured in terms of years (26 years above).

Average distance is the distance covered from home to work is. It is a continuous variable. Distance was measured in kilometer per seconds; residential zone and gender are all categorical variables; income is a continuous variable in terms of monthly income. Risk specific issues are categorical and were measured on a scale of one to three, with the three being not risky at all and one representing very risky. Though the above variables are important in determining the choice of mode of transport, some of them could not pass the univariate F test and therefore did not enter the final discriminant model.

It also not farfetched, that the Discriminant Function Analysis is unreliable, when testing for a large number of predictor variables. Therefore, only

those variables that passed the tolerance test in the preliminary analysis were included in the model. The number of variables included in most discriminant analysis studies is limited to something on the order of 10 or 12 unless there are compelling reasons for including more (Hurberty & Olejinik, 2006).

Techniques of Data Analysis

The preliminary analysis and exploration of the data was done, employing Statistical Product and Service Solution (SPSS) version12.0. This was done seeking patterns within responses, looking for casual pathways and connections and constant comparisons (Cohen, Manion & Morrison, 2000). By the nature of the measurement scales, two other statistical techniques, namely: Descriptive statistics of frequencies to determine whether distribution occurred evenly across categories or whether responses were skewed towards one end of the rating scales were employed. This enabled a meaningful description of the data with numerical indices and also checked for errors. Internal consistency methods or procedures were applied to ensure the reliability of scores, since the interview schedules were administered only once.

The cross tabulation of frequencies and tables were used to analyse the demographic characteristics of respondents and other factors that influence the choice of mode of transport of the spare part dealers. The associations between personal and mode specific characteristics of respondents and their choice of mode of transport were analysed using the chi square test of independence.In addition, SPSS version 17.0 was used to analyse the data for the discriminant

model. The discriminant analysis was used in the study to classify specific spare parts dealers into their appropriate mode choice groups based on a set of discriminating variables. The classification was based on the discriminant function and the discriminant score for each of the business person in the sample.

The discriminant functions were derived using two different techniques. The first was the canonical discriminant function and the associated coefficients and the second was the Fisher's linear discriminant function and its coefficients. The Canonical technique involved the computation of eigen values as well as the canonical correlation coefficients. The computed eigen values and the canonical correlation coefficients were tested for their significance using wilk's lambda (λ) and chi-square. The second technique was the computation of the Fisher's linear discriminant function coefficients for the classification of the spare parts dealers into their proper mode choice groups. Fisher's linear discriminant function coefficients offered explanation on the effect of each of the variables on the mode choice behaviour of spare parts dealers in the study area.

The discussion in the methodology focused on ex post facto survey design. Primary data were collected through survey of individual spare parts dealers in Accra. The data collection spanned across four weeks in September, 2009. The study employed questionnaire instruments for data collection. The discriminant function specification was used for the classification of spare parts dealers into their mode choice groups. In all, 200 spare parts dealers were selected for the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

Ortuzar and Willumsen (2005) provided a useful list of factors known to influence the choice of mode in three main groups: Attributes of the traveler, attributes of the journey and characteristics of the transport facility. This chapter examines some of the characteristics falling under these three groups. It commenced with the analysis of the demographic characteristics of the respondents, followed by the discussion on the attributes of the modes. The chapter ends with the discussion of the results of the discriminant analysis (DA).

Demographic Characteristics of Spare Parts Dealers

The demographic characteristics were described in terms of the sex, age groups, marital status and educational level of spare parts dealers, who were basically inner zone and peripheral zone residents. The inner zone residents were spare parts dealers who lived in and around the Central Business District (CBD) of Accra. The peripheral zone residents were those who lived in the urban edges of the study area. These groups were chosen carefully to give each respondent in the sample equal choice opportunities. The cross tabulation was used to analyse

the demographic characteristics. The associations between personal and mode specific characteristics of respondents and their choice of mode of transport were also analysed using the chi square test of independence and the results are presented in the ensuing sections.

In all, 200 spare parts dealers with ages between 26 years and 60 years were sampled for the study. Out of this sample, 42 percent were females and 58 percent constituted males. According to Table 1, the minimum age is 26 years with the maximum age being 60 years.

Table 1: Frequency of age groups by sex of respondents

	Sex			
Age groups	Male	Percent	Female	Percent
26- 30	18	15.5	16	19.0
31-35	13	11.2	10	11.9
36-40	22	19.0	9	10.7
41-45	29	25.0	18	21.4
46-50	8	6.9	17	20.2
51-55	16	13.8	14	16.7
56-60	10	8.6	0	0.0
Total	116	100.0	84	100.0

Source: Fieldwork, 2009

The average age of the male spare parts dealers was approximately 37 years and that for the female counterparts was about 36 years.

From Table 1, age group with the highest number of spare parts dealers is 41-45 years for both females (21.4%) and males (25%). The age group of 56-60 years has no females and only 8.6 percent males. This demonstrates that a few of the spare parts dealers are nearing their retirement in the entirety of the population under consideration.

With regards to education, about six percent of the respondents had no formal education while females who had no education were about five percent.

Table 2: Frequency of educational level by sex of respondents

	Sex			
Educational level	Male	Percent	Female	Percent
No Formal Education	7	6.0	4	4.8
Primary Education	7	6.0	9	10.7
JSS/Middle School	26	22.4	13	15.5
Secondary/ Voc Education	52	44.8	40	47.6
Tertiary Education	24	20.7	18	21.4
Total	116	100.0	84	100.0

Source: Fieldwork, 2009

From Table 2, about 28.4 percent of the male respondents have had education up to junior secondary or middle school level. Their female

counterparts with the same level of education, however, constituted 26.2 percent.

The analysis of the marital status of the respondents is considered in Table 3. The analysis reveals that one hundred and forty (140) spare parts dealers constituting about 70 percent of the respondents sampled for this study were in matrimonial relationship. About 17.5 percent of them were single with a little over 12 percent divorced, separated or have had their partners dead.

Table 3: Frequency of marital status of respondents

Marital Status	Frequency	Percent
Single	35	17.5
Married	140	70.0
Divorced	9	4.5
Widowed	12	6.0
Separated	4	2.0
Total	200	100.0

Source: Fieldwork, 2009

The national minimum wage in Ghana within the study period was GH¢ 2.65.This means that on the average, the average minimum monthly income of any gainfully employed Ghanaian should be about GH¢ 53 for twenty working days. The frequency of average monthly income level of the respondents is shown in Table 4. It was observed that the average monthly income of the respondents varied from a minimum of GH¢ 100 to a maximum of GH¢ 1500.

However, the majority (58%) of the respondents had income within the range of GH¢ 300 to GH¢ 500. Consequently, the majority of the respondents sampled earned income far and above the national minimum wage in Ghana. What is interesting, though, is the number of respondents who earned between GH¢ 1100 to GH¢ 1500. The Table shows that only five respondents (2.5%) were within this income cohort. This means that there is an inequity in the distribution of income earned among the respondents in the study area.

Table 4: Frequency of monthly income groups of respondents

Average income groups	Frequency	Percent
0-100	5	2.5
101-300	34	17.0
301-500	116	58.0
501-700	25	12.5
701-900	11	5.5
901-1100	4	2.0
1101-1300	1	0.5
1301-1500	4	2.0
Total	200	100.0

Source: Field Work, 2009

Distribution of Spare Parts Dealers by Mode of Transport

This section focused on the general distribution of spare parts dealers by mode of transport. Data was collected on the daily movement of the respondents who used various modes of transport to and from work, children school, social gathering and hospital. As noted earlier, 200 respondents were sampled for the study. However, 198 of them used private car, public bus, public trotro and public taxi from home to work. Two of the respondents (not considered in Table 5) walked from home to work. From Table 5, it can be observed that out of 198 spare parts dealers who used the various modes of transport to work, about 42 percent of them used public trotro to work. This is followed by about 36 percent of the respondents who used private car as their main mode of transport from home to work.

Table 5: Distribution of respondents by mode of transport

Mode of transport	Frequency	Percent
Private car	72	36.4
Public bus	18	9.1
Public trotro	83	41.9
Public taxi	25	12.6
Total	198	100.0

Source: Field Work, 2009

On the basis of public taxi, about 13 percent of the respondents used public taxi from home to work. Similar results were found in the National Transport Survey by the Department of Urban Road in Ghana in 2005. The remaining 9.1 percent of the spare parts dealers sampled, however, preferred the bus, as a means of transport to work, to other alternative modes of transport. These results only confirm the pervasive popularity of trotro and the private car in the Metropolitan Area of Accra.

Residential Zone and Transport Mode Choice

This section of the analysis considers the relationship between the respondents' mode of transport from home to work and where they live. The analysis indicates that out of 36 percent of the respondents who used private car from home to work, about 56 percent lived within the peripheral zone of Accra whiles the remaining 44 percent lived within the inner zone. From Table 6, it can be observed that, of the entire peripheral zone dwellers, about 83 percent used private car and public trotro as a means of transport from home to work. About 7 percent and 10 percent, respectively, used public taxi and public bus. In terms of all those spare parts dealers who lived in the inner zone, the Table shows that about 73% of them used both private car and public trotro. About 20 percent and 10 percent used public taxi and public bus, respectively.

The analysis further indicates that out of 9.1 percent of the respondents who used public bus from home to work, about 61 percent lived within the peripheral zone and a little over 38 percent lived within the inner zone of Accra.

When this result was compared with that of those who used private car, we observed that about 15 percent more of the respondents, who lived within the peripheral zone of Accra, actually used public bus as a means of transport from home to work.

The results again show that six percent less of the respondents who lived within the inner zone, however, used private car from home to work. The high patronage of public bus among peripheral zone dwellers could be attributed to lower costs charged by some bus company over long distance in Ghana. This result, therefore, is consistent with what was found by Mintesnot and Takano (2007) in Addis Ababa and Corpuz (2006) in Australia, and may have some policy implications for road traffic regulation and effective transport service delivery within Accra Metropolitan Area.

Table 6: Frequency of mode of transport by residential zone

	Residential zone			
Mode of transport	Inner zone	Percent	Peripheral zone	Percent
Private car	32	35.2	40	37.4
Public bus	7	7.7	11	10.3
Public trotro	34	37.4	49	45.8
Public taxi	18	19.8	7	6.5
Total	91	100.0	107	100.0

Source: Fieldwork, 2009

Table 6 further shows that a lot more of the respondents (45.8%) who lived in the peripheral zone used public trotro as means of transport from home to work. In the inner zone, about 37 percent being the highest number of the spare parts dealers also used public trotro from home to work. This means that, comparatively, about eight percent more of spare parts dealers who used public trotro as means of transport to work lived in the peripheral zone of Accra. About six percent of peripheral zone dwellers used taxi from home to work whiles the lowest number (7.7%) of the inner zone dwellers, used public bus as means of transport from home to work.

In trying to answer the question posed earlier about whether or not respondents' residential zone significantly influences their choice of mode of transport, the following hypothesis was made that: Residential zone has no influence on the choice of mode of transport of spare parts dealers. The results in (Appendix B) indicate that residential location of respondents, indeed, influenced their choice of mode of transport, as revealed by the χ^2 value of 8.089, with its associated p-value of 0.044. Pallant (2001) was of the view that for a test to be significant, the p-value must be equal to or smaller than 0.05. The test was therefore significant and the null hypothesis could not be accepted, implying that residential zone significantly influences the choice of mode of transport.

The results corroborated Mintesnot's and Takano's (2007) findings that the peripheral zone dwellers exhibit a high tendency for choosing bus over taxi because buses are affordable means of transport for long trips, whiles inner city dwellers prefer taxi because trips tend to be shorter. Their findings further show

that for the urban poor living in the urban expansion area, buses were indispensable choice because they were affordable.

Demographic Characteristics and Choice of Mode

The importance of this section is to relate the demographic characteristics of the spare parts dealers to the various mode choice opportunities available to them. In all, there were four alternative modes equally available to the respondents. From Table 7, the analysis shows that of all the respondents who used private car, about 14 percent were up to 30 years. About 23 percent of all those who used public trotro were up to 30 years and 20 percent of all public taxi users were up to 30 years. Conceivable reason, like accessibility to bus, inflexibility of bus in terms of where those within this age group want to go, could be adduced to explain this outcome.

Furthermore, it was observed that, of all the respondents interviewed, about 15 percent aged between ages of 51 years and 55 years. About 67 percent out of that (15%) used private car. This represented the highest percentage for all modes and for all respondents within that age bracket. The analysis in Table 7 once more reveals that out of the 36 percent of the respondents that generally used private car from home to work, about 28 percent were between the ages of 51 years and 55 years. About 10 percent and eight percent out of the generality of the respondents who used public trotro and public taxi to work were between ages of 51years and 55 years. No one in this age group used public bus as a means of transport from home to work.

Table 7: Frequency of age groups by mode of transport

	Mode of transport							
Age groups	Car	Percent	Bus	Percent	Trotro	Percent	Taxi	Percent
26-30	10	13.9	0	0.0	19	22.9	5	20.0
31-35	4	5.6	4	22.2	9	10.8	4	16.0
36-40	10	13.9	6	33.3	9	10.8	6	24.0
41-45	14	19.4	5	27.8	23	27.7	5	20.0
46-50	9	12.5	3	16.7	12	14.5	1	4.0
51-55	20	27.8	0	0.0	8	9.6	2	8.0
56-60	5	6.9	0	0.0	3	3.6	2	8.0
Total	72	100.0	18	100.0	83	100.0	25	100.0

Source: Fieldwork, 2009

It is significant to note, at this point, that as the age increases for the spare parts dealers, the percentage of the respondents who used private car to work also increases. These results confirm the assertion made by Mintesnot and Takano (2007) that the probability of choosing a bus decreases when age increases. This is to be expected because the physical predisposition of the elderly people may not permit them to struggle for public trotro and public bus. Many of them may also want to use private car as a status symbol in the society. Others may not use the bus because of inconvenience. Currently, there are no policies or technical support existing in Ghana to encourage the elderly to use public bus. Also, the

design of the high steps on the bus might not be friendly to the elderly. All these may have accounted for the trend in our results.

Only about five percent of all the spare parts dealers considered for the study aged between 56 years and 60 years. Out of this percentage (5%), half of the respondents (50%) used private car as a means of transport to work. Thirty percent and 20 percent, respectively, used public trotro and public taxi. An observation of the Table also indicates that, of all the spare parts dealers who used private car from home to work, only about 10 percent were within ages of 56 years to 60 years whiles only eight percent of all those who used public taxi were in this group (56-60). About four percent of the respondents who went to work with public trotro were within ages of 56 years to 60 years.

In order to find out whether or not the pattern observed in the respondents' age groups and their choice of mode of transport was due to chance, the null hypothesis was tested that: Age group has no influence on the choice of mode of transport of spare parts dealers. The findings reveal that age group significantly influenced the choice of mode of transport of spare parts dealers. This is because with a calculated p-value of 0.011 less than the theoretical p-value of 0.05 and a χ^2 value of 34.340 (Appendix B), the null hypothesis could not accepted.

Sex and Choice of Mode of Transport

With regards to transport mode, Table 8 indicates that about 41.5 percent of the respondents who used private car were females with less than one-third (32.8%) being males. The Table further shows that, there were male dominant in

the use of public bus (12.1%), public trotro (42.2%) and public taxi (12.9%) at all levels of transport, apart from private car.

This result starkly contrasts Mathies', Kuhn's and Klockner's (2002) findings in Germany, Switzerland and Australia that women use public transport more than men and reversibly use cars less frequently. Additionally, the results also refute the findings of Davidov, Schmidt and Banberg (2003) that females have a lower technical affinity than men and therefore have a lower tendency to use the private car. Hanson and Hanson (1980) noted that men travel more frequently than women and rely on bus to a lesser extent than women. This was corroborated by the results from the study.

Table 8: Frequency of mode of transport by sex of respondents

	Sex			
Mode of transport	Male	Percent	Female	Percent
Private car	38	32.8	34	41.5
Public bus	14	12.1	4	4.9
Public trotro	49	42.2	34	41.5
Public taxi	15	12.9	10	12.2
Total	116	100.0	82	100.0

Source: Fieldwork, 2009

To examine whether or not sex of respondents significantly influence their choice of mode of transport, the hypothesis was formulated that: Sex has no

influence on the choice of mode of transport of spare parts dealers. The results turns out not to be significant based on a chi square χ^2 statistic of 3.761, with its associated p-value of 0.288 (Appendix B), implying that gender, has no significant influence on the choice of mode of transport of spare parts dealers. Davidov et al. (2003) concluded from a study that gender has no significant effect on travel mode choice. This was exactly the case in this study. A similar conclusion was reached by Rhoulac (2003) that gender was not significant in predicting mode choice for high school students.

Family Size and Mode of Transport

The number of spare parts dealers who had children were 141.Their family size varies from one child to six children. The distribution of the spare parts dealers as well as their choice of mode of transport is presented in Table 9. The results indicate that more than one-third (36.9%) of the spare parts dealers had between 4-5 children, with 10.6 percent having up to one child. Overall, 65.2 percent of the spare parts dealers had more than three children.

Table 9 indicates that up to a majority (84.6%) of public bus users had more than three children. In terms of all the taxi users, up to the lowest (44.5%) of the respondents had more than three children. This result simply means that up to 40.1 percent more of the respondents, who had more than three children, used bus other than public taxi. These results confirm the argument of Mintesnot and Takano (2007) that respondents with large family size had higher tendency of choosing bus over taxi. This outcome is to be anticipated as the carrying capacity

of both public taxi and private car, constraints large family size travelers from using private car or public taxi.

Table 9: Frequency of family size by mode of transport of respondents

	Mode of transport							
Family Size	Car	Percent	Bus	Percent	Trotro	Percent	Taxi	Percent
Up to 1	6	12.0	0	0.0	5	8.6	4	22.2
2-3	8	16.0	2	15.4	16	27.6	6	33.3
4-5	14	28.0	7	53.8	29	50.0	2	11.1
6+	22	44.0	4	30.8	8	13.0	6	33.3
Total	50	100.0	13	100.0	58	100.0	18	100.0

Source: Fieldwork, 2009
Note: The table excludes two spare parts dealers who walked from home to work

One of the tentative statements was that: Family size has no influence on the choice of mode of transport of spare parts dealers. In order to confirm or disconfirm this assertion, chi-squared value of 23.267 and its associated p-value of 0.006 were obtained. Since the computed p-value was lower than the theoretical p-value of 0.05, the result was significant (See Appendix B). Therefore, the assertion was disconfirmed that family size has no influence on the choice of mode of transport of respondents, and conclusion was drawn that family size, indeed, influenced the choice of mode of transport of respondents.

Distribution of Respondents by Time Spent in Vehicle

Under this section, we discussed the findings in terms of the distribution of spare parts dealers by time spent in traffic while on their way to work. The section also touched on the influence of time on the choice of mode of transport of spare parts dealers. The findings were discussed in four parts to reflect the modes of transport available to spare parts dealers and their time spent while on their way from home to work. The first part considered the distribution of the respondents by time spent in private car and discussed the results of the chi square and the associated p-value, the second part dealt with the distribution of spare parts dealers by their time spent in public bus, together with the discussions on whether or not time has a significant influence on the choice of public bus. The third and fourth parts considered the distribution of spare parts dealers by time spent in taxi and trotro, while going to work.

Distribution of Respondents by Time Spent in Private Car

As noted earlier, the spare parts dealers who used private car from home to work were 72. Out of this 25 (34.7%) spent a minimum of 4 minutes to a maximum of 57 minutes in traffic before getting to work. On the average, 20.09 minutes were spent by private car users from home to work. A little below one-third 8 (32%) of all private car users who spent at most 75 minutes in traffic, spent between 13-21 minutes in traffic before getting to work. On the whole, Table 10 shows that about 28 percent of the respondents who used private car to work spent more than 30 minutes in traffic.

Table 10: Distribution of respondents by time spent in private car

Time Spent	Frequency	Percent
4-12	3	12.0
13-21	8	32.0
22-30	7	28.0
31-39	1	4.0
40-48	4	16.0
49-57	2	8.0
Total	25	100.0

Source: Fieldwork, 2009

To examine whether or not in-private car time of respondents significantly influenced their choice of mode of transport, an educated guess was formulated and tested that: In-car travel time has no influence on the choice of mode of transport of spare parts dealers. The results in Appendix B tend out not to be significant because a chi-squared analysis yielded a χ^2 statistic of 14.716, with its associated p-value of 0.257, implying that although there appears to be some pattern in in-private car time and the choice of private car, our guess that in-private car time has no influence on the choice of private car was true.

That is, the hypothesis that in-private car time has no significant influence on the choice of mode of transport of spare part dealers was not accepted. This outcome is very strange as travel time, which is a generic variable, is an attribute that varies across alternative modes of transport. Fredrik Carlsson and Martinsson,

(2001) pointed out that average travel time was one of the significant determinants of transport mode choice.

Distribution of Respondents by Time Spent in Public Bus

With regards to public bus, up to 140 minutes were spent in traffic by those respondents who used public bus from home to work. On the average, the respondents who used public bus to work spent nearly an hour (57.55 minutes) in traffic on their way to work. From Table 11, it can be observed that between 45-76 minutes were spent by two-third (67%) of those who used public bus from home to work. About six percent of the respondents who used public bus from home to work, however, spent between 125-140 minutes in traffic on their way to work. Exactly half (50%) of the respondents, who used public bus from home to work, spent at most one hour in traffic before getting to work.

Table 11: Distribution of by time spent in public bus

Time Spend	Frequency	Percent
0-12	3	16.7
45-60	6	33.3
61-76	6	33.3
77-92	2	11.1
125-140	1	5.6
Total	18	100.0

Source: Field Work, 2009

This outcome is not surprising because, in Ghana, the public bus does not have exclusive right of way, as we have it in other jurisdictions. As a result, the bus delays on the way. The public bus, too, makes frequent stoppages, to onboard passengers as well as discharges them. This turns to extend the number of minutes the bus spends on the way.

To examine whether or not in-bus time significantly influenced the choice of mode of transport of spare parts dealers, the hypothesis that in-bus time has no influence on the choice of mode of transport of spare parts dealers was tested. The results tends out not to be significant because a chi-squared analysis yielded a χ^2 statistic of 5.867, with its associated p-value of 0.662 (Appendix B), implying that in-bus time has no significant influence on the choice of mode of transport of spare parts dealers. The null hypothesis could therefore not be rejected. This conclusion is at variance with the findings of Alpizar, Carlsson and Martinsson (2001) that a reduction in travel time for the bus mode emerges the most significant element in a programme aimed at attracting commuters towards public transport and away from the private car mode.

Distribution of Respondents by Time Spent in Public Trotro

Considering public trotro, the results show that about 94 percent of all the respondents who used public trotro to work spent between 15 minutes to 120 minutes in traffic before getting to work. The average time spent by all those who used public trotro from to work was 38.82 minutes. The results in Table 12 shows that a little over half (53%) of the spare parts dealers, who used trotro to work,

spent between 16-36 minutes in traffic. About four percent spent between 100-120 minutes on the trotro from home to work, with up to about 85.0 percent of the respondents spending at most 57 minutes in traffic on their way to work. In sum, about 15 percent of the trotro users spent over 57 minutes in traffic from home to work.

Table 12: Distribution of respondents by time spent in public trotro

Time Spent	Frequency	Percent
0-15	3	3.8
16-36	41	52.6
37-57	22	28.2
58-78	9	11.5
100-120	3	3.8
Total	78	100.0

Source: Fieldwork, 2009

To examine whether or not in-trotro time of respondents significantly influenced their choice of mode of transport, the hypothesis was formulated and tested that: In-trotro time has no influence on the choice of mode of transport of spare parts dealers. The results turns out not to be significant because a chi-squared analysis yielded a χ^2 statistic of 4.780, with its associated p-value of 0.965 (Appendix B). Therefore, the null hypothesis could not be rejected, implying that

in-trotro time in fact has no significant influence on the choice of mode of transport of spare parts dealers.

Distribution of Respondents by Time Spent in Public Taxi

In terms of public taxi, the results in Table 13 show that respondents who used their cars to work spent between 4 minutes to 58 minutes in traffic on their way. The mean time spent in public taxi by the spare parts dealers on their way to work was 27.30 minutes. More than half (56%) of the spare parts dealers, who used public taxi to work, spent between 15-25 minutes in traffic, with four percent spending between 26-36 minutes in traffic from home to work. About 84 percent of the respondents spent at most 47 minutes in traffic from home to work.

Table 13: Distribution of Respondents by time spent in taxi

Time spent (mins)	Frequency	Percent
4-14	4	16.0
15-25	14	56.0
26-36	1	4.0
37-47	2	8.0
48-58	4	16.0
Total	25	100.0

Source: Field Work, 2009

To ascertain whether or not in-taxi time significantly influenced the choice of mode of transport, the hypothesis was formulated that: In-taxi time has no influence on the choice of mode of transport of spare parts dealers. The results in Appendix B tend out to be significant because a chi-squared analysis yielded a χ^2 statistic of 20.750, with its associated p-value of 0.023, implying that in-taxi time has significant influence on the choice of mode of transport of spare parts dealers.

Considering the mean times spent in traffic from home to work, we observed that, although the various modes were equally constrained in terms of exclusive right of way, the respondents spent much more time in traffic on the public bus (57.55) than on any other modes, with the lowest time being spent on the private car (20.09). The results support Torid's (2003) argument that without exclusive right-of-ways, both private and public modes of transport are subjected to delays and rising in-vehicle time, due to traffic congestion and other occurrences on the highway system, and that the stops that a public transport makes to onboard or alight passengers cause increase in in-vehicle travel time and a less desire for it. What is interesting about the results, however, is the different mean traffic times spent on the private car (20.09) and public taxi (27.30). But this is also not surprising because public taxi also stops and picks and discharges passengers, and in the process have to spend more time than the private car.

Reasons for not Using Public Trotro

This section of the analysis considers the reasons spare parts dealers do not use public trotro regularly for their trips. As it were, 83 spare parts dealers

used public trotro from home to work. Out of this number, 57 (69%) did not use the public trotro regularly from home to work.

From Table 14, it can be observed that one-fourth (25%) of the respondents who did not use public trotro regularly cited chivalrousness of public trotro drivers as their reason for not using the public trotro regularly to work. About 14 percent of the respondents did not use the public trotro regularly because they now own a car. From the analysis, about two percent of the irregular public trotro users cited physical inability as a reason for not using it regularly.

Table 14: Reasons for not using public trotro regularly

Reasons	Frequency	Percent
I have a car now	8	14.0
It is inconvenient	6	10.5
It is not comfortable	11	19.3
I am physically unable	1	1.8
Drivers are not courteous	14	24.6
It is too slow	12	21.1
It is not safe	5	8.8
Total	57	100.0

Source: Fieldwork, 2009

Reasons for not Using Private Car

As part of the objective of the study to determine factors that will influence the choice of mode of transport of spare parts dealers, the interview schedules were structured in a way that enabled us elicited reasons spare parts dealers do not drive private car regularly for their trips. In the ensuing Table 15, the results demonstrates that out of the 72 spare parts dealers that used private car from home to work, 6 (8.3%) did not use the private car regularly from home to work. The results further indicate that out of all those respondents who did not use the private car regularly, about one-third were unable to drive regularly because of high fuel cost and unafffordability of private car. It can be observed further from the table that, about 17 percent of the irregular car users cited lack of license as a reason for not driving regularly.

Table 15: Reasons for not using private car regularly

Reasons	Frequency	Percent
I have no license	1	16.7
Fuel cost is high	2	33.3
Service cost is high	1	16.7
Not affordable	2	33.3
Total	6	100.0

Source: Field Work, 2009

It can be observed from the analysis that, out of the 25 spare parts dealers that used public taxi from home to work, 2 (8%) did not regularly use the public taxi because it was an inconvenient means of transport. In terms of public bus, 2 (11%) who did not use public bus regularly claimed it was an in convenient means of transport.

Access to Main Modes of Transport from Home to Work

The views of spare parts dealers with regard to their access to modes of transport were examined under this section. Transport accessibility analysis is particularly necessary to address accessibility and other improvements needs in public transport. It is widely considered as promoting sustainable travel behaviour and therefore conntinues to be an area of focus in urban and transport planning (Corpuz, 2006). Figure 2 presents the results on access to main modes of transport from home to work by spare parts dealers. The prvious analysis indicates that 72 spare parts dealers used their private cars from home to work. Out of this (72), the majority (94.4%) who used car from home to work claimed car was very easily accessible to them. Two (2.8%) out of the total number of users find the private car not to be accessible.

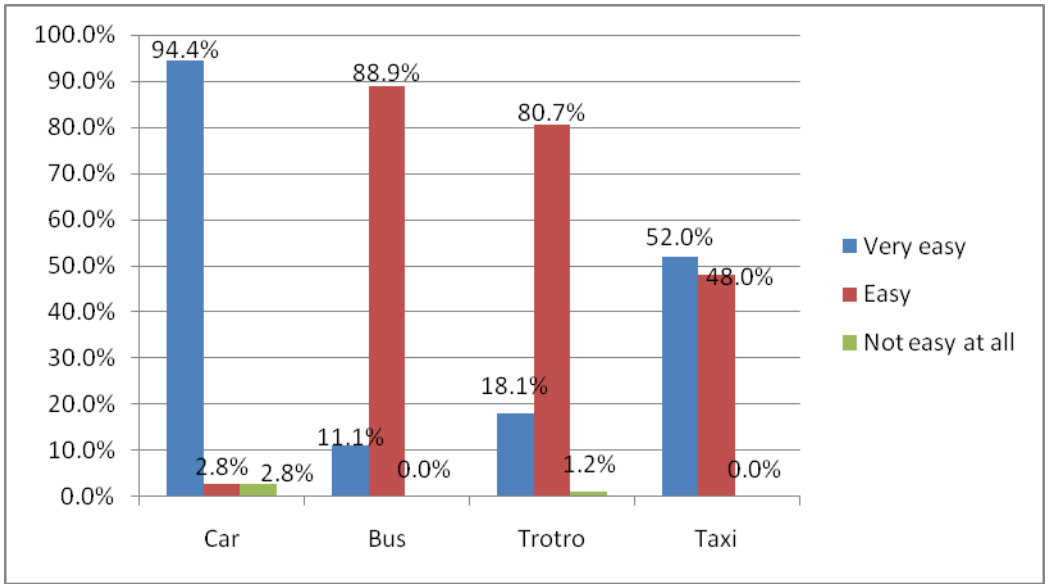

Figure 2: Spare parts dealers' access to transport mode

Source: Fieldwork, 2009

In terms of public bus, the results indicate that 18 out of the total number of spare parts dealers interviewed used the public bus from home to work. Majority (88.9%) of that number find the public bus easily accessible with no one saying the bus was inaccessible. Figure 2 further rveales that two-third (67) out of 83 (80.7%) of all those who used trotro from home to work, saw the trotro as easily accessible. With regards to taxi, a little over half (52%) of all taxi users claimed that the taxi was very easily accessible. No one out of the taxi users finds it inaccessible. The figure further reveals that out of 98 spare parts dealers who used the various modes of transport, 68 (94.4%) who used car saw it as very accessible, while 2 (11%) out of those who used the public bus claimed that the bus was very accessible.

The resuls disclose that majority (88.9%) of all those who used the various modes of transport find the bus easily accessible. Two (2.8%) of all the three spare parts dealers who used the various modes of transport from home to work used private. The results suggest that there is a positive relationship between accessibility and transport use and this is in line with the evidence from the Household Transport Survey in Australia which concluded that about a third who used the private car for their trip to work did so because public transport was inaccessible (Corpuz, 2006).

Perceived Risk Specific Issues

Another factor thought to have a significant impact on the choice of mode of transport is spare parts dealers' perception of risk of mode of transport. Under this section, we considered risk in terms of missing appointments, robberies, accidents and breakdowns. Risk can be seen as the probability that a hazard will turn into a disaster.

Risk Specific Issues in terms of Missing Appointments

Figure 3 presents the results on the risk specific issues in term of missing appointment. According to the results, many spare parts dealers drove their private car to work (88.9%) because they perceived the car as the most non risky mode of transport in terms of missing appointments. Majority of those who used the taxi (84%) similarly perceived it as the most non risky mode of transport in terms of missing appointments.

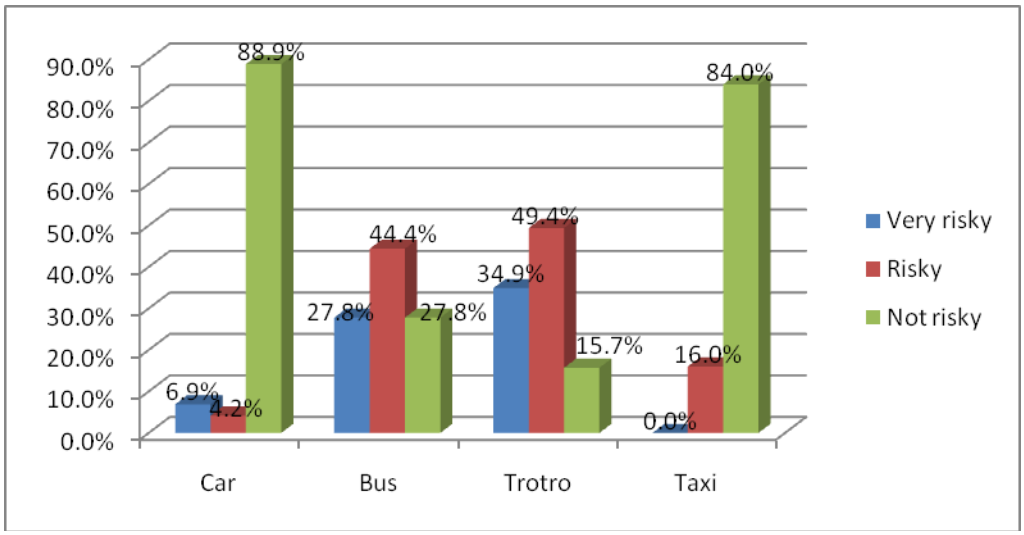

Figure 3: Spare parts dealers' risk rating of transport modes

Source: Fieldwork, 2009

In terms of all those who used the public bus and public trotro to work, almost 45 percent and 50 percent of the respondents perceived public bus and public trotro as risky when it comes to missing appointments. These results will have serious implication for public transport so long as both public transport and private car are subjected to the same constraints and conditions on the roads in Ghana.

Risk Specific Issues in terms of Robbery

With regards to petty rubbery, majority (76.4%) of the spare part dealers believed that private car was not risky. For public bus, 100 percent believed that it was not risky given robberies, with 80.7 percent of the spare part dealers perceiving that public trotro was not risky when it comes to robberies. Although no one among those who used the public bus from home to work thought that the

public bus was very risky in terms of robberies, a little below one-fourth (23.7%) of the respondents indicated that private car was risky, with more than a fourth (29.3%) of public trotro users conceding that the public trotro was risky so far as robberies were concerned. Over one-half (52%) of the public taxi users, however, claimed that public taxi was risky when it comes to robberies (Fig. 4).

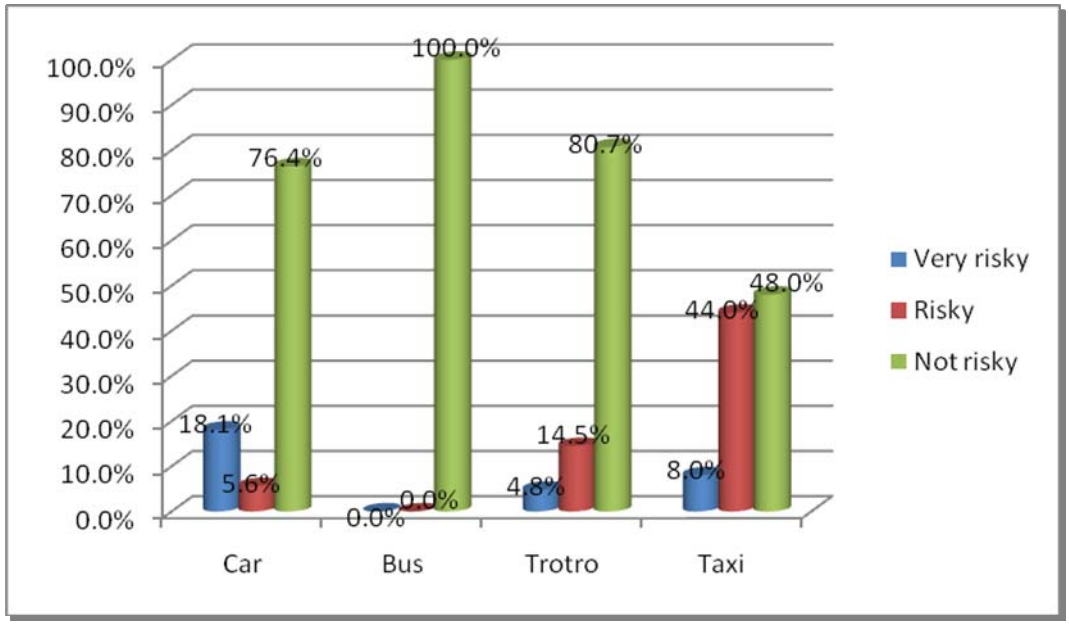

Figure 4: Spare parts dealers' risk rating of transport modes

Source: Fieldwork, 2009

Risk Specific Issues in terms of Accident

Spare parts dealers appear to consider accident in their risk rating assessment of the choice of modes of transport. Figure 5 displays the risk rating assessment of spare parts dealers in terms of accidents. It can be observed from the Figure that all those who used the public bus (100%) from home to work did

not rate the bus as risky in terms of accident. This outcome is very strange as it did not reflect in the choice of public bus from home to work by spare parts dealers. Some of the private car users (9.7%), trotro users (20.5%) and taxi users (36%), however, pointed out that those modes were risky in terms of accidents. These results are not surprising because as it were many spare parts dealers went to work on private car, public trotro and public taxi.

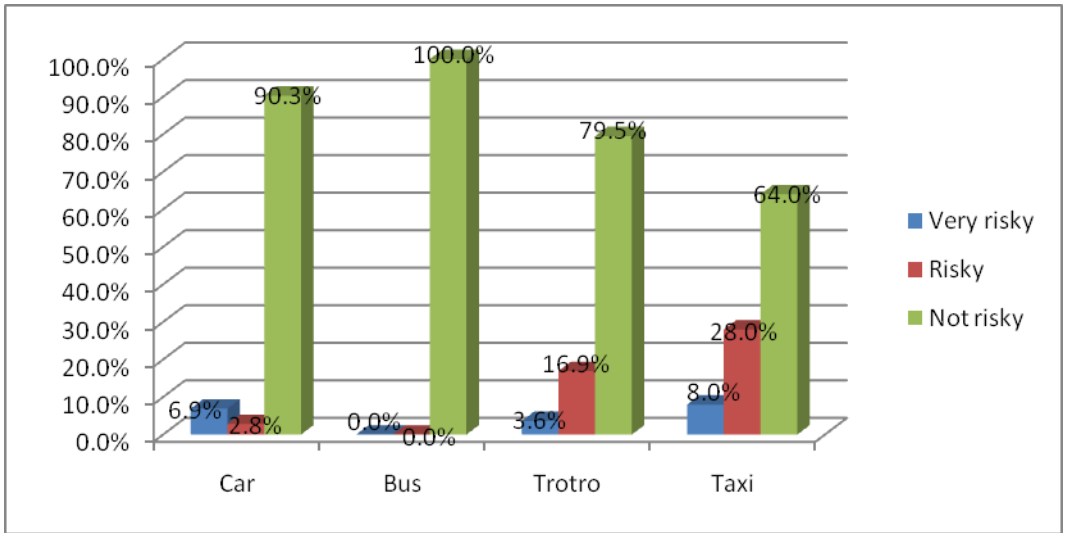

Figure 5: Spare parts dealers' risk rating of transport modes

Source: Fieldwork, 2009

Risk Specific Issues in terms of Break-down

Other revelations were disclosed by the results in Figure 6. The results show that, of all those who used the bus as well as trotro, majority perceived the public bus (61%) as well as public trotro (54.2%) to be risky as far as the break-down of these modes of transport is concerned. Below half (48.6%) and over one-third (40%) of all private car and public taxi users, however, did not rate these

modes as risky in terms of break-down. Perhaps, this explains why a lot more spare parts dealers used private car than public bus for their trip to work.

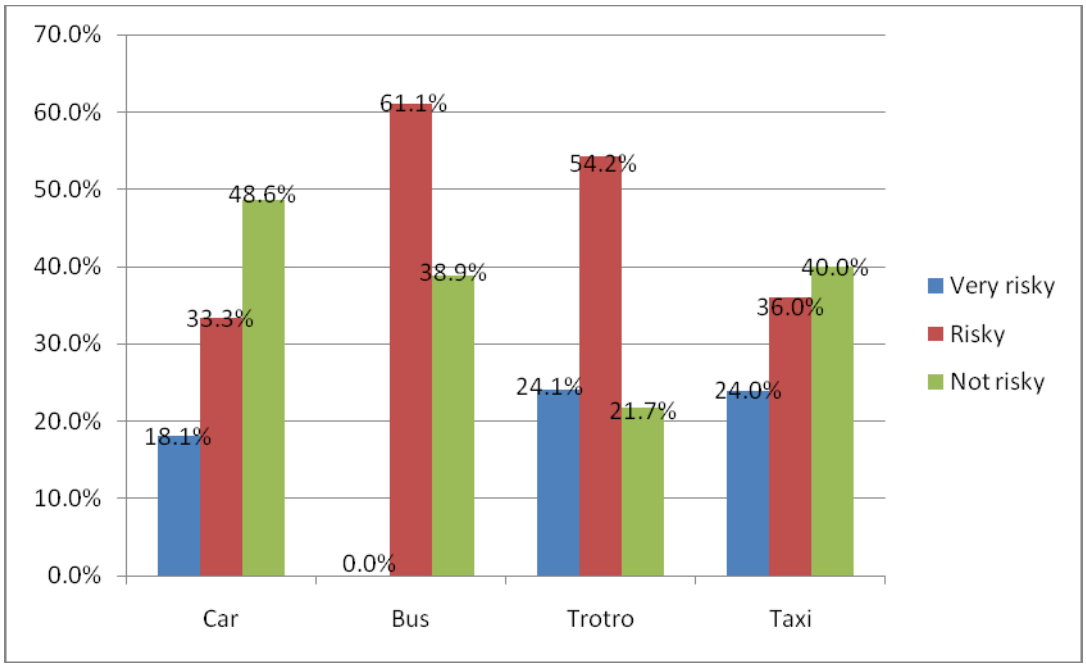

Figure 6: Spare parts dealers' risk rating of modes of transport

Source: Fieldwork, 2009

Results of the Discriminant FunctionModel

The previous analysis under the descriptive statistic results in relevant information about the factors that may affect the choice of mode of transport. However, explaining why spare parts dealers choose one mode over the other is much more complicated than simply saying, factors determining the choice of mode of transport. Thus, the problem suggests much more important areas of inquiry to understand the nuances of the various modes of transport within the

group of intra-city spare parts dealers. Therefore, it could be out of order to draw conclusions and make policy recommendations based on raw response rates, even of the magnitude detected in the initial analysis. Recognition of this fact suggests a more refined approach of analysing the data.

The preliminary analysis revealed that the spare parts dealers varied in terms of personal specific characteristics and mode choice attributes. However, the group is occupationally homogeneous. For this reason, developing systematic categorisation of spare parts dealers into a coherent scheme may be useful in determining the significant factors that influence their choice of transport. Thus, it is important to explore how the various characteristics of spare parts dealers and their mode choice attributes, jointly and significantly determine choice of mode of transport. Linear discriminant function model was employed to do the analysis.

The discriminant analysis was used in the study to classify specific spare parts dealers into their appropriate mode choice groups and to predict their choice of mode of transport based on a set of characteristic variables. The classification was based on the discriminant function and the discriminant score for each of the spare parts dealers in the sample. The discriminant functions were derived using two different techniques. The first was the canonical discriminant function and the associated coefficients and the second was the Fisher's linear discriminant function and its coefficients. The canonical technique involved the computation of eigen values as well as the canonical correlation coefficients. The computed eigen values and the canonical correlation coefficients were tested for their significance using wilk's lambda (λ) and chi-square.

The second technique was the computation of Fisher's linear discriminant function coefficients for the classification of the spare parts dealers into their appropriate mode choice groups and to predict their choice of mode of transport. Fisher's linear discriminant function coefficients offered explanation on the effect of each of the characteristic variables on the mode choice of spare parts dealers in the study area. From previous results of chi-squared and its associated p-values, theory and previous research, it initially assumed that the choice of mode of transport was influenced by a number of personal specific characteristics and mode choice attributes.

These variables include: accessibility of mode (X_1); average distance travel from home to work (X_2); respondent's level of education (X_3); number of times a mode is used (habit) (X_4) and average monthly income (X_5). The rest were respondent's residential zone (X_6); risk in terms of accident(X_7); in-vehicle travel time (X_8); risk in terms of missing appointment (X_9); risk in terms of robbery (X_{10}); number of children (X_{11}) and respondent's age (X_{12}); sex (x_{13}), respondent's marital status (X_{14}) and risk in terms of breakdown (X_{15}). These were the characteristic variables (independent variables or covariates) assumed to influence the choice of mode of transport of spare parts dealers in Accra and were quantified as explained under identification of variables and their operational definition. A number of tests were conducted to ascertain the importance of the personal specific and mode choice characteristics to the discriminant functions. Box's test of equality of covariance matrices was also conducted to test the assumption of homogeneity of covariance matrices.

Test of Equality of Group Means

This test, tests the importance of each predictive or independent variables to the discriminant functions. The results of the test are shown in Table 16.

Table 16: Tests of equality of group means for predictive variables

Variable	Wilk's lambda (λ)	F	df1	df2	Sig
Accessibility*	.802	16.002	3	194	.000
Habit**	.964	2.402	3	194	.069
Average time*	.955	3.033	3	194	.030
Average distance***	.988	.807	3	194	.492
Average income*	.920	5.644	3	194	.001
Age of respondent**	.961	2.632	3	194	.051
Sex***	.981	1.252	3	194	.292
Marital status***	.988	.763	3	194	.516
Level of education*	.909	6.437	3	194	.000
Location of residence*	.957	2.913	3	194	.036
Family size**	.967	2.182	3	194	.091
Accident***	.971	1.944	3	194	.124
Missing appointment*	.958	2.869	3	194	.038
Petty robbery*	.957	2.900	3	194	.036
Breakdown***	.990	.656	3	194	.580

Note: *, ** denote variable statistical significance at 5% and 10% levels
*** denote variable that contributes "noise" to the model
Source: Computed from Field Data, 2009

In the table, the smaller the wilk's lambda, the important the predictive variables to the discriminant functions. From Table 16, wilk's lambda is statistically significant by the F test for all the predictive variables except average distance, sex, marital status, risk in terms of accident and risk in terms of breakdown. The implication of the results was that all those variables that were statistically significant at five percent and 10 percent levels were important to the discriminant functions.

This means that a consideration should be made to drop average distance, sex, marital status, risk in terms of accident and risk in terms of breakdown from the model. However, not all the variables that did not yield statistical significance were dropped except those that contribute a univariate F value of less than 1.0 (see Hurberty and Olejinik, 2006 for more on univariate test). From the results, average distance, marital status and risk in terms of breakdown contributed a univariate F value of less than 1.0 and for that matter were dropped from subsequent analysis.

Box's Test of Equality of Covariance Matrices

One of the assumptions of the discriminant analysis is that the covariance matrices across groups are equal. The Box's M test tests the assumption of homogeneity of covariance matrices. This test is very sensitive to also meeting the assumption of multivariate normality. Table 17 presents the results on Box's test of equality of covariance matrices. From the Table, the results indicate that the Box's M test of homogeneity of covariances was very significant at five percent

level of significance. Therefore, the hypothesis of equality of covariances at ($p<.05$) was rejected, implying that the groups differ in their covariance matrices. This violates the assumption of the discriminant model. Because the data violate the assumption of homogeneity of variance, this could lead to classification problems, meaning that the resulting predictions about transport modes may be less than optimal. This problem was therefore corrected by using separate group covariance matrices in the analysis (see Borders, 2006).

Table 17: Box's test of equality of covariance matrices

Box's M	F	df1	df2	sig
1200.461	6.629	156.000	16309.701	0.000

Source: Computed from Field Data, 2009

Summary of Canonical Discriminant Functions

The preliminary results of the discriminant analysis were promising. The canonical correlation, which is equivalent to the Pearson correlation coefficient, in the case of two-group discriminant analysis, measures the correlation between the discriminant scores and the grouping variable, in this case, choice of mode of transport. The canonical technique involves the computation of eigen values as well as the canonical correlation coefficients. A squared canonical correlation indicates the proportion of variation in the discriminant function that is explained by the grouping variable.The eigen values determine the variation in the grouping variable accounted for by the model.

The larger the eigen value, the more of the variance in the grouping variable is explained by that function. Since the grouping variable (dependent variable) in this analysis has four categories, there are three discriminant functions. This is because the number of discriminant function depends on number of groups minus one or number of characteristic or independent variables, whichever is less (see Equation 3.12). The preliminary results of the discriminant analysis are shown in Table 18.

From Table 18, the computed eigen values for the three discriminant functions were 0.563, 0.217, and 0.103 and the canonical correlation coefficients were 0.600, 0.422 and 0.306. The squared of the correlation coefficients do point out that about 36 percent of the variation in the groupings is explained by the first function, 17.8 percent by the second and nine percent by the third function. This is an indication that, the discriminant functions have predictive utility or value.

Table 18: Eigen value and wilk's lambda (λ) test of function

Functions	Eigen value	Canonical correlation	Wilk's lambda	Chi-squared	Degree of freedom	Sig
Function 1	0.563*	0.600	0.477	140.098	36	0.000
Function 2	0.217*	0.422	0.745	55.691	22	0.000
Function 3	0.103*	0.306	0.906	18.571	10	0.046

Note: * denote statistical significance at the 5% level
Source: Computed from Field Data, 2009

The eigen values for each discriminant function were also tested for their significance using wilk's lambda (λ) and chi-square (Table 18). For each set of functions, wilk's lambda tests the hypothesis that the means of the functions listed are equal across groups. The test of the functions was found to be significant at a standard 5 percent for all the three functions. This implies that the discriminant functions will do better than chance at classifying the spare parts dealers into their appropriate mode choice groups. It is important to state that wilk's lambda and eigen values can also be used to assess how well the discriminant model as a whole fits the data.

Standardised Canonical Discriminant Function Coefficients

The standardised discriminant function coefficients serve the same purpose as beta weights in multiple regression models. Thus, they indicate the relative importance of the outcome or predictor variables in predicting the grouping variables or the dependent variables. The coefficients on the function indicate the partial contribution of each variable to the discriminant function(s), controlling for other independent variables entered in the model. The standardised canonical discriminant function coefficients are given in equations 4.12-4.14 for all the functions.

$$F_1 = X_1(.760) + X_2(-.171) + X_3(.093) + X_4(-.285) + X_5(-187) + X_6(.-.754) + X_7(-.098) + X_8(.030) + X_9(.699) + X_{10}(.-.017) + X_{11}(-.095) + X_{12}(.041) \quad (4.12)$$

$$F_2 = X_1(.190) + X_2(.554) + X_3(-.403) + X_4(.379) + X_5(.273) + X_6(-.531) + X_7(-.243) + X_8(.395) + X_9(-.014) + X_{10}(.203) + X_{11}(-.001) + X_{12}(-.302) \quad (4.13)$$

$$F_3 = X_1(-.257) + X_2(-.135) + X_3(-.169) + X_4(.000) + X_5(.232) + X_6(-.161) + X_7(.570) + X_8(.361) + X_9(.483) + X_{10}(.471) + X_{11}(.092) + X_{12}(.122) \quad (4.14)$$

Structure Matrix

The characteristic or independent variables measured on different scales were correlated with the output of the standardised canonical coefficients and were accordingly re-arranged in their order of importance based on the absolute size of the correlation coefficients to give the structure matrix. The structure matrix Table 19 shows the correlations of each outcome variable with each discriminant function. The correlations coefficients serve like factor loading in factor analysis. That is, the matrix helps us identify the largest absolute correlations associated with each discriminant function so that we can know how to assign a meaningful label to each function.

From Table 19, it can be observed that accessibility of transport (X_1) has the largest absolute correlation coefficient within the function 1, suggesting that it is the most useful outcome or predictor variable in predicting the choice of private car. In terms of public bus, the results indicate that the level of education (X_2), habits (X_3), average monthly income (X_4), respondent's residential zone (X_5) and

risk in terms of accident(X_6) were the useful discriminating outcome variables, because they were absolutely highly correlated with public bus.

Table 19: The structure matrix

Predictor variable	Function 1	Function 2	Function 3
X_1	.657*	.033	-.194
X_2	-.274	-.480*	-.264
X_3	.063	-.378*	-.194
X_4	-.303	.391*	.157
X_5	.188	.330*	.122
X_6	-.174	-.236*	.093
X_7	-.041	-.304	.501*
X_8	.191	.116	.450*
X_9	.225	-.060	.387*
X_{10}	-.158	.140	.387*
X_{11}	-.222	.164	.265*
X_{12}	.092	-.209	.222*

Note: * denotes variable ordered by absolute size of correlation within functions
Source: Computed from Field Data, 2009

However, in order of absolute size of correlation coefficients within the public bus function 2, it was observed that the respondents' levels of education (X_2) was likely to be the best determinant of the choice of public bus followed by respondents' average monthly income (X_4) in that order. The reason is that, the

absolute size of correlation coefficient of X_2 within function two was highest than the other variables. In terms of direction, the result implies that the higher the level of education for spares parts dealers, the less likely they will be to choose public bus as a means of transport.

The results in Table 19 also showed that, majority of the characteristic variables was useful in determining choice of public trotro. It was also observed from the table that in-vehicle travel time (X_7), risk in terms of missing appointment (X_8), risk in terms of robbery (X_9), number of children (X_{10}), respondent's age (X_{11}), sex (x_{12}), were absolutely highly correlated with the choice of public trotro. It was also observed that among these variables, in-vehicle average travel time was the most useful outcome variables because it was absolutely highly correlated with public trotro. This is followed by risk in terms of appointment and the rest followed in that order (see Table 19).

Unstandardised Canonical Discriminant Function Coefficients

The set of ensuing equations contain the unstandardised discriminant function coefficients. These coefficients could be used like the unstandardised beta coefficients in multiple regressions to construct actual predictive equation to classify new cases, the choice of transport. The unstandardised canonical discriminant function coefficients are given in Equations 4.15-4.17.

$$G_1 = (-3.822) + X_1(2.618) + X_2(-.375) + X_3(.667) + X_4(-.061) + X_5(.379)$$
$$+ X_6(-2.166) + X_7(-.456) + X_8(.093) + X_9(1.866) + X_{10}(-.014)$$

$$+X_{11}(-.011) +X_{12}(.083) \quad (4.15)$$

$$G_2= (6.069) +X_1(.656) +X_2(1.215) +X_3(-2.884) +X_4(.081) +X_5(.554) +X_6(-1.526) +X_7(-1.136) +X_8(1.216) +X_9(-.036) +X_{10}(.170) +X_{11}(.000) +X_{12}(-.612) \quad (4.16)$$

$$G_3= (-5.629) +X_1(-.886) +X_2(-.296) +X_3(-1.213) +X_4(.000) +X_5(.470) +X_6(-.461) +X_7(2.663) +X_8(1.111) +X_9(1.290) +X_{10}(.394) +X_{11}(.010) +X_{12}(.247) \quad (4.17)$$

Fisher's Linear Discriminant Functions

The second approach to the discriminant analysis was the computation of Fisher's linear discriminant function coefficients for the classification of spare parts dealers into their appropriate mode choice groups. In combination with the data from the group centroids, the direction of the relative impact of the predictor or characteristic variables could be determined. In Table 20, the results on Fisher's classification coefficients are presented.

From Table 20, the variable accessibility to mode of transport (X_1) was positively heavily loaded on public taxi function. This means that spare parts dealers who reported having very easy or unrestricted access to public taxi within their immediate locality are most likely to be taxi users. A similar conclusion was reach by Eno (2007) that respondents who had unrestricted access to private cars at home persistently preferred the private car mode to public bus. Spare parts

dealers who expressed their risk perception in term of missing appointment (X_8) will less likely use any other modes of transport except public taxi. The justification is that risk in terms of missing appointment was positively heavily loaded on the public taxi mode.

Table 20: Fisher's classification function coefficients

Discriminating Variables	Car	Bus	Taxi
X_{11}	1.406*	1.402	1.381
X_2	22.732*	20.637	22.269
X_5	5.703	5.763	6.796*
X_{10}	1.989	2.033*	2.017
X_8	27.772	27.145	28.425*
X_9	16.541	19.511	20.942*
X_7	26.675	29.369*	25.223
X_3	197.680	201.107*	198.237
X_1	30.658	32.132	37.059*
X_4	.167*	.002	.052
X_{12}	4.663	5.670*	4.648
X_6	31.909*	31.077	26.261
Constant	-439.466	-456.668	-448.605

Note: * denotes figures have higher values
Source: Computed from Field Data, 2009

The analysis, furthermore, indicated that the residential zone of spare parts dealers discriminates in their choice of mode of transport. The variable X_5 (respondent's zone of residence) was heavily loaded on public taxi with positive sign and this means that spare parts dealers who lived within the inner zone will most likely choose the public taxi for their trips to work. The reason being that, inner-city trips tend to be short, so using a taxi could be seen as a reasonable option. This outcome confirms the findings of Mintesnot and Takano (2007) that peripheral zone residents had higher tendency to choose bus over taxi. Another variable that was positively heavily loaded on the public taxi function was the perception of spare parts dealers in terms of robbery (X_9). The implication of this outcome is that, spare parts dealers who perceived risk of transport in terms of robbery will most likely use public taxi as their mode of transport.

On the other hand, average monthly income (X_4) had some impact on the choice of mode of transport. The results in Table 20 revealed that average monthly income (X_4) of spare parts dealers was positively heavily loaded on private mode. This is indicative of the fact that when the average monthly earnings of spare parts dealers increase the tendency of using other modes of transport, such as public bus, public trotro and public taxi decreases. This is in line with the normally accepted understanding that in most transport situations there is a positive correlation between increasing affluence and car usage. This is so because rich people tend to look for more convenient, although more costly, mode like private car as their level of affordability grows. These results reinforce

the findings of Mintesnot and Takano (2007) and Davidov et al. (2003) that higher income groups tend to prefer private car to any other modes of transport.

Another variable that impacted the private mode of transport was the level of education (X_2) of the spare parts dealers. The level of education of respondents (X_2) was positively heavily loaded on the private transport mode. The explanation to this is that spare parts dealers who are highly educated will most likely prefer private car to either public bus or public trotro or public taxi. These results is not entirely different from the argument by Davidov et al. (2003) that higher education often relates to higher status or higher income and this might lead to a lower preference for public transport.

In connection with perceived risk in terms of accident, the results show that people who perceived risk in terms of accident (X_6) will less likely use public bus, public trotro or public taxi. This is so because perception of risk in terms of accident (X_6) was positively heavily loaded on private mode of transport. From Table 20, it was again observed that age was positively heavily loaded on the private mode of transport. This also shows that people who are older will most likely patronise the private mode of transport. Again, this result is consistent with the assertion made by Mintesnot and Takano (2007) that the probability of choosing a bus decreases when age increases. This is to be expected because the physical predisposition of the elderly people may not permit them to struggle for public trotro and public bus. Many of them may also want to use private car as a status symbol in the society. Another reason could be that, the bus was over crowded and was not convenient to the elderly.

The results in Table 20 revealed that habit (X_3), which is measured in terms of the number of times a particular mode was used in the last week preceding the survey, also had a significant impact on group membership as well. Habit (X_3) was positively heavily loaded on public bus mode of transport, implying that spare parts dealers who reportedly used the public bus from home to work routinely will most likely continue to use public bus. This result confirms the findings of Verplanken et al. (1994) who argued that making exactly the same journey to work under the same circumstances on the same way every morning, is not guided by deliberate decision, but is habitual.

In terms of average in-vehicle travel time (X_7), the results revealed that spare parts dealers who spend longer time from home to work will most likely prefer public bus to other transport, for example, private car or public taxi. The reason is that as average time increases, it makes it difficult for spare parts dealers to afford longer trips by private car, taxi or any other forms of transport. This conclusion is at variance with the findings of Alpizar, Carlsson and Martinsson (2001) that a reduction in travel time was significant in attracting commuters towards public transport. Other variables that were positively heavily loaded on the public bus were sex of respondents (X_{12}) and number of children in respondents' family (X_{10}). These results imply that, male spare parts dealers with large family size will most likely be bus users.

Classification Results

While the interpretation of the usefulness of the characteristic variables and the impact of the coefficients on the choice of mode of transport is informative, the primary objective of this study was to correctly classify spare parts dealers into appropriate mode choice groups and, to predict their choice of modes of transport. The classification table shows the practical results of using the discriminant model.

Table 21: Discriminant model classification result

	Predicted Group Membership				
Original count	Private car	Public bus	Public trotro	Public taxi	Total
Private car	45	3	21	3	72
Public bus	4	9	5	0	18
Public trotro	18	3	59	3	83
Public taxi	1	1	5	18	25
Total	68	16	90	24	198

66.2% of original grouped cases correctly classified
Source: Computed from Field Data, 2009

Each of the twelve variables in the discriminant model had a few cases of exclusion. Table 21 shows the classification of spare parts dealers into their appropriate mode choice groups. Of the 200 cases, only 2 (1%) were excluded from the final model because those cases relate to other forms of mode other than those under consideration.

The empirical results indicated that out of 72 original private car users, 45 (62.5%) were classified correctly. The remaining 27 were, however, re-assigned to other modes of transport. Out of the 27 that were re-assigned, 3 were re-assigned to public bus; 21 were re-assigned to public trotro with 3 re-assigned to public taxi. Of the 18 spare parts dealers who originally used the public bus, the results in Table 21 indicated that the model classified 9 (50%) correctly. Four were re-assigned to private car, while 5 were re-assigned to public trotro. No user was re-assigned to public taxi. Again, the results showed that 59 (71.1%) out of the original 83 trotro users were correctly classified. Three and 3 were re-assigned to public bus and public taxi, respectively.

The analysis further revealed that out of the 25 original taxi users, the model correctly classified 18 (72%). One respondent was re-assigned to the private car; another one was re-assigned to public bus, while 5 were re-assigned to public trotro. In predictive terms, the model predicted 68 out of the 72 original private car users. It also predicted 16 out of the 18 original bus users. Although 83 original trotro users were used to create the model, the model suggested that 90 should have gone to work on trotro, while 24 instead of 25 taxi users should have gone to work on taxi. Overall, the discriminant model was successful in correctly classifying 66.2% of original group cases (See Table 21). The results suggest that the discriminant model did relatively good job at classifying spare parts dealers into their appropriate modes. In fact, the model is correct about two out of three times.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

Chapter Five of this study provides a discussion on the summary, conclusions and recommendations. It outlines the main findings and conclusions derived from the empirical results. The chapter also discusses the policy implications and touches on the limitations of the study. The chapter ends with direction for future research.

Summary

The objective of this study was to classify intra-city spare parts dealers into their appropriate mode choice groups and to examine their personal specific characteristics and mode choice attributes that are relevant in the choice of mode of transport. The coefficients of all the relevant personal specific and mode choice characteristic variables that provide the best discrimination were estimated. The theoretical and empirical literatures were reviewed on the problem to determine the models and relevant mode choice variables that are appropriate for the study. The research instrument used for the collection of data was questionnaire. In all, 200 respondents were interviewed. The main findings of the study are as follows:

Demographic Characteristics

Spare parts dealers with ages between 26 years and 60 years were sampled for the study. The average age of the male spare parts dealers was approximately 37 years and that for the female spare parts dealers was about 36 years. Average age of spare parts dealers significantly influenced the choice of mode of transport. Many of the spare parts dealers had more than three children. Family size has significant influence on the choice of mode of transport of spare parts dealers. Majority of the male spare parts dealers had no formal education, whiles their female counterparts were in the minority. Most of the respondents sampled for this study were in matrimonial relationship, with less than one-third single, separated or divorced. Majority of the spare parts dealers also earned income far and above the national minimum wage at the time of the study in Ghana.

A lot more of the spare parts dealers used public trotro to work; over one-third used private car; about 13 percent used public taxi whilst the remaining 9.1 percent used public bus from home to work. A little over three-quarters of the spare parts dealers who used public bus were males whereas less than one-quarters were females. Less than half of the spare parts dealers who used private car were females with less than one-third being males. There were male dominant in the use of public bus, public trotro and public taxi at all levels of transport, apart from private car. Sex has no significant influence on the choice of mode of transport of spare parts dealers.

Over half of the spare parts dealers lived within the peripheral zone of Accra whiles the remaining lived within the inner zone. Many of the peripheral

zone spare parts dealers used private car and public bus as a means of transport to work. Less than three-quarters of the inner zone spare parts dealers used both private car and public trotro to work. A little below half of the spare parts dealers who lived in the peripheral zone used public trotro as means of transport to work. Over one-third of the inner zone spare parts dealers used public trotro from home to work. Residential zone of spare parts dealers has a significant influence on their choice of mode of transport.

The average in-vehicle time spent by private car users from home to work was 20.09 minutes. The average time spent in private car from home to work has no significant influence on the choice of mode of transport spare parts dealers. The average time spent by spare parts dealers in a public bus to work was nearly an hour. The average time spent in a bus has no significant influence on the choice of mode of transport spare parts dealers. The average time spent by spare parts dealers in a public trotro from home to work was 38.82 minutes. The average time spent in public trotro from home to work by spare parts dealers was 27.30 minutes. More than half of the taxi users spent between 15-25 minutes in traffic before getting to work. The average time spent by spare parts dealers in public taxi has significant influence on the choice of mode of transport.

All the spare parts dealers did not use public bus regularly because public bus was inconvenient means of transport. About one-fourth of the public trotro users claimed drivers were not chivalrous. Over one-third of private car users did not use it regularly from home to work because of high cost of fuel. Unafffordability and lack of drivers' license were the reasons given by some of

the irregular private car users. All the spare parts dealers who did not use public taxi regularly disclosed that it was not convenient to them. Majority of private car users claimed it was very accessible to them. Most public bus users claimed it was easily accessible. Two-third of all those who used trotro from home to work, saw the trotro as easily accessible. Over half of all taxi users claimed that the taxi was very easily accessible.

Majority of private car users perceived the car as the most non risky mode in terms of missing appointments. Spare parts dealers also perceived taxi as the most non risky in terms of missing appointments. Some spare parts dealers reported that public bus and public trotro were risky when it comes to missing appointments. Majority of the Spare parts dealers who used private car, public bus and public trotro believed they were not risky, given robberies. All public bus users did not rate it as risky in terms of accident. Some of the private car, trotro and taxi users, however, pointed out that they were risky in terms of accidents. Majority of public bus and public trotro users perceived these modes to be risky in terms of break-down. Below half of all private car users and over one-third of all public taxi users did not rate these modes as risky in terms of break-down.

Results of the Discriminant Model

The previous analysis under the descriptive statistic results in relevant information about the factors that may affect the choice of mode of transport. However, explaining why people choose one mode over the other is much more complicated. Linear discriminant function model was employed to do the

analysis. A number of tests were conducted to ascertain the importance of the personal specific and mode choice characteristic to the discriminant functions. The initial test results showed statistical significance indicating that all the predictive variables were important, except average distance, sex, marital status, risk in terms of accident and risk in terms of breakdown. Therefore, those variables that contribute nothing but a univariate F value of less than 1.0 were dropped from the subsequent analysis.

The second test of homogeneity of covariances was also very significant at five percent level of significance. The hypothesis of equality of covariances was not accepted, implying that the mode choice groups differ in their covariance matrices, violating the assumption of the discriminant model. This informed the use of separate group covariance matrices for the analysis. The eigen values test of significance for the three discriminant functions, using wilk's lambda (λ) and chi-squared, was significant at a five percent, implying that the means differ and that the discriminant functions would do better than chance at classifying the spare parts dealers into their appropriate mode choice groups.

The characteristic or independent variables were correlated with the output of the standardised canonical coefficients and were re-arranged in their order of importance to give the structure matrix. The correlations coefficients indicated that accessibility of transport (X_1) was the most useful predictor variable in predicting the choice of private car. In terms of public bus, the level of education (X_2), habits (X_3), average monthly income (X_4), respondent's residential zone (X_5) and risk in terms of accident(X_6) were the useful discriminating variables.

However, in terms of absolute size of correlation coefficients within the public bus function, respondents' levels of education (X_2) was the best predictor of the choice of public bus transport, followed by respondents' average monthly income (X_4) in that order.

The results further showed that in-vehicle travel time (X_7), risk in terms of missing appointment (X_8), risk in terms of robbery (X_9), number of children (X_{10}), respondents' age (X_{11}) and sex (x_{12}) were absolutely highly correlated with the choice of public trotro. But among these variables, average travel time was the most useful outcome variables followed by risk in terms of appointment and the rest followed in that order.

The second approach to the discriminant analysis showed that spare parts dealers with unrestricted access to public taxi were most likely to be taxi users. Spare parts dealers who expressed risk in terms of missing appointment (X_8) would most likely use public taxi at the expense of private car, public trotro and public bus. The analysis, furthermore, indicated that spare parts dealers who lived within the inner zone were most likely to choose the public taxi for their trips to work. The results further implied that, spare parts dealers who perceived risk in terms of robbery are most likely to use public taxi as their mode of transport.

Again, it was realised that spare parts dealers with higher income have the tendency of using private car. The level of education of respondents (X_2) was also heavily loaded on private transport mode, implying that highly educated people would most likely prefer private car to other forms of transport. It was also found that spare parts dealers who perceived risk in terms of accident (X_6) would most

likely use private car. The results further indicated that spare parts dealers who are older would most likely patronise private mode of transport. Those who routinely used the public bus would most likely continue to use public bus.

Average travel time (X_7) was also heavily loaded on the public bus function demonstrating that spare parts dealers who spend longer time from home to work will most likely prefer to use public bus to any other forms of transport. It was also observed that sex of respondents (X_{12}) and number of children in respondents' family (X_{10}) were loaded heavily on public bus, implying that male spare parts dealers with large family size would most likely be bus users.

Classification Results

The primary objective of this study was to correctly classify spare parts dealers into appropriate mode choice groups and, to predict their choice of modes of transport. The classification results showed that 2 spare parts dealers were excluded from the final model due to lack of information. Empirically, more than half of the original private car users were classified correctly. The remaining original private car users were, however, re-assigned or misclassified into other modes of transport. It was also found that half of the original public bus users were classified correctly. The rest were re-assigned to other modes of transport.

Again, the analysis demonstrated that over two-third of the original trotro users were correctly classified. The rest were re-assigned to other modes of transport. Furthermore, more than two-third original taxi users were correctly classified, with seven of them re-assigned to other modes. In terms of prediction,

the model predicted more than two-third of the original private car users. The model also predicted over three-quarters of the original bus users. The analysis showed that the model over predicted the original trotro users, while almost all the original taxi users were predicted by the model. Overall, the discriminant model was successful in correctly classifying about two-third of original group cases.

Conclusions

The objective of this thesis was to employ discriminant model to classify intra-city spare parts dealers into their appropriate mode choice groups and to examine their personal specific characteristics and mode choice attributes that are relevant in the choice of mode of transport. It was expected that all the personal specific and mode choice characteristics included in the model would have the rightful impact on the choice of mode of transport. For example, we expected that respondents' age, level of education and income would load heavily on private car, while time and family size were expected to load heavily on bus.

From the study, it was observed that spare parts dealers' choice of mode of transport was determined by their sex, age, income, family size and level of education. Factors such as time, residential zone, risk (missing appointment, robbery, accident and break-down), accessibility and habit also determined the choice of mode of transport. This means that higher education and higher income increase the chance of choosing private car. It was also realised that the older people become the more predisposed they become to private car. Again, when an individual perceives a particular mode to be risky in terms of accident, the

individual is likely to shy away from that mode. Male spare parts dealers with large family size will patronise public. If Individuals expressed risk in term of missing appointment for a particular mode, the individual will sacrifice that mode. When individual has unrestricted access to any transport within their locality, they will continue to use that transport. The longer time an individual expect to spend from home to work in traffic, the more likely they are to choose bus.

In terms of best predictors for each mode, accessibility of transport (X_1) was the most useful predictor variable for private car. Though the level of education (X_2), habits (X_3), average monthly income (X_4), respondent's residential zone (X_5) and risk in terms of accident(X_6) were useful discriminating variables in favour of public bus, in terms of absolute size of correlation within the public bus function, respondents' levels of education (X_2) was the best predictor of the choice of public bus because it has the highest absolute size of correlation, followed by respondents' average monthly income (X_4) in that order. In-vehicle travel time (X_7), risk in terms of missing appointment (X_8), risk in terms of robbery (X_9), number of children (X_{10}), respondents' age (X_{11}) and sex (x_{12}) were all useful discriminators in favour of public trotro. However, average travel time was the most useful one, followed by risk in terms of appointment and the rest followed in that order.

The classification results from the discriminant analysis showed that, more than half of the original private car users should have gone to work on private car. The remainder should have used other modes of transport. In terms of the original public bus users, the results showed that half should have used other modes of

transport. Again, less than two-third of the original trotro users should have used other means to work. Furthermore, more than two-third original taxi users were correctly classified, meaning that the rest will shift to other modes.

In terms of accuracy of the discriminant model to predict spare parts dealers, the model predicted more than two-third of the original private car users. The model also predicted over three-quarters of the original bus users. In addition to that, however, the model over predicted the original trotro users, while almost all the original taxi users were predicted by the model. Overall, the discriminant model was successful in correctly classifying about two-third of original spare parts dealers in the study area.

It is informative to note that the approach adopted in this thesis yielded conclusions that are consistent with the results from studies which used more complex modeling techniques. The key findings from the discriminant model showed that individual characteristics and mode choice attributes, in particular, sex, age, income, family size, level of education, time, residential zone, risk (missing appointment, robbery, accident and break-down), accessibility and habit determined the choice of mode of transport of spare parts dealers [Alpizar, Carlsson and Martinsson (2001); Bill (2008); Mintesnot & Takano (2007); Corpuz, McCabe & Ryszawa (2006); and Eno (2007)]

Policy Implications

Based on the findings, the following policy conclusions were drawn: As noted earlier in the background to this thesis, the government of Ghana through

the Department of Urban Road is currently redesigning BRT system. These findings shed light on the most important features required by the system if it is to attract commuters from private mode of transport. If the object is to encourage the patronage of mass transit system, as envisaged in the National Transport Policy document, then the Ministry of Transport should ensure that the mass transit buses are in good conditions, convenient and must not be risky in terms of accident to attract older spare parts dealers who own private cars.

In addition to that, efforts should also be made by the Ministry of Road to provide exclusive bus lanes and traffic priorities for public buses to ensure free flow of buses to avoid the risk of missing appointment. It is also recommended that efforts should be made by the Ministry of Water Resources, Works and Housing, together with Town and Country Planning Departments (TCPD), to provide residential accommodations to workers on the periphery of cities, and buses provided to increase accessibility to ensure patronage of buses.

Evidence emerging from the study further suggests that, there is a connection between family size of male spare parts dealers and their tendency to choose public bus. Ministry of Information should intensify education on the connection between family size and the choice of transport to encourage male spare parts dealers to accord patronage. In addition to the information campaigns to increase this awareness, it is also recommended that efforts should be made by the transport service providers to encourage spare parts dealers with large family size to patronise public bus. This could be done by offering free public bus tickets

on selected days to spare parts dealers with large family size and also distributing free public bus tickets to frequent users with large family size among others.

The study also suggests that people will stick stubbornly to the use of particular modes of transport if they have unrestricted access to them. One real strategy that could be employed by government as a policy instrument to restrict access and cause modal shift on the road is the introduction or enhancement of taxes and charges. The tax in question could be in the form of toll tax. The proceeds from such taxes or toll could be used to provide standard mass transit facilities. This practice is in line with the famous Robin Hood principle. The major tenet of the Robin Hood principle is to tax private car users heavily and with the proceeds, support mass transit delivery and making it much more accessible them.

It is important to note that the issue of transport mode choice is a topical subject. This is partly because it is seemingly absolutely preposterous that private car users would abandon their private cars and travel by mass transport. The satisfactions of a private car are plentiful and one would least expect private car users to easily park their cars and use a public transport, especially, in a situation where the level of service rendered by mass transport is sub-optimal. Some of the utilities of a private car include comfort, convenience, flexibility and the fact that it is seen as a symbol of esteem. In advanced economies where public transport is well organised and adept, private car users find it convenient to park their cars at home and commute by public transport to their work places. This is a paradigm worthy of emulation by private car owners in Accra.

Limitations of the Study

Although some necessary data for the study were gathered, some setbacks were encountered. Some spare parts dealers interviewed were unable to recall accurately the number of times they used a particular mode of transport. Therefore, there were systematic under reporting and over reporting by some respondents about their choices, which made it difficult to capture all pertinent data and also be able to verify all information. These add to the measurement errors and for that matter a limitation of the study.

It was not surprising that time was not significant under the descriptive analysis and distance, including some other predictive variables, failed the univariate F test under the discriminant analysis. It was because most of the spare parts dealers interviewed had difficulty answering questions regarding time and distance due to measurement scale. Gifts were also demanded by some respondents before accepting to be interviewed. The overall accuracy of the model was 66.2%, implying that there were other important mode choice variables that were not captured in this study.

Direction of Future Research

It is difficult to exhaust the entire problem under consideration in a single research, since transportation economics is a broad spectrum including air, road, rail and sea transportation. Owing to limited resources available and other obvious limitations, this thesis concentrated only on road transport mode choice.

It is therefore, recommended that a replica of this study using a larger overall sample size and a more evenly distributed sample groups, should be done in future as this would increase the predictive power of the mode, which, because of the size of the sample size in this thesis remains tentative. Additional research is also necessary to identify alternative motivation for choice factors that will distinguish between the choice patterns of the spare parts dealers. Further analysis should aim at adding a predictive quality to each factor in order to help spare parts dealers make optimal choices or allow institutions to prepare quantitatively for the number of spare parts dealers associated with each mode.

REFERENCES

Abane, A.M. **(**1994). Driver behaviour and city traffic empirical observations from Accra, Ghana**.** *Research Review, 10* (1 & 2), 1-13**.**

Abdelwahab, W., & Sargious, M. (1992). Modeling the demand for freight transport. *Journal of Transport Economics and Policy*, *26*(1), 49-70.

Aldrich, J.H., & Nelson, F.D. (1984). *Linear probability, logit, and probit models.* Newbury Park, CA: Sage Publications, Inc.

Alpizar, F., Carlsson, F., & Martinsson, P. (2001). *Using choice experiments for non-market valuation*. Working Paper in Economics No. 52. Department of Economics, Gothenburg University.

Asiyanbola, R. (2007, 11th-13th June). *Intra-urban Transportation, Gender and Psychological Distress in Developing Countries: Nigeria*. Paper Presented to the PRIPODE Workshop on Urban Population, Development and Environment Dynamics in Developing Countries, Nairobi, Kenya.

Ball, W. L., & Edward, M. (1990). New findings on factors related to transit use. *ITE Journal*, 34-39.

Beimborn, E.A. (1995). *A transportation modeling primer***.** Centre for transportation studies**.** Milwaukee, Wisconsin. Retrieved from http://www.uwm.edu/Dept/CUTS/primer .htm.

Ben-Akiva, M., & Bierlaire M. (1999). Discrete choice methods and their applications to short term travel decisions. *Handbook of transportation science (*Vol. 23). Dordrecht: Kluwer Academic Publishers.

Ben-Akiva, M., & Lerman, S. (1985). *Discrete choice analysis: Theory and application to travel demand*. Cambridge: the MIT Press.

Bhat, C. (2000). Incorporating observed and unobserved heterogeneity in urban work travel mode choice modeling. *Transportation Science, 34*, 228-238.

Bill, R. (2008). *How we got to school: A study of travel choices of Christchurch primary school pupils*. Unpublished master thesis, University of Canterbury, Canterbury.

Borders, S. (2006). *The transportation barriers to health care: Assessing the Texas Medicare Program.* Unpublished doctoral dissertation, University of Texas, Texas.

Carrol, J., & Johnson, E. (1990). *Decision research: A field guide*. Newbury Park: Sage Publication.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education*. London and New York: Rutledge Falmer.

Corpuz, G. (2006). *Analysis of peak hour travel using the Sydney household travel survey data.* Papers from the 29th Australasian Transport Research Forum. Gold Coast: ATRF.

Corpuz, G., McCabe, M., & Ryszawa, K. (2006). *The development of a Sydney VKT regression model.* Papers from the 29th Australasian Transport Research Forum. Gold Coast: ATRF.

Danielis, R., Marcucci, E., & Rotaris, L. (2005). Logistics managers' stated preferences for freight service attributes. *Transportation Research Part E: Logistics and Transportation Review, 41*(3), 201-215.

Davidov, E., Schmidt, P., & Banberg, S. (2003). Time and money: An empirical explanation of behaviour in the context of travel mode choice with the German micro census. *European Sociological Review*, *19*(3), 267-280.

Department of Urban Road (2005). *Urban transport survey*, 2005. Accra: Department of Urban Road.

Eno, O. (2007). Gender and transport: Women's proclivity to minimise car use in Akure. *Pakistan Journal of Social Sciences*, *4*(1), 56-63.

Fadare, S.O., & Morenikeji, W. (2001). Gender-bias in intra-urban trip pattern in Niger State, Nigeria. *International Journal on Transportation Studies*, *1*(1), 73-85.

Ghana Ministry of Transportation. (2005). *Urban transport planning and traffic management studies: Final report* (Vol. 2). Accra: Ministry of Transportation.

Ghana Ministry of Transportation. (2005). *National transport policy.* Accra: Ministry of Transportation.

Ghana Ministry of Transportation. (2009). *Urban transport projects*. Accra: Ministry of Transportation.

Ghana Shippers Council. (2003). *Annual report*. Accra: Ghana Shippers Council.

Ghana Statistical Service. (2000). *2000 population and housing census*. Accra: Ghana Statistical Service.

Ghana Statistical Service. (2007). *Statistical and analytical report*. Accra: Ghana Statistical Service.

Hal, R.V. (1993). *Intermediate microeconomics*: *A modern approach*. New York: W. W. Norton and Company.

Hanson, A., & Hanson P. (1980). Gender and urban activity pattern in Upsalla, Sweden. *Geographical Review*, *70*, 191-299.

Hastie, T., Tibshirani, R., & Friedman, J. (2001). *The elements of statistical learning*: *Data mining, inference and prediction*. Stanford, California: Springer Series in Statistics.

Hill, P. (1979). *Making decision: A multidisciplinary introduction.* Reading: Addision-Wesly Publication Co.

Horowitz, J. L., Frank, S.K., & Steven, R. L. (1986). *A self-instructing course in disaggregate mode choice modeling*. A paper prepared for the Urban Mass Transit Administration (now Federal Transit Administration), Washington, D.C.

Hunt, J.D. (1990). A Logit model of public transport route choice. *Journal of Institute of Transportation Engineers*, *60*(12), 26-30.

Hurberty, C.J., & Olejinik, S. (2006). *Applied MANOVA and discriminant analysis* (2nd ed.). New Jersey: John Wiley & Sons Inc.

Hurberty, C.J. (1994). *Applied discriminant analysis*. New Jersey: John Wiley & Sons, Inc.

Hughes, P., & Whitelegg, J. (1993). *Personal transport and the green house effect*. London: Earthscan.

Johnson, B. (2001). Toward a new classification of nonexperimental quantitative research. *Educational Research, 30* (2), 3-13.

Kanafani, A. (1983). *Transportation demand analysis*. New York: McGraw-Hill.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*, 607-610.

Labuschagne, M., (2003). *Motivational factors affecting a student's choice between print and on-line modes of delivery in distance education.* Unpublished doctoral dissertation, University of South Africa.

Lancaster, K. (1966). A new approach to consumer theory. *Journal of Political Economy*, *74*, 217-231.

Li, J. (2001). Explaining high-occupancy-toll lane use. *Transportation Research Part D*, *6*, 61-74.

Lia-Hoagberg, B., Rode, P., Skovholt, C.J., Oberg, C.N., Berg, C., Mullett, S., et al. (1990). Barriers and motivators to prenatal-care among low-income women. *Social Science and Medicine, 30*(4), 487-495.

Liao, T.F. (1994). *Interpreting probability models: Logit, probit, and other generalised linear models*. Thousand Oaks, CA: Sage Publications, Inc.

Louviere. J.J., Hensher. D. A., & Swait, J. D. (2005). *Stated choice methods: Analysis and application.* Cambridge: Cambridge University Press.

Matalon, B. (1992). Mobility with regards to social groups and attitude. *Transport and Road Research Laboratory Report,* 689, 133-151.

Mathies, E., Kuhn, S., & Klokner, C.A. (2002). *Travel mode choice of women: The result of limitation, ecological norm, or weak habit? Environmental and Behaviour, 2*, 163-177.

Melnikow, J., & Alemagno, S. (1993). Adequacy of prenatal-care among inner-city women. *Journal of Family Practice, 37*(6), 575-582.

Middendorf, D. P., Jelavich, M., & Ellis, R .H. (1982*). Development and application of statewide, multimodal freight forecasting procedures for Florida.* Washington, D.C: National Research Council,

Mintesnot. G., & Takano, S. (2007). Diagnostic evaluation of public transportation mode choice in Addis Ababa. *Journal of Public Transportation,* 10(4), 27-50.

Monroe, P. (1968). *Choice in encyclopedia of education*. Detroit: Gale Research Company.

Newacheck, P.W., Stoddard, J. J., Hughes, D. C., & Pearl, M. (1998). Health insurance and access to primary care for children. *New England Journal of Medicine,* 338, 513-519.

Newman, P., & Kenworthy, J. (1999). *Sustainability and cities: Overcoming automobile dependence*. Washington, D.C.: Island Press.

Ortuzar, J. D., & Willumsen, L.G. (2005). Modelling transport (3rd ed.). West Sussex: Johniley & Sons.

Pallant, J. 2001. SPSS Survival Manual. *A step by step guide to data analysis using SPSS for windows* (Version 10-11)**.** Buckingham: Open University Press

Papacostas, C. S., & Prevedouros, P. D. (2001). *Transportation engineering and planning* (3rd ed.). Upper Saddle River, New Jersey: Prentice Hall, Inc.

Peirson, J., Skinner, I., & Vickerman, R. (1996). Estimating the external costs of UK passenger transport: The first towards an efficient transport market. *Environment and Planning*, *27*, 1977-1993.

Perlmutter, L., & Monte, R. (1979), *Choice and perceived control*. New York: Halsted Press.

Polak, J. & Jones, P. (1997). Using stated-preference methods to examine travelers preferences and responses. In P. Stopherand and M. Lee-Gosselin (Eds.), *Understanding travel behavior in an era of change* (pp.177-207). Oxford: Pergamon.

Potter, S., & Hughes, P. (1990). *Vital travel statistics*. London: Transport Research 2000

Press, S.J., & Wilson, S. (1978). Choosing between logistic regression and discriminant analysis. *Journal of the American Statistical Association, 73*(364), 99-705.

Rhoulac, T. (2003). *School transportation mode choice and potential impacts of automated vehicle location technology*, Unpublished doctoral dissertation, North Carolina State University, North Carolina.

Sarantakos, S. (1993). *Social research* (2nd ed.). New York: Palgrave.

SPSS Inc. (2003). *Advanced statistical analysis using SPSS*. Chicago: SPSS Inc.

Thurstone, L. (1927). A law of comparative judgment. *Psychological Review, 4*, 73-86.

Triandis, H. C . (1980). Values, attitudes, and interpersonal behavior. In H . E. Howe (Ed.), *Nebraska symposium on motivation, 1979: Beliefs, attitudes and values* (pp. 195-259). Lincoln: University of Nebraska Press.

Transportation Research Board (1996). *NCHRP synthesis 230: Freight transportation practices in the public sector*. Washington D.C: Transportation Research Board

Ullrich, O. (1990). The pedestrian town as an environmentally tolerable alternative to motorised travel. In R. S. Tolley (Ed.). *The greening of urban transport: Planning for walking and cycling in western cities* (pp.97-109). London: Belhaven Press.

Verplanken, B., Aarts, H., & Van, K.C. (1994). Attitude versus general habit: Antecedents of travel mode choice. *Journal of Applied Social Psychology*, *24*, 285-300.

Vidya, T. C., & Michael, J. D. (2004). *Supply chain models for freight transportation planning.* Research report No, UVCTS-14-85, August 2004, Stanford, California.

Winston, C. (1983). The demand for freight transportation: Models an applications. *Transportation Research*, *17a* (6), 20-35.

Wright, C. L. (1992). *Fast wheels, slow traffic.* Philadelphia, PA: Temple University Press.

World Bank (1996). *Sustainable transport, priorities for policy reform*. Washington D.C: World Bank.

APPENDIX A

A QUETIONNAIRE ADMINISTERED TO SPARE PARTS DEALERS AT ABOSSEY OKAI IN ACCRA

Dear Sir/ Madam,

This study is concerned with investigating the factors that affect the choice of mode of transport. It is conducted at the Department of Economics, University of Cape Coast by James Dickson Fiagborlo, under the supervision of Professor Vijay Bhasin and Dr. Henry Jackson, in partial fulfillment of the requirements for the award of Master of Philosophy Degree in Economics. Please, be assured that all responses are strictly confidential. Neither your name nor any other identification will be attached to our findings. Your participation is voluntary. The interview will take approximately 30 minutes. Would you like to participate in the interview?

A. Yes B. No

If yes, kindly proceed with the following questions.

Instruction: Tick where appropriate and provide answers to the questions, please.

Q1 Sex: Male [ ] Female [ ]

Q2 What is your age in years?

Q3 What is your marital status?

a. Single (DO NOT ASK Q4)

b. Married

c. Divorced

d. Widowed

e. Separated

Q4 If married, how many children do you have?

Q5a How many of your dependants who are staying with you are below 18 years?

Q5b How old is your last child or ward who is staying with you?

Q6 Educational backgrounds:

a. No formal education 1

b. Primary education 2

c. J.S.S /Middle 3

d. Secondary / Vocational 4

e. Tertiary 5

f. Other (specify) 8

Q6b Which parts of Accra do you live? _____

Q7A How do you usually make a trip within Accra?

a. Drive myself 1

b. Ride with a family member (DON'T ASK Q20) 2

c. Ride with a friend or neighbor (DON'T ASK Q20) 3

d. I take the bus 4

e. I take the trotro 5

f. I take a taxi 6

g. I walk 7

h. Other: (specify) _____ 8

Q7B What is the distance between where you live and your work place?

Q8 How much time does it take you to get you to the nearest bus stop from your house? _____

Q9 Please, indicate your main modes of transport from where you live to the following places:

	Bus	Trotro	Taxi	Car
Work place				
Children School				
Social gathering				
Hospital				
Shopping				

Q10A Please, indicate how many times within a week you and your child (ren) used the following modes of transport to the following places:

	Bus	Trotro	Taxi	Car
Work place				
Children Schools				
Social gathering				
Hospital				
Shopping				

Q10B If you do not take the bus always, which of the following are the main reasons why?

		Yes	No
A.	I have a car now or have someone that can give me a ride	1	2
B.	The bus stop is too far from my home	1	2
C.	The bus does not go where I need it to go	1	2
D.	It is too expensive	1	2
E.	It is not comfortable	1	2
F.	I don't feel safe riding the bus	1	2
G.	I don't feel safe waiting at the bus stop	1	2
H.	The drivers are not courteous	1	2
I.	The bus is too slow	1	2
J.	The hours of operation are inconvenient	1	2
K.	I am physically unable to take the bus	1	2
L.	Other(s) specify _____		

Q11A How much time in minute(s) does it take you to make a one way trip from where you live to your work place using the bus? _____

Q11B what do you consider this time to be?

a.	A very long time?	1
b.	A long time?	2
c.	A short time?	3
d.	A very short time?	4

Q12 How often can you count on the bus to get you to where you work?

a. All of the time 1

b. Most of the time 2

c. Seldom 3

d. Never 4

Q13 If you do not use the trotro often, which of the following are the reasons why?

		Yes	No
A	I have a car now or have someone that can give me a ride	1	2
B	It is too expensive	1	2
C	I don't feel safe riding in a trotro	1	2
D	The drivers are not courteous	1	2
E	It is not comfortable	1	2
F	The trotros are never on time	1	2
G	The hours of operation are inconvenient	1	2
H	physically unable to take a trotro	1	2

Q14A How much time in minute(s) does it take you to make a one way trip from where you live to your work place using the trotro? _____

Q14B What do you consider this time to be?

a. A very long time 1

b. A long time 2

c. A short time 3

d. A very short time 4

Q15 If you do not use your personal car often, which of the following are the reasons why?

		Yes	No
A.	Don't have a driver's license	1	2
B.	Denied or had your car insurance canceled	1	2
C.	Car insurance is expensive	1	2
D.	Gasoline is expensive	1	2
E.	Maintenance is expensive	1	2
F.	Car is unreliable	1	2
G.	Cannot afford a car payment	1	2
H.	Avoid parking problem	1	2

H. Other: (Specify) _____

Q16 How often can you count on your personal car to get you to your work place from where you live?

a.	Most of the time	1
b.	Frequently	2
c.	Seldom	3
d.	Never	4

Q17 If you do not take the taxi always, which of the following are the reasons why?

		Yes	No
A	I have a car now or have someone that can give me a ride	1	2
B	It is too expensive	1	2
C	I don't feel safe riding in a taxis	1	2

D	The drivers are not courteous	1	2
E	It is not comfortable	1	2
F	The taxis are never on time	1	2
G	The hours of operation are inconvenient	1	2
H	physically unable to take a taxis	1	2

Q18A How much time in minute(s) does it take you to make a one way trip to your work place from your residence using the taxi? _____

Q18B What do you consider this time to be?

a. A very long time 1

b. A long time 2

c. A short time 3

d. A very short time 4

Q19 Please, indicate how easy it is for you to access the following modes of transport from where you live to the following places:

Scale: 1- Very easy 2- Easy 3- Not easy at all

	Bus	Trotro	Taxi	Car
Work place				
Children School				
Social gathering				
Hospital				
Shopping				

Q20 Does someone in your household own a car or can you borrow one or get rides from someone else?

Yes 1 No 2

Q21A Do you have a parking lot at your work place? Yes 1 No 2

Q21B If you do not have a parking lot, do you have any problem with parking?

Yes 1 No 2

Q21Bi If yes, what type of problems are they? _____

a. Cost _____

b. Space _____

c. Others specified _____

Q21Bii how much do you pay to park a day? _____

Q22 How comfortable is it driving your personal car from where you live to your work place?

a. Very comfortable 1

b. Comfortable 2

c. Normal 3

d. Uncomfortable 4

e. Very uncomfortable 5

Q23 Are you in business partnership with someone? Yes 1 No 2

Q24 If yes, what is the value of his/her share contribution to the business?

Q25 How much is your income (salary) per month from your business?

Q26A Do you have any other source of income? Yes 1 No 2

Q26 B If yes, how much on the average do you make from this source in a month? _____

Q27 Do you live in your own house? Yes 1 No 2

Q28 Are you the head of your family? Yes 1 No 2

Q29 Which tribe are you from? _____

Q30 On a scale of 1 to 3, how will you rate the following modes of transport in terms of risk specific issues?

Scale: 1-Very Risky 2-Risky 3-Not Risky at all.

	Bus	Trotro	Taxi	Car
Accident				
Petty robbery				
Missing appt				
Breaking down				

APPENDIX B

Table 1: Chi-squared test for age, sex, family size, residential zone, in-vehicle time for private car, public bus, public trotro and public taxi

Variable	χ^2	P-value
Age	34.340	0.011
Sex	3.761	0.288
Family Size	23.267	0.006
Residential Zone	8.089	0.044
In-private Car time	14.716	0.257
In-public bus time	5.867	0.662
In-public trotro time	4.870	0.965
In-public taxi time	20.750	0.023

Source: Field work, 2009