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MBA (LOGISTICS AND SUPPLY CHAIN MANAGEMENT)

ASSESSING THE IMPACT OF EFFICIENT LOGISTICS ON URBAN TRANSPORT ENERGY DEMAND – THE CASE OF ACCRA METROPOLIS

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by

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DECLARATION

I hereby declare that, this submission is my own work towards the MBA and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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ABSTRACT

Urban congestion is set to get worse under current trends for growth in traffic. Poor air quality remains a major concern, despite substantial reductions in the importation of over aged vehicles into the country. Public transport services have declined in the face of increasing use of cars, reducing the mobility of disadvantaged groups. It is significant to note that without well developed transportation systems, logistics could not bring its advantages into full play. Besides, a good transport system in logistics activities could provide better logistics efficiency, reduce operation cost, and promote service quality.

This study assesses the impact of efficient urban transport on energy demand in Accra Metropolis, with particular focus on identifying the various factors that cause urban transportation energy demands and its effects as well as determining the appropriate logistics strategies that can reduce transport energy demand. Non probability sampling methods were used with both primary and secondary data on five arterial principal roads sample from Accra Metropolis and analysed using Statistical Package for Social Scientist and adoption of some aspect of fuzzy set theory. It was surprisingly found from the study that, the ratio of vehicles and the total length of paved roads (PCU/KM) which fall directly under the study area is steadily rising, meaning more traffic congestion will continue happen in these road systems and traffic efficiency may be damaged greatly. The imbalance in growth of road length and vehicle registration has resulted in serious traffic congestion. The effect of this is, more waste of fuel energy on our roads which have been a serious drain on our national coffers due to its high importation.

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LIST OF ABBREVIATIONS

HCM	Highway Capacity manual
CBA	Central Business Area
LCA	Life Cycle Analysis
AMA	Accra Metropolitan Assembly
GDP	Gross Domestic Product
PCU	Passenger Car Unit
LPG	Liquefied Petroleum Gas
EPH	Evening Peak Hours
DVLA	Driver Vehicle and License Authority
UTC	Urban Traffic Control
O-D	Origin and Destination
HDVs	Heavy-Duty Vehicles
CNG	Compressed Natural Gas
CI	Compress Ignition
SI	Spark Ignition
DDF	Diesel Dual Fuel
KM	Kilometre
LDVs	Light Duty Vehicle
Mpg	Miles per gallon
SUVs	Sport Utility Vehicles

CHAPTER ONE

INTRODUCTION

1.0 BACKGROUND OF THE STUDY

Traffic congestion in urban areas at peak hours has several repercussions on the economy; one of them is increased energy demand on transportation. Some potential elements in urban planning are transport and energy consumption. Reducing energy demand on transportation is a topic which is becoming increasing important as efforts to attain millennium goals and sustainable life styles as well as sustainable travel behaviour are being sought, yet proving intractable to achieve (Hickman and Banister, 2007).

Without well developed transportation systems, logistics could not bring its advantages into full play. Besides, a good transport system in logistics activities could provide better logistics efficiency, reduce operation cost, and promote service quality. The improvement of transportation systems needs the effort from both public and private sectors. A well-operated logistics system could increase both the competitiveness of the government and enterprises (Tseng and Yue, 2005).

The transport sector plays a key role in economic development. In West Africa, the sector generates about six percent (6%) of total Gross Domestic Product (GDP) and in Ghana is about 4.8 % (Ghana statistical service, 2007). However, inefficiency prevails due to the high cost of vehicle operation. In Ghana, roads are the predominant mode of transport accounting for about ninety-four percent (94%) of freight and ninety-seven percent (97%)

of passenger traffic movements. The subsector is the most viable alternative except for rail to transport bulk commodities like manganese, bauxite, timber and cocoa. The railway network operates at limited capacity with low efficiency (Last, 2008). All the same, among the benefits that trains are expected to deliver to cities are capacity expansion of the current congested transportation infrastructure; reducing the geographical isolation of the towns within region; improving cohesion and quality of life in the city by stimulating the economy; and reducing the external costs of transportation in the region.

Road transport currently represents sixteen percent (16%) of global energy demand and forty-six percent (46%) of global demand for petroleum products. The issues relating to climate change and the local air quality in some cities present a unique set of challenges for the growth and development of the automotive industry and the transportation sector (Chenoy, 2008).

Our increasingly urbanized civilization must pay attention to its cities, which are growing in size and complexity. One of the major challenges of our time is how to ensure that cities have operationally and economically efficient services, which enhance their environment, their social and cultural values. Cities have always been centres of human activities. Given the large population, the demand for efficient, economical and equitable public transportation will also increase. The challenge of modern transportation is to be able to meet these aspirations, satisfy the quest and need for transport, and yet do it in a

manner that is inclusive, in harmony with nature, which also has minimal impact on the environment and does not accelerate climate change.

According to Chenoy (2008) transport will primarily be a means for commuting either to office and back or used as a means to earn livelihood or for carrying out essential activities related to daily life. On the other hand, there are several arguments for using cars in the city. Firstly, if one has a car, one would have easy mobility because one does not depend on public transport for moving about. Secondly, one can travel and go wherever he/she want and the cost of the trip will not be as expensive as travelling by plane. Thirdly, for a family of medium class the cost of having a car is better than the cost of paying the transport fee of individually. Finally, in the case of emergency one can drive himself/herself to respond to the problem. In the case of using the train in the city, the long term benefits are many. It can cut journey times in half and it's cleaner and cheaper to run than aeroplanes. The modern Train technology uses five times less energy per passenger mile than a jet aeroplane. The train itself costs only a hundredth part of what a jet can cost. In addition, the train is not affected by bad weather or congestion. As the train has no wheels, the track suffers very little erosion. To sum up, the fact of using a car or train is very important in our society, although it would be necessary that all the families which have more than one car should sometimes think of the possibility of using public transport or train to minimise traffic and saving energy.

Tremendous progress in transportation technology has been achieved during the last century. The great impact that the transportation developments have had on modern

civilization is also evident: the intensive urbanization that has taken place in all countries would not have been possible without modern transportation systems. Urban transport is an important component of the urban infrastructure system. A good urban transport system will also depend on some sort of energy to increase productivity, enhance efficiency, ensure competition, and promote urban economy. It will also facilitate social interactions, provide people with accessibility to opportunities, set directions and pattern of land use development safeguard environment, and ensure quality of life.

In physical science terminology "energy" is the capacity for doing work, e.g., lifting, accelerating, or heating material. In economic terminology, "energy" includes all energy commodities and energy resources, commodities or resources that embody significant amounts of physical energy and thus offer the ability to perform work. Energy commodities - e.g., gasoline, diesel fuel, natural gas, propane, coal, or electricity – can be used to provide energy services for human activities, such as lighting, space heating, water heating, cooking, motive power, electronic activity. Energy resources - e.g., crude oil, natural gas, coal, biomass, hydro, uranium, wind, sunlight, or geothermal deposits – can be harvested to produce energy commodities (Sweeney, 2000). The impacts of energy use affect all of us and consequently, we should all be concerned about how to use energy more efficiently.

Energy efficiency is understood to mean the utilization of energy in the most cost effective manner to carry out a manufacturing process or provide a service, whereby energy waste is minimized and the overall consumption of primary energy resources is

reduced. In other words, energy efficient practices or systems seek to use less energy while conducting any energy-dependent activity: at the same time, the corresponding (negative) environmental impacts of energy consumption are minimized.

The research is worth studying in that a good urban transport system will increase productivity, enhance efficiency, ensure competition, and promote urban economy. It will also facilitate social interactions, provide people with accessibility to opportunities, safeguard environment, set directions and pattern of land use development, and overall ensure quality of life.

1.2 PROBLEM STATEMENT

Car journeys and road-freight movements become less predictable, trains and buses run late or are too crowded for passengers to get on (Kelly, 2007). This is not just a problem for the individual user. There is common agreement that urban transport systems need to be improved.

Urban congestion is set to get worse under current trends for growth in traffic. Poor air quality remains a major concern, despite substantial reductions in the importation of over aged vehicles into the country. Public transport services have declined in the face of increasing use of cars, reducing the mobility of disadvantaged groups. It causes cost and inconvenience to companies. Most businessmen found it very difficult locating their businesses in areas where access to suppliers or markets is unacceptably slow or unreliable or where they cannot attract the workforce they need. Now if nothing is done about these problems, it could ultimately become an impediment on economic growth.

The underlying issue for conducting this research is to find out how to minimise these traffic and its adverse impacts, yet fulfilling the demand for accessibility in support of economic and social goals.

1.3 RESEARCH OBJECTIVES

The main objective of this study is to obtain an in-depth knowledge in the impact of efficient logistics on urban transport energy demand. The specific objectives are:

- Identifying the various factors that cause urban transportation energy demands.
- Investigating the effects that factors identified at the one above have on transport energy demand
- Investigate the relationship between urban transport efficiency and energy demand.
- To determine whether appropriate logistics strategies can reduce transport energy demand.
- To recommend efficient and effective logistics on transport energy demand.

1.4 JUSTIFICATION OF THE STUDY

The thesis will provide benefits at various levels. The vehicle owners will benefits from fuel savings, lower fuel bills and increased their vehicle life span. Furthermore, large fleet owners in both the public and private sectors will also gain by reducing their vehicle operating costs and maintenance expenses while increasing their revenue-kilometres. This will trigger off substantial amount of reduction in the country's fuel imports.

The global environmental benefits will be in the form of reduced greenhouse gas emissions. As a result of reduction in vehicle emissions, air quality will improve and there will be a direct effect on the health of the general population in the short run. In the long run, dampened growth of greenhouse gas emissions will help in controlling the present trends towards global warming. Thus, the main impact of this thesis will improve traffic situation as well as quality of life in city of Accra.

1.5 SCOPE OF THE STUDY

The study is restricted to the Accra Metropolitan Area on energy efficiency on public transport due to huge traffic situations, congestions, population and high commercial activities. Also due to available and easy access to data on energy and transport of which, the analysis could be generalized to the rest of the cities in Ghana. Based on the outlined objectives, questionnaires and interviews would be the main instrument for data collection. The data or information obtained from the questionnaires and interviews as well as secondary sources like articles from the internet, journals and books would be used in the development of the study.

1.6 LIMITATION OF THE STUDY

This study will not discuss in depth, the issues regarding the use of alternative fuels to fossil fuels such as biofuels or electricity, the use of alternative systems such as light rail or metro transit transport and the future capacity of the road system, due to denial of information and the time frame that this work has to be submitted. Though these cases could be addressed in further research about the public transport of the city.

1.7 ORGANIZATION OF THE STUDY

The study was organized into five chapters, which are summarized below:

Chapter one; provides the introduction of the study and gives a background to the general area of study. Also the importance of public transportation. In addition, the major objective within the scope of the purpose of the study was clearly stated and, brief information on the statement of the problem, justification of the study, the scope of the study, limitations as well as the organization of the study was given.

Chapter two; focuses on the review of literature that is related to the topic, the concept of the study and the conceptual model. It delves into the theories of transport, energy efficiency as well as transport efficiency. An empirical literature on energy efficiency on public transport in Accra Metropolitan that supports this study would be presented as well.

Chapter three; presents the methodology, that is research working definitions, sample size and technique. This basically has to do with the instruments that would be used to gather information from Accra Metropolitan Assembly, the data presentation and analysis and the profile of the study location.

Chapter four; deals with the data that have been analyzed, organized and illustrated with the use of appropriate models, tables and figures. Here, the results of the data analysis would be discussed in the context of the study objectives.

Chapter five; covers the conclusions, recommendations and summary of the study.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

This section of the study reviews the literature on assessing the impact of efficient logistics on urban transport energy demand. It focuses on overview of logistics, Components of Logistics System, efficient logistics, meaning of transport, the evolution of transport and logistics, urban transport system, urban transport system efficiency, factors affecting urban transport system efficiency and methods for assessing urban transportation.

2.1 OVERVIEW OF LOGISTICS

Logistics is one of the key economic activities throughout the world. Global logistics industry is estimated to be worth $3.5 trillion in 2005, out of which over twenty-five percent (25%) is contributed by US alone. The retailing industry accounts for more than seventy percent (70%) in the global logistics industry. Other major industries that contribute to logistics industry are transportation, Hi-tech, Pharmaceutical and Consumer Electronics (Cygnus, 2006).

With regard to the role of transportation in logistics, Tseng and Yue (2005) reviewed that, Council of Logistics Management (1991) defined logistics as 'part of the supply chain process that plans, implements and controls the efficient, effective forward and reverse flow and storage of goods, service and related information between the point of origin and the point of consumption in order to meet customers requirements'.

Tseng and Yue (2005) in their recent research paper found that, Johnson and Wood's (Tilanus, 1997) definition uses 'five important key terms', which are logistics, inbound logistics, materials management, physical distribution, and supply-chain management. To interpret, logistics describes the entire process of materials and products moving into, through, and out of firm. Inbound logistics covers the movement of material received from suppliers. Materials management describes the movement of materials and components within a firm. Physical distribution refers to the movement of goods outward from the end of the assembly line to the customer. Finally, supply-chain management is somewhat larger than logistics, and it links logistics more directly with the user's total communications network and with the firm's engineering staff.

The commonality of the recent definitions is that logistics is a process of moving and handling goods and materials, from the beginning to the end of the production, sale process and waste disposal, to satisfy customers and add business competitiveness. It is 'the process of anticipating customer needs and wants; acquiring the capital, materials, people, technologies, and information necessary to meet those needs and wants; optimising the goods- or service-producing network to fulfil customer requests; and utilizing the network to fulfil customer requests in a timely way' (Tilanus, 1997). Simply to say, 'logistics is customer-oriented operation management'.

2.1.1COMPONENTS OF LOGISTICS SYSTEM

Logistics services, information systems and infrastructure/resources are the three components of this system and closely linked. The interaction of the three main components in the logistics system is interpreted as follows.

Logistics services support the movement of materials and products from inputs through production to consumers, as well as associated waste disposal and reverse flows. They include activities undertaken in-house by the users of the services (e.g. storage or inventory control at a manufacturer's plant) and the operations of external service providers (Tseng and Yue, 2005).

Logistics services comprise physical activities (e.g. transport, storage) as well as non-physical activities (e.g. supply chain design, selection of contractors, freightage negotiations). Most activities of logistics services are bi-direction.

Information systems include modelling and management of decision making, and more important issues are tracking and tracing. It provides essential data and consultation in each step of the interaction among logistics services and the target stations.

Infrastructure comprises human resources, financial resources, packaging materials, warehouses, transport and communications. Most fixed capital is for building those infrastructures. They are concrete foundations and basements within logistics systems (Tseng and Yue, 2005).

2.1.2 EFFECTIVE LOGISTICS

The ratio of total logistics cost to gross domestic product represents the efficiency of logistics operation in the economy, i.e., the lower the ratio, the better the efficiency. Despite the People Republic of China (PRC's) ratio declining from 21.2% in 1991 to 18.4% in 2007, it is still double that of developed countries. Moreover, the share of logistics cost of finished products in the PRC is much higher than the normal range of ten to twenty-five percent (10%–25%) for an efficient operation—particularly in inland regions—further reflecting a needed improvement in its logistics development (Greenwood et al., 2008).

Inefficient logistics also result in increased energy consumption and air pollution concerns; unsurprisingly, the PRC is the world's fastest growing oil consumer. From 2000 to 2005, the transport sector's consumption of petroleum increased from twenty-five to thirty percent (25% to 30%) of total use and is projected to reach fifty percent (50%) in 2020. To cope with emerging environmental issues, policies and measures to increase transport energy efficiency are highly desirable, such as raising the quality of transport services, raising vehicle standards (with greater use of containers and larger, multi-axle trucks), and fostering integrated logistics service provider development. Further developing inland waterway transport can also lower environmental impact in terms of high energy efficiency per ton-km. (Greenwood et al. 2008).

Tseng and Yue (2005) on their account on the Effects of Transportation on Logistics Activities states that transportation plays a connective role among the several steps that

result in the conversion of resources into useful goods in the name of the ultimate consumer. It is the planning of all these functions and sub-functions into a system of goods movement in order to minimize cost maximize service to the customers that constitutes the concept of business logistics. The system, once put in place, must be effectively managed. (Fair *et al.*, 1981).

2.2 MEANING OF TRANSPORT

According to Chenoy (2008) transport will primarily be a means for commuting either to office and back or used as a means to earn livelihood or for carrying out essential activities related to daily life. In Operational Management, transport is define as the movement of a product or people from one location to another as it makes it way to the end –use customer (Russell and Taylor 2003).

2.2.1 THE EVOLUTION OF TRANSPORT AND LOGISTICS

Three generations of transportation according to Sjostedt, et al (1998) has been well established as an international scientific discipline at least since the sixties. As the need to construct highways for the rapidly growing automobile traffic escalated shortly after World War II, this became a natural field of application when the operations research community, which had firmly established itself during the war, was looking for applications in the civilian sector. The growing discipline of transportation found a strong foothold in the civil engineering faculties of many American universities and likewise in technical universities in other parts of the world.

First generation. The original focus was the traffic process. Traffic engineering grew in importance as a profession as most cities found it necessary to employ one or several traffic engineers. Many have written an excellent overview of the evolution of traffic management. Speed-flow relationships are fundamental to understand traffic flow phenomena. In the thirties Greenfield's proposed that speed was a linear function of density, implying a parabolic relation between speed and flow. Theoretically, a great step forward was made when the 1965 version of the US Highway Capacity Manual (HCM) was published. The previous concepts of 'possible' and 'practical' capacity were abolished. Instead capacity was defined as the upper bound of the traffic volumes that could be observed in practice. Simultaneously the level of service based on the volume/capacity ratio was introduced as a measure of the extent to which the individual motorist could travel free of disturbances and delays.

Second generation, as part of the strong environmental movement and changes of values that swept through universities in 1968 the first strong reactions against unlimited use of the private car in cities appeared. This caused a renewed interest in the role of public transport and partly explains the shift of academic work from traffic to transport that took place in the seventies.

Manheim has summarized the theoretical development during this period in a classical text book. The level of service is perceived as a function of the design of the transportation system and the volumes of travellers using the system and serves a similar role as price in ordinary market theory.

Third generation, following the Brundtland report and the United Nation (UN) conference in Riode Janeiro on Sustainable Development a further shift has taken place from transport to mobility. The increasing use of the term mobility not only reflects attempts to look at the qualitative aspects or utility of transport. It is also closely associated with the ambition to measure consumption of non-renewable resources and energy conversion efficiency as well as emissions of greenhouse gases and substances harmful to living organisms and plants. Techniques such as Life Cycle Analysis (LCA) are increasingly being used to assess transportation systems serving various mobility needs.

2.2.2 URBAN TRANSPORT SYSTEM

Transport in Ghana is accomplished by road, rail, air and water. Ghana's transportation and communications networks are centered in the southern regions, especially the areas in which gold, cocoa, and timber are produced. The northern and central areas are connected through a major road system; some areas, however, remain relatively isolated (Wikipedia 2007)

Earlier research by (Tiwari, 2002) found that, travel characteristics of large cities in high-income countries differ from those in low- and middle-income countries in the use of mass rapid transit and commuter rail systems. Throughout Asia buses form the backbone of urban public transport services. However, overcrowding, the increased incidence of breakdowns and poor service frequency have resulted in a decline in general levels of service and comfort. Consequently, a large number of indigenously designed vehicles are

operating as paratransit modes in Asian cities. This service is mostly provided by the informal sector. Paratransit operations provide an important service in cities throughout the region, with the notable exceptions of China and high-income countries such as Australia, Japan and Singapore (World Bank 1991).

Nuworsoo (2006) state that, 'public transportation is the dominant method of travel in Accra, and the nation as a whole. Nearly half of all trips to work are completed by one of many types of buses that operate like jitneys. This means they have no fixed schedules or stop locations although they may run specific origin to destination routes. Nearly fifteen percent (15%) more of work trips are by taxis, which are shared-ride for which passengers pay per person per ride. A healthy twenty-five (25%) of work trips are conducted on foot. About ten percent (10%) of commuters use private automobiles. Due to climate and lack of safe facilities, less than three percent (3%) of trips are by bicycle or motorcycle'.

Large municipal buses have been unable to compete effectively for trips to the Central Business Area (CBA) of Accra due to high levels of delay and inability to maintain any semblance of a regular schedule. Thus the traffic stream comprises of multitudes of "jitney" type public transportation vehicles intermingled with private automobiles, trucks and taxis. The lack of pullouts or designated stopping points for jitneys results in numerous interruptions to flow even within non-conflicting streams of traffic. Planners and government officials realized the need to find a solution before the City grinded to a halt. This realization prompted the development of the Bus Rapid Transit (BRT) plan (Nuworsoo, 2006).

Research recently carried out by Kenworthy (2003), urban Transport is one of the most important components of urban infrastructure. A good network of roads and an efficient Mass Urban Transport System make a substantial contribution to the "working efficiency" of a large city. A poor urban transport system may slow down economic growth of the city and also lead to its decay. It has been estimated that the poor Traffic and Transportation scenario in the urban areas of the country currently result in an annual loss of the order of Rs. 20,000 crores in vehicles operating and travel time costs alone. In view of the rapidly growing urban population, pressure on urban transport system is bound to increase much more in the coming years. Urgent measures, are, therefore, needed to tackle this problem.

2.2.3 URBAN TRANSPORT SYSTEM EFFICIENCY

Yuan and Lu (2001) in their recent research paper defined transportation efficiency as the extent to which a certain transportation input can meet the travel demand of people in a transportation system. It is the main factor that determines the scale of transportation supply and the relationship between supply and demand in a transportation system. In a macroscopic point of view, if we take transportation infrastructure as the input element and take transportation mobility (or transportation capacity) as the output element in transportation systems, then transportation efficiency is the macro parameter influencing the input/output proportion of the system.

Generally, transportation efficiency can be further categorized as macrocosmic or microcosmic, intercity or intracity, passenger or freight transportation efficiency, etc. At

the same time, different categories are interrelated. If combined by certain means, more particular categories can be obtained, for example: efficiency of urban passenger transportation system, efficiency of intracity, freight transportation system etc (Yuan and Lu, 2001)

According to Yuan and Lu (2001) the efficiency of urban transportation systems is the relationship between the input of an urban transportation system and its capability of satisfying the transportation demand in the system. Generally, the total efficiency of the urban transportation system is scaled by "social benefits/social costs". The greater the ratio, the higher the transportation efficiency. However, social benefits and social costs are both macrocosmic indexes and cannot be quantified and analyzed exactly. Therefore the main objective of this paper is to discuss the detailed content of urban transportation efficiency and make quantitative analysis and evaluation (Yuan and Lu (2001)).

2.2.3.1. FACTORS AFFECTING URBAN TRANSPORT SYSTEM EFFICIENCY

2.2.3.1.1 URBAN LAND-USE PATTERN

Land use: including resident population density, resident employment density, workplace population density, workplace employment density, resident population size, workplace population size, distance from urban centres and strategic transport networks, jobs-housing balance, resident location (relative to the urban area), type of journey to work, neighbourhood streetscape layout, public transport accessibility, and resident location (relative to the green belt).

Hickman and Banister (2007) in their recent research paper discuss that the role of urban planning has been underplayed in reducing journey to work energy consumption. Yet, within this, there are a large number of nuances to the findings. Rather than a small number of relationships at work (such as density and travel), there are a wide range of relationships involved. Each variable, by itself, offers a relatively weak relationship with travel, but when considered with others become important. The lesson perhaps is that we should widen our aspect somewhat in looking at the land use and travel debate.

Population density: an inverse relationship is found between residential population density and energy consumption: lower residential population densities are associated with higher energy consumption patterns, and higher densities with lower energy consumption patterns, in the commute to work. Housing located in wards with the highest densities (over 35 persons/ha) is associated with 29% less energy consuming commutes than the sample average (Hickman and Banister (2007)).

Population size: reflecting the Banister (1997 cited in Hickman and Banister (2007) , threshold debate, households located in towns (and rural areas) in Surrey, below a threshold of 25,000 residential population size, are associated with high energy consumption patterns. There is however more subtlety within the evidence: there is much variation within the towns above the 25,000 threshold, reflecting the complexity of commuting possibilities in Surrey.

Distance from strategic road network: households located close to the strategic highway network are associated with high energy consumption patterns: the A31 (in particular),

A3, M25 and M3 all contribute to lengthy commutes by car. This reflects the initial findings of Headicar (1997) cited in (Hickman and Banister (2007)) in Oxfordshire, but uses a different scale of analysis. Better access to the strategic road network in Surrey extends the distance that can be travelled in a fixed time of around forty- five (45) minutes. The analysis in Surrey shows that resident locations within 3km of the uncongested M3 and A31 are associated with commutes consuming forty-four percent (44%) more energy than resident locations >3km from the strategic road network. Journey to work distance and mode shares contribute to these trends.

2.2.3.1.2. THE STRUCTURE OF URBAN TRANSPORTATION SYSTEMS

Hickman and Banister (2007) in their recent research paper found that, the role of urban structure, at the strategic and local scales, would appear, intuitively, to be critically important in facilitating travel. Urban structure provides the framework for the location of housing, employment and other developments, such as health, education and leisure facilities. Urban structure thus provides the physical rationale for travel alongside socio-economic and cultural factors. We might expect different urban forms (say low density sprawl and high density, public transport orientated development) to be clearly associated with different travel behaviours on the ground.

Earlier research (Yuan and Lu (2001)) demonstrated that under a certain land-use pattern, the total capacity of the urban transportation system is basically determined by the composition of different transport modes in the system. Whether the structure of urban transportation system is harmonized with the land-use pattern, will directly impact the balance between transportation demand and supply. Given the total amount of

transportation demand and a certain level of transportation infrastructure in a city, a good transportation structure will most effectively utilize the infrastructure and will help fully realize the functions of urban transportation systems.

2.2.3.1.3 URBAN TRANSPORTATION INFRASTRUCTURE

Urban transportation infrastructure mainly includes roads, parking lots, vehicles and transportation terminals. It is the direct carrier of urban transportation demands and the basic input of the capacity of transportation supply. From the viewpoint of the relationship among transportation efficiency, input and output, the operational efficiency of transportation infrastructure is the key factor which will directly influence the urban transportation capacity provided by the system (Yuan and Lu (2001)).

2.2.3.1.4 URBAN TRAFFIC MANAGEMENT SYSTEM

Research recently carried out by Efimenko (2007) found that public transport vehicles can be given priority over general traffic by integrating their operation into urban traffic control (UTC) systems. AVL enables buses and trams to be identified on the approaches to signalized intersections, where they 'request' the traffic light controller to extend or recall the green phase for long enough to let them through. Detection can be via inductive loops under the road' surface, roadside beacons, or satellite-based positioning systems. This supplements conventional bus lanes with specially-designed track sections that deter general traffic and speed buses past known congestion points. In mechanical systems, lateral wheels on front wheel mountings guide the bus along raised curbs (relieving the driver of the need to steer). The electronic system is based on an electric cable embedded in the centre of the bus way, with onboard inductive detection that continuously steers the

wheels to keep the vehicle centered over the cable. At the end of a bus way section, traffic signal priority gives access to general lanes. Urban traffic management system is an important component which can properly control and guide the distribution of traffic flows on roads, and can help improve the urban environment.

The recent research (Efimenko, 2008) demonstrated that even the urban transportation infrastructure in different cities is at the same level, the capacity of urban road systems may vary greatly with different traffic management systems. For example, according to our surveying of some main intersections in Beijing, capital of China, most of them have a queue of more than 200 meters during the morning and evening peak hour. And the average delay of motor vehicles at these intersections is about 2 or 3 minutes. However, the actual highest traffic volume of these intersections is only sixty to eighty percent (60%-80%) of that at similar intersections in developed countries. Therefore, given a certain land-use pattern and transportation structure in a city, traffic management system then becomes the key factor to determine the level of transportation efficiency and the relationship between transportation demand and supply.

According to Litman (2007) the physical impacts of vehicle traffic can have significant equity impacts. For example, the congestion impacts that motor vehicles impose on other road users is horizontally inequitable to the degree that High-Occupant Vehicle (carpools, vanpools and buses) passengers are delayed by congestion, although they use less road space and so impose less delay on others per passenger-mile. Similarly, motor vehicle use imposed delay and accident risk on pedestrians and cyclists, and noise and air pollution on nearby residents.

According to Tiwari et al. (2007) there are two kinds of traffic, Homogeneous and non-Homogeneous. Homogeneous traffic has strict lane discipline and has traffic entity types whose physical dimensions do not vary much. The Highway Capacity Manual 2000 (HCM) of USA mentions six traffic entity types: (a) passenger car including vans, (b) heavy vehicle including buses and trucks, (c) recreational vehicle, (d) motorcycle, (e) pedestrian, and (f) bicycle (HCM 2000). .

Homogeneous traffic follows strict lane discipline as compared to non-homogeneous traffic, which is more of chaotic where loose-lane discipline prevails (figure 2). In addition to passenger cars, motorized two-wheelers, motorized three-wheelers, mini-trucks, mini-buses, bicycles, pedestrians, animals, animal-drawn carts, and vendor push pull carts are usually present on the road.

Western traffic planning methodologies mostly address the concerns of homogeneous traffic and therefore often prove inadequate in solving problems involving non-homogeneous traffic conditions. One characterizes non homogeneous traffic as having lane discipline that is relaxed or 'loose'. Complicated lateral position changing and car-following behaviour also characterizes non-homogeneous traffic conditions.

Homogeneous Traffic

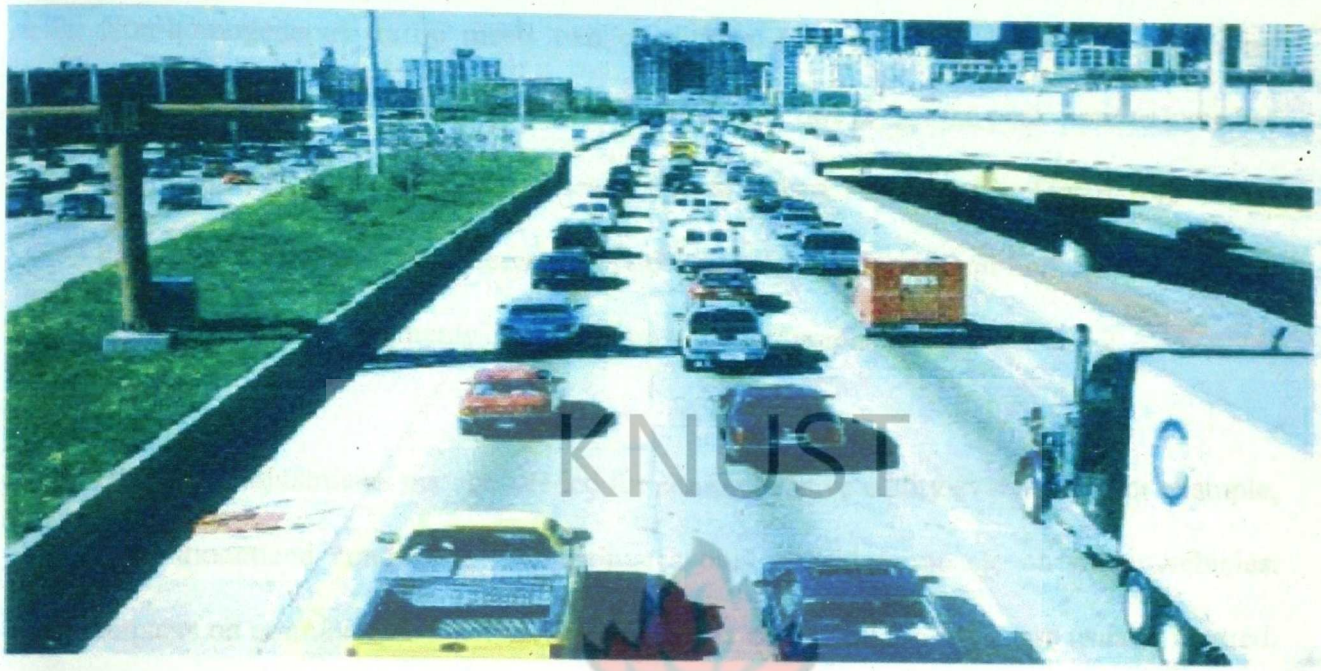

Figure 2.1. Source :(Modified from Tiwari, 2007)

Non-homogeneous traffic

Figure 2. Source :(Modified from Tiwari, 2007)

Non-homogeneous traffic meets two conditions. One condition is that the peak hour volume has less than 85% passenger-cars. The other one is that the peak-hour volume has less than 90% cars, trucks, and buses (Fazio & Tiwari 1995 cited in Tiwari, 2007). The best way to illustrate the difference between homogeneous and non-homogeneous traffic at non-intersection segments is to compare the photographs in figures 1 and 2.

However, adjustments may be needed for comprehensive equity evaluation. For example, most monetized congestion cost estimates only consider impacts on motor vehicles. Impacts on nonmotorized travel, including delay and travel foregone, are usually ignored, although they are often significant compared with costs that are considered, particularly in urban areas ("Barrier Effects," Litman, 2005a cited in Tiwari 2007). They represent a horizontal inequity (motorists impose far more delay and risk on nonmotorized travelers than nonmotorized travelers impose on motorists), and to the degree that people who are transportation disadvantaged drive less and rely more on nonmotorized modes, this represents a vertical inequity

2.2.4 METHODS FOR ASSESSING URBAN TRANSPORT SYSTEM

2.2.4.1 FUZZY THEORY AND FUZZY LOGIC MODEL

Hoogendoor et al. (2000) found that, fuzzy set theory and fuzzy logic are approaches that are much closer to real human observation, reasoning and decision making than other (traditional) approaches, such as probability theory. These fuzzy approaches have been applied successfully in a wide range of industrial processes (cement kilns, incineration

processes, and waste water treatment) and products (e.g. camera's, washing machines). Applications in the field of traffic engineering have only recently emerged in larger numbers and in many cases seem very promising. Most of these applications have an experimental and preliminary nature, whereas real-life applications of fuzzy sets and fuzzy logic in the field of traffic engineering are rare. However, from a number of applications the potential of the fuzzy approach becomes already apparent.

Recent research has found that a variety of methods for prediction have been reported in the literature during the last few decades. The regression method is one of the main ways used in Forecasting (Draper and Smith, 1980 cited in Wong et al., 2003). When conventional regression methods are applied to large scale and complex systems such as transportation problems, the ambiguity or fuzziness of human's subjective judgment usually comes into play. Therefore, exact and accurate modeling of these systems may be very difficult. Alternatively, the concept of the fuzzy set theory seems to be applicable for modeling such systems (Wong, et al., 2003).

In the conventional linear regression analysis, the deviations between the observed and the estimated values are assumed to be due to the observation or measurement errors (Draper and Smith, 1980 cited in Wong et al., 2003). According to Tanaka (1982 cited in Wong, 2003), these deviations depend on the types and on the nature of the uncertainties, ie. On the fuzziness of the system structure, or the fuzziness of the system parameters. It is reflected in a fuzzy linear regression model that the regression coefficients of the regression function are fuzzy members. Although the fuzzy method has been successfully

applied in the many engineering applications, very few transport applications have been reported.

2.2.4.2 ROAD TRAFFIC & PUBLIC TRANSPORT ASSIGNMENT MODELS

According to Shires (2006) a number of assignment models exist and they can be used to model a range of networks from assessments of local junctions to large scale city networks. The basic theory behind assignment models is based upon the actual exchanges of goods and services (supply & demand) and obtaining an equilibrium point where the, '*...marginal cost of producing and selling the goods equals the marginal revenue obtained from selling them*' (Ortuzar & Willumsen, 2001 cited in Shires, 2006). Placing this into a transport context sees a supply side consisting of a road network and the links and their associated costs (a function of their attributes, e.g. distance & capacity); and a demand side consisting of number of trips . The corresponding equilibrium within a transport system may occur at several points.

1. Road network equilibrium – when car travellers for a fixed trip matrix find routes which minimise their generalised travel costs. With such equilibrium the pattern of travel is such that those travelling are already on the best routes available to them.
2. Multi-modal network equilibrium – as in (1) but now the decisions of car travellers impact upon the journey times of bus users leading them to a change of behaviour in terms of route choice which impacts upon car users choice of route etc.
3. System Equilibrium – As in (2) but now the interaction between different modes may lead to travellers to, switching between modes, change their destinations, or alter the time of day they travel. This may lead to a re-estimation of the O-D travel matrix and

service patterns offered. This process will be iterative until a final equilibrium is reached (if it is every reached).

2.2.4.3 STOCHASTIC AND CONGESTED MODEL

Making reference to Public Transport Review 'Stochastic methods of assignment' address some of the shortfalls of the 'all or nothing assignment'. They allow a driver's perceptions of costs to vary as well as the costs of alternative routes. According to Ortuzar and Willumsen (2001) cited in Shires (2006) this method centres around stochastic (Monte Carlo) simulation and proportional stochastic methods, with the former introducing, *'...variability in perceived costs'* and the latter allocating flows via a logit-like algorithm. Whilst these methods are seen as advancement on 'all or nothing assignment' one of the criticisms of the approaches are that they don't make allowances for congestion costs. One method which addresses this is 'congested assignment'.

2.2.5 PUBLIC TRANSPORT ENERGY USE

In physical science terminology (Sweeney, 1999) define "energy" as the capacity for doing work, e.g., lifting, accelerating, or heating material. In economic terminology, (Sweeney ,1999) states that"energy" includes all energy commodities and energy resources, commodities or resources that embody significant amounts of physical energy and thus offer the ability to perform work. Energy commodities - e.g., gasoline, diesel fuel, natural gas, propane, coal, or electricity – can be used to provide energy services for human activities, such as lighting, space heating, water heating, cooking, motive power, electronic activity

Energy resources - e.g., crude oil, natural gas, coal, biomass, hydro, uranium, wind, sunlight, or geothermal deposits – can be harvested to produce energy commodities. Kenworthy (2003) has written and demonstrated that total annual public transport energy consumption is defined as: The annual public transport traction energy consumption, detailed by mode and by operator. All traction energy for all modes of public transport is collected for this item. Station energy use is specifically excluded. All data are converted to megajoules using standard conversion factors as shown in the table 3. 2.

Table 2.1 FUEL TYPES AND THEIR CONVERSIONS

Fuel type	Conversion factor
Motor spirit (Petrol, Gasoline)	34.69 MJ/litre
Automotive Distillate (Diesel	38.29 MJ/litre
LPG	26.26 MJ/litre
Electric power	3.60 MJ/kWh

Source: Modified from Kenworthy (2003)

Note: 1 Imperial gallon = 4.546 litres

1 US gallon = 3.785 litres

MJ = Megajoules

According to Kenworthy, in some cases it was not possible to collect actual fuel data from any source. In these cases average fuel consumption per unit distance for an average

or typical passenger car and motorcycle was obtained in any units (eg km/l or l/100km or mpg). The figures provided were deemed to represent the average or typical car or motorcycle travelling in road conditions characteristic of the city. This was mainly an issue in developing cities, not so much in developed cities.

2.3 FACTORS AFFECTING DEMAND FOR ENERGY

Sweeney (1999) demonstrated that demand for energy is derived from wishes to use energy to obtain desired services. It is not derived from preferences for the energy commodity itself. Energy demand depends primarily on demand for desired services, availability and properties of energy conversion technologies, and costs of energy and technologies used for conversion. For example, consumers use gasoline to fuel an automobile or other motorized vehicle, converting gasoline to mechanical energy for motive power. The amount of gasoline used is proportional to the miles the auto is driven and inversely proportionate to the efficiency by which gasoline is converted to useful mechanical energy, measured as miles per gallon (Mpg) of gasoline of the automobile. Demand for gasoline is thus derived from choices about distances vehicles are driven and their energy conversion efficiencies.

Research recently carried out by Kavalec et al. (2003) found that the demand for motor gasoline in 2000 exceeded that of jet fuel, the second largest use, by a factor of three. Distillate, primarily diesel, is used for both on-road and off-road vehicles. On-road vehicles use about 90 percent, and railroad applications use another 8 percent of the distillate consumed in California as shown by the table 2.2.

Table 2.2: California Petroleum Demand in the Transportation Sector—2000

Fuel Type	Percent	Barrels Per Day
Motor Gasoline	61.1%	933
Jet Fuel	18.4%	282
Distillate	12.5%	191
Residual	7.3%	112
Other	0.7%	11
Total	100.0%	1,529

Source: Modified from Kavalec et al. (2003)

Historical figures demonstrate that in 2002, Californians registered about 24 million gasoline-powered vehicles. Small fleets of liquefied petroleum gas, natural gas, alcohol, and electric vehicles, cumulatively totaling about 120,000 (or approximately six-tenths of 1 percent of the vehicle population), also operate in California (Kavalec et al. (2003)). In 2001,as found in Kavalec (2003) research demonstrated that Californians purchased 1,078,000 new cars and 971,000 new Light Duty Vehicles (LDVs) which include automobiles, and pickup trucks, vans, and sport utility vehicles (SUVs) that are collectively termed "light trucks." LDVs account for nearly all of California's on-road passenger movement. Commercial fleet vehicles account for about one-third of these purchases.

Kavalec et al. (2003) found that, average fuel economy of gasoline-powered by LDVs has steadily increased since the mid-seventies from about 12.6 miles per gallon to today's

20.6 miles per gallon. However, consumers' growing preference for light trucks, particularly minivans and SUVs, which have lower average fuel economy, has caused fleet-average fuel economy to level off for the first time since 1973. Heavy-duty vehicles (HDVs) include medium and heavy-duty trucks and buses. Most HDVs provide on-road freight movement; a much smaller number transport passengers. There are about 867,000 HDVs registered in California (HDVs are generally defined as those vehicles that weigh over 10,000 pounds), which use approximately 2.6 billion gallons of diesel and 0.7 billion gallons of gasoline annually.

2.3.1 KEY FACTORS AFFECTING FUTURE TRANSPORTATION ENERGY AND DEMAND

As suggested by (Kavalec *et al.*, 2003), Economic conditions and population growth are the primary drivers of transportation energy demand. Average household size is projected to increase, so that total households grow at a lower rate than population, an average of 1.2 percent per year.

Recent research has found that, population density and income are two of the most important factors influencing passenger transportation demand in Canada. Urban areas tend to have less per carpita transportation demand than rural areas as residents generally live closer to work and to necessary services (e.g., health and educational institutions, retail stores, etc.). Increasing income leads to increases in transportation demand. As consumers become wealthier they are more likely to purchase additional vehicles, engage in more travel and take additional discretionary trips (National Energy Board, 2009). Cities everywhere are concerned about growing automobile dependence. Two of the factors that

are increasingly important to consider are the energy and greenhouse implications of automobile dependence in cities (Kenworthy Jr, 2003)

2.3.2 RECENT ENERGY TRENDS AND ENERGY POLICY

The transport sector in Japan continues to drive up oil demand barring a major technological breakthrough. According to APEC (2006) forecast shows that, by 2030, oil is expected to continue to be the major energy source for the transport sector. With that of the transport sector leading about 70 percent of incremental oil demand growth. Whiles by that same duration road transport is projected to account for about eighty percent (80) of total transport energy demand. APEC's net oil import dependence will jump from the current 36 percent to 52 percent by 2030.

Over the outlook period, energy demand in the transport sector is projected to grow at an annual rate of 0.4 percent per year, compared with the previous two decades at 2.5 percent per year. Near term growth to 2010 is projected to be faster at 1.1 percent, slowing down to 0.2 percent between 2010 and 2020. Due to the decline in population, transport energy demand is expected to reach its peak sometime in 2025 and decline thereafter by an annual rate of 0.1 percent to the end of outlook period. Energy demand for road transport is projected to increase by an annual rate of 0.2 percent, maintaining the largest share at around 78 percent of the total transport energy demand. Gasoline for passenger vehicles is expected to increase by 0.5 percent per year, compared with that of 2.6 percent in the previous two decades.

Korea's transport energy consumption on the other hand dominated by the road transport sub-sector, representing more than three quarters of the economy's total transport energy consumption in 2002 (APEC 2006). Over the past two decades, income growth, improvements in living standards, expansion of residential suburbs and development of vehicle manufacturing industries have all contributed to a thirty-fold increase in the stock of vehicles, which have in turn resulted in a ten-fold increase in gasoline and diesel consumption. Managing road transport congestion, and air pollution caused by passenger vehicles and freight trucks continues to be a significant challenge for the economy.

Over the outlook period, the road sub-sector is projected to dominate energy demand, accounting for about three quarters of total transport energy demand. Demand for diesel is projected to grow robustly, at an annual rate of 2.4 percent due to the continued popularity of SUVs and increased trade as a result of economic development. By contrast, gasoline demand is projected to grow at a slower rate of 1.7 percent per year through 2030 (APEC 2006).

2.4 HARMFUL EFFECTS OF CO_2 EMISSION

Earlier research (Kelly, 2007) demonstrated that transport contributes about 15 per cent of global carbon dioxide (CO_2) emissions and 23 per cent (by source) of UK domestic CO_2 emissions. In his discussion paper issue in IEE bi-monthly Magazine Kemp (2004), show that the greatest contribution of greenhouse gases is attributable to petrol-fuelled cars (55%) and the second greatest to diesel vehicles (23%). In it effects, Gambarelli (2002) has written and demonstrated that the increase in concentrations of CO_2 and other gases (mainly CH_4 and N_2O) in the atmosphere causes the so called greenhouse effect,

i.e. an increase in the global temperature. Likely consequences of this warming include such things as biodiversity losses, effects on agriculture, a rise in sea level, etc. The exact extent of temperature increase due to urban emissions of such gases and its impact on regional and local meteorological conditions, as well as the resulting economic and social impacts are uncertain.

As suggested by Kelly (2007) urgent action to tackle transport emissions of CO_2 and other greenhouse gases is necessary and we are committed to doing so in a deliverable, measurable, and cost-effective manner. This is studies done by Gambarelli (2002) of the monetised value of damage done from global warming are now quite extensive. Two forms of estimate have been produced in the literature:

- estimates of actual damage arising at the point in time when $2xCO_2$ occurs (i.e. a doubling of pre industrial atmospheric concentrations of CO_2) and arising from a small increase in emissions now;
- a "shadow price" defined as the level of tax required to keep emissions on an optimal trajectory as estimated by the modeller.

2.4.1TARGETS FOR CO_2 CONCENTRATION

Nonetheless, from his research Kemp (2004) states that, there are different view about what represents a sustainable limit for CO_2. The European Commission and the Royal Commission on Environmental Pollution both suggest 550 ppm. The IPCC have calculated that this would result in a temperature change greater than 2.0°C which the Stockholm Environment Institute describes as a high risk situation that would "elicit

rapid, unpredictable, and non-linear responses that could lead to extensive damage". The Global Commons Institute (GCI) suggests a lower target of 450 ppm.

2.5 CONCLUSION

Urban transport efficiency is the key factor which determines the capacity of urban transportation systems and the balance between transportation demand and supply. Among the factors influencing urban transportation efficiency, the effects of urban land-use pattern and transportation structure are chronic and long term, while those of urban transportation infrastructure and traffic management systems are obvious and short term. This has resulted that the evaluation of urban transport efficiency may involve many indices, many of which are highly uncertain or complex and these can be analyse through establishing the hierarchical evaluation framework and adopting fuzzy evaluation method.

CHAPTER THREE

RESEARCH METHODOLOGY AND PROFILE OF THE ACCRA METROPOLITAN ASSEMBLY

3.0 INTRODUCTION

This section seeks to detail the methods used in data collection, the target population, sampling technique, data analysis and the study area. This research used case study strategy to assess the impact of efficient logistics on urban transport energy demand in Accra Metropolis. The use of case study strategy permits a detailed and in-depth examination that is not possible in a wide cross sectional study. Both primary and secondary sources data was used in this research.

3.1 SAMPLING TECHNIQUE

In social science research, purposive Critical Case Study is one of non-probability sample which is most frequently used technique for data gathering. Purposive sampling technique was used to narrow down the urban areas to Accra Metropolitan area. This form of sample was used on the basis that they can make a point dramatically. The focus of data collection is to understand what is happening in each critical case so that logical generalisations can be made for all urban areas in the country- Ghana (Saunders et al. 2007).

3.2 DATA COLLECTION

There were various data collection technique which was used in combination, primary and secondary data were collected and used; they include interviews, observation, documentary analysis and questionnaires.

3.2.1 PRIMARY DATA COLLECTION

Primary data was obtained using questionnaires, personal observations, formal and informal interviews with management in some of the institutions and the drivers. Questionnaires were more objective and certainly because the responses were gathered in a standardized way. In order to gain a deeper understanding of the system, interviews were conducted; semi-structured interviews were used with the drivers (Appendix 2), to be more flexible during the interview (Bryman, 2004 cited in cinquina, 2008)). In semi-structured interviews, the interviewer asked a series of questions so as to cover specific topics, but the order may not have followed the pre-established questions, for instance if the interviewer wants to focus more on some answers of the interviewee. Combinations of closed and open-ended questions were used, sometimes probing for a more complete answer or better explanation of the question.

3.2.2. SECONDARY DATA COLLECTION

Secondary data which are related findings for other purposes were obtained from relevant sources such as Ghana Statistical Service, Urban Roads, and National Petroleum Authority etc. Also some of the secondary data were obtained from relevant published and unpublished reports written on urban transport systems and energy demand, and other related materials. They included data from some concerned organisations,

information from the internets, dailies, libraries and other institutions of interest. This provided relevant background information for the actual research study.

3.3 POPULATION AND SAMPLE SIZE

All drivers in Accra Metropolitan Area as well as officials of urban roads, National Petroleum Authority, Driver Vehicle License Authority and Ghana Statistical Service form the population of this study. A convenience sample method was adopted, interviewing only five hundred (500) drivers out of this population that were already working in the five principal arterial roads chosen for the study. The interviewed were those who have parked in the lorry terminals as it was not feasible to stop the users outside the terminals, because of time related issues (the users would not have stopped for a long time). Users from different route of the city were chosen, (on roads from Kwame Nkrumah Circle to Ofankor barrier, CBA, Medina, Spintex, and Malam Junction) so as to have different users of different route, different economical situations between the commercial and the private drivers.

Interviews were conducted always in an informal environment, at the drivers own relaxed times and sometimes boarding the vehicle to the propose destination; thus creating an even more informal atmosphere in order to reduce the possibilities of biased response (Powell et al., 1997 cited Lumes,2008)). The aim of these interviews was to assess whether efficient urban transport have any impact on energy demand.

Some institutions like Urban roads, National Petroleum Authority, Driver Vehicle License Authority and Ghana Statistical Service were also interviewed in order to provide

a better comprehensive study, and future implementation, always with semi-structured interviews (Appendix 2), which was used in order to highlight the interviewees' point of view, what they thought was more important to explain, leaving the researcher the possibility of asking new questions while important ideas were coming out from the answers

3.4 DATA PRESENTATION AND ANALYSIS

Given the nature of the issues that were to be investigated, it was decided that a combination of quantitative and qualitative methods were to be used in the analysis of this case study of which qualitative was used extensively. The data from this study were analysed, using Statistical Package for Social Scientist and adoption of some aspect of fuzzy set theory. This theory was adopted in order to reduce uncertainty. When using fuzzy evaluation methods, the key step is to build a set of evaluable objects. The outcome of the method depends on the absolute evaluation criteria, which could be obtained by referring to the corresponding optimal figures chosen from Accra city to be evaluated.

3.5. PROFILE OF THE STUDY LOCATION

Ghana is located on the West Coast of Africa, the country lays north of latitude 4 degrees north and is intersected by longitude 0 degrees, the Greenwich Meridian. Ghana is a former British Colony named the Gold Coast. Thus the official language of Ghana is

English, although there are several local languages of which seven are officially used on radio. The country covers an area of 238,477 square-kilometers (or 93,000 square-miles) and is about the size of the state of Oregon (Nuworsoo, 2006). Ghana's population estimate for 2007 by African Economic Outlook, (2008) is 23,478,000 people, of which forty percent (40%) live in urbanized areas

With regard to New Public Transit System for Accra Ghana, Nuworsoo (2006) states that, the Capital City of Ghana Accra is situated on the southern coast, along the Gulf of Guinea. It is a Primate City spread over an area of 1,390 square-kilometers, which is the equivalent of two times the land area of either Singapore or the City of San Francisco. Accra stretches along the Atlantic Coast and north into the interior. It was originally built around the port. Its architecture ranges from large and elegant 19th Century colonial buildings to skyscrapers and apartment blocks made of concrete, glass and steel in the 1970s.

The city of Accra has been Ghana's capital since 1877, and contains fine public buildings reflecting its transition from a 19th century suburb of Victoriaburg to the modern metropolis it is today. The Metropolitan area boasts 25% of the urban population in the country, 50% of the national vehicle fleet and a density of approximately 1150 persons per square-kilometer (or 11.5 persons per hectare). Automobile ownership is relatively low at 60 autos per 1000 population, which is equivalent to 1/9th the US rate in 1995, or the rate where Greece was in 1975 or where the United Kingdom was in 1955.

CHAPTER FOUR

RESULTS PRESENTATION, ANALYSIS AND DISCUSSION

4.0 INTRODUCTION

This chapter presents some analysis, results and discussions on impact of efficient logistics on urban transport energy demand. In all, two sets of data would be analyzed, one set from primary source and the other from secondary sources including response from interviews that were conducted in both settings.

4.1 RESULTS AND DISCUSSIONS FROM THE PRIMARY DATA

Five hundred questionnaires were administered and filled by the drivers commuting in the five major roads in Accra City -Circle to Ofankor, Circle to Malam Junction, Circle to Spintex Road, Circle to Medina and Circle to CBA who are the end users of the roads, with the help of the researcher who did the interpretations of the questionnaire for most of the drivers. The analysis was based on the response from the five hundred (500) drivers and some data collected from Ghana Statistical Service, National Petroleum Authority and Urban Roads- Accra Metro.

4.1.1 DRIVERS CONTRIBUTION TO EFFICIENT URBAN TRANSPORT

The results from figure 4.1, shows that 60 percent of the drivers have the low level education (i.e. MSLC and JHS) with 7.6 percent being illiterate. Such level of education well makes it very difficult for these drivers to undertake any refresher course to sharpen their skills just to minimise their contributions toward consumption of fuel by their vehicles. From the literature energy savings programme implemented through training

proved to be highly cost effective in achieving fuel savings of about 8 percent in the first year and subsequently have a significant reduction of maintenance cost almost halving the cost of accident (Jones and Collings, 1999).

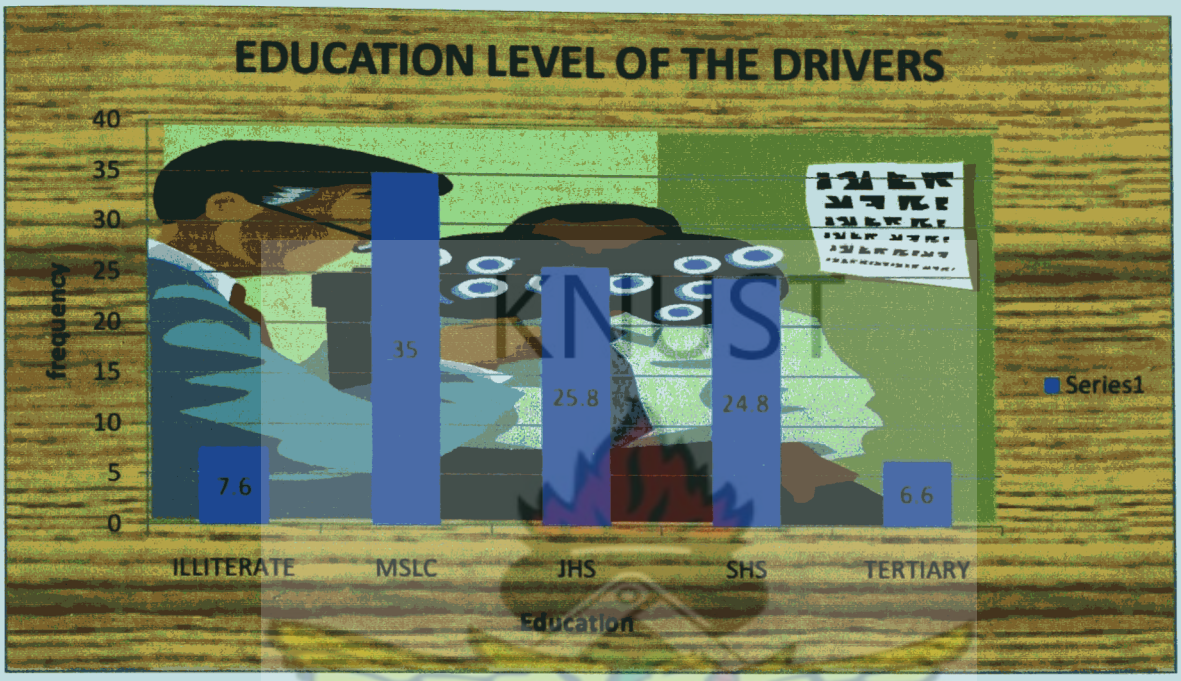

Figure 4.1 **Source: Field Survey (2009)**

Table 4.1 **ATTENDENCE OF REFRESHER COURSE(S)**

	Frequency	Percent	Valid Percent	Cumulative Percent
YES	32	6.4	6.4	6.4
NO	468	93.6	93.6	100.0
Total	500	100.0	100.0	

Source: field Survey 2009

From the above discussion it does not really surprise to record from (table 4.1) 93.6 percent 'No' meaning not participating in any refresher course. It is only 6.7 percent who

sometime undertake such courses all because of their level of education which make most of these drivers ignoring some of the best logistics practices in transport services.

4.1.2 CONTRIBUTIONS OF THE VEHICLES ON OUR ROADS

4.1.2.1THE AGE OF THE VEHICLES

To achieve efficient logistics on urban transport energy demand, the age of the vehicle play an important role as normally the older the vehicle the more it turn to consume fuel on mpg.

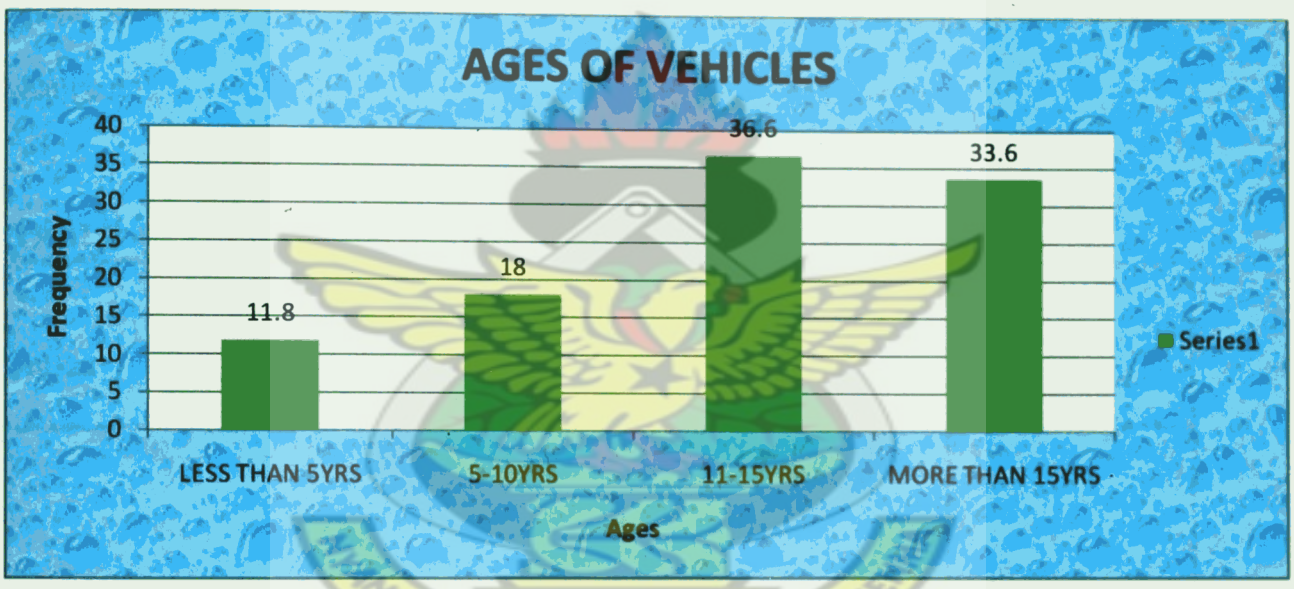

Figure 4.2 Source: Field Survey (2009)

The data from table 4.2 shows that 36.6 percent of the population samples of the vehicles were between ages 10-15 years whiles 33.6 percent were also above 15 years of age, all totaling about 70.2 percent of the vehicles that are Ten (10) years and above operating in Accra Metropolis. From the researcher observation and information gathered almost all the commercial vehicles and some of the private vehicles operating in Accra are imported

'used vehicles' brought in to the country by Ghanaian used car dealers. Majority of these vehicles might have been used for at least 8 years before being imported into the country.

4.1.2.2 PERIOD FOR SERVICING THE VEHICLE

The above situation turns to increase the rate at which most of these vehicles are services. But the response from the drivers (table 4.2) shows that 82.6 percent of the drivers always wait as and when there is a fault before they service their vehicles whiles eight percent (8) have a scheduled plan of servicing their vehicles every six months and as seven percent (7) treat the services as secondary issue. For example, if they want to change either their oil or sometime fixed new item in their vehicles, etc.

TABLE 4.2 PERIOD FOR SERVICING THE VEHICLE

Period	Frequency	Percent	Valid Percent	Cumulative Percent
ONCE EVERY 3 MONTHS	4	0.8	0.8	0.8
ONCE EVERY SIX MOTHS	40	8.0	8.0	8.8
ONCE EVERY YEAR	14	2.8	2.8	11.6
AS AND WHEN A FAULT OCCURS	407	81.4	81.4	93.0
OTHERS	35	7.0	7.0	100.0
Total	500	100.0	100.0	

Source: Field Survey (2009)

As greater number of drivers service their vehicles as and when is faulty. This brings a lot of inefficiencies in the vehicle operation. As it increases the one time service cost,

reducing the vehicle output and can make the whole vehicle break-down. The percentage response of drivers both private and commercial who has a scheduled plan is only about 9 percent.

Table 4.3 PLACE OF SERVICING THE VEHICLE

	Frequency	Percent	Valid Percent	Cumulative Percent
RECOGNISED INSTITUTION	52	10.4	10.4	10.4
INDIVIDUAL SPECIALISTS	413	82.6	82.6	93.0
SELF SERVICING	32	6.4	6.4	99.4
OTHERS	3	0.6	0.6	100.0
Total	500	100.0	100.0	

Source: Field Survey (2009)

With the sample of population who has a scheduled plan for servicing their vehicles about 10.4 percent used recognized institution like Japan Motor, mechanical Lyold, Toyota Company etc whiles 82.6 make used of individual specialist in places like Kokompe, Abosseokai and the likes (table 4.3). This sometimes account for inefficiencies in the transport system because most of these individual specialist normally do 'try and error' and sometime they could compound the problem. But most of the drivers prefer using them due to their low charges than to use the recognized institution for accurate services.

Notwithstanding these issues, some go to the extent of buying second hand tyres, that is 72.8 percent with a few of 27.2 percent who sometimes buy the brand new tyres (see

Appendix 6) which all account for so many transport logistics problems as well as not changing their engine oil according to manufactures scheduled. From the table (4.4) 70.8 percent changed the oil every one month whiles 10 percent and 19.2 percent changed them two (2) months and three (3) months respectively.

Table 4.4 RATE AT WHICH ENGINE OIL IS CHANGE

	Frequency	Percent	Valid Percent	Cumulative Percent
1 MONTH	354	70.8	70.8	70.8
2 MONTHS	50	10.0	10.0	80.8
3 MONTHS	96	19.2	19.2	100.0
Total	500	100.0	100.0	

Source: Field Survey (2009)

4.2 RESULTS AND DISCUSSIONS FROM THE SECONDARY DATA

4.2.1 URBAN TRANSPORT STRUCTURE

The result from table 4.5 gives comparable values for most of the vehicles types (2003-2005). It is interesting to note that the cars (which consist of PMV up to 2000CC, CMV up to 2000CC, PMV above 2000CC, and CMV above 2000CC) categories constitute about 95.1 percent whereas the buses and coaches which are able to pick an average of six times the number of passengers for the cars constitute only 3.7 percent (Figure 4.1) resulting to huge traffic congestion on our roads which end up with high energy (fuel) demand. The rate of increase of the cars is not directly proportional to the land use pattern in Accra Metropolis and this will confirm Yuan and Lu (2001) accession that it is

the main reason for traffic congestion and low transportation efficiency in Accra Metropolis. Urban congestion is set to get worse under current trends for growth in traffic.

Table 4.5 SUMMARY OF ROADWORTHY VEHICLES IN ACCRA

YRS.	MOTOR CYCLE A	PMV UP TO 2000CC 1	CMV UP TO 2000CC 2	PMV ABOVE 2000CC 3	CMV UBOVE 2000CC 4	TOTAL SHARE OF CARS B(1+2+3+4)	P/BUS AND COACHES	C/BUS AND COACHES	TOTAL SHARE OF BUSES C	TOTAL A+B+C
2003	2 063	78 654	39 154	25 806	17 570	161 184	262	6 030	6 292	**169 539**
2004	5 700	75 362	34 990	26 927	13 980	151 259	263	4 759	5 022	**161 981**
2005	2 485	85 497	37 072	28 689	12 496	163 754	335	4 993	5 328	**171 567**
TOTAL	**10 248**	**239 513**	111 216	**81 422**	**44 046**	**476 197**	**860**	**15 782**	**16 642**	**503 087**

SOURCE: (MODIFIED FROM GHANA STATISTICAL SERVICE, 2009)

a. Motor cycle = Motor Cycles Of All Categories

b. PMV up 2000cc = Private Motor Vehicles Up To 2000 Cubic Capacity

c. CMV up to 2000cc = Commercial Motor Vehicles Up To 2000 Cubic Capacity

d. PMV above 2000cc = Private Motor Vehicle Above 2000 Cubic Capacity

e. CMV above 2000cc = Commercial Motor Vehicle Above 2000 Cubic Capacity

f. P/bus and coaches = Private Buses And Coaches

g. C/bus and coaches = Commercial Buses And Coaches

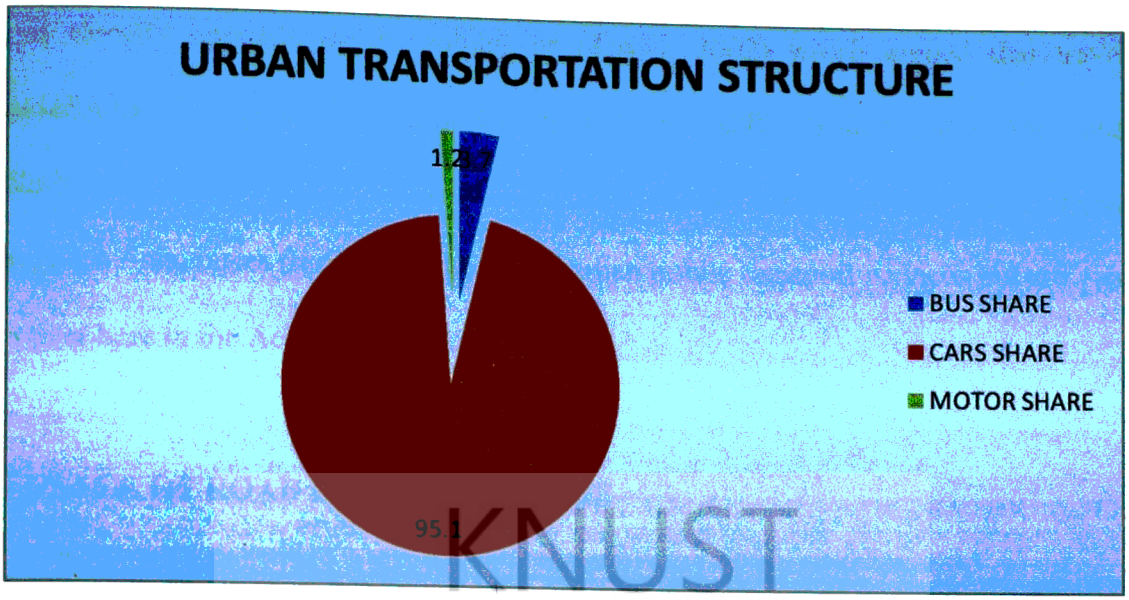

Figure 4.3 Source: Field Survey (2009)

Public transport buses and train services have declined in the face of increasing use of cars, reducing the mobility of disadvantaged groups and the use of more fuel by the cars.

The reasons that accounts for this is what Nuworsoo (2006) states in his work on New Transit Public System for Accra that, large municipal buses have been unable to compete effectively for trips to the CBA of Accra due to high levels of delay and inability to maintain any semblance of a regular schedule. Thus the traffic stream comprises of multitudes of "jitney" type public transportation vehicles intermingled with private automobiles, trucks and taxis. The lack of pullouts or designated stopping points for jitneys results in numerous interruptions to flow even within non-conflicting streams of traffic.

This is directly opposite the foundlings of (Tiwiri, 2002) which argued that travel characteristics of large cities in high-income countries differ from those in low- and middle-income countries in the use of mass rapid transit and commuter rail systems. Throughout Asia, buses form the backbone of urban public transport services but are vice versa over here in the Accra Metropolis.

4.2.2 USAGE OF ROAD INFRASTRUCTURE

Table 4.6 LENGTHS AND NATURE OF ROAD SURFACE

	Paved Roads		Unpaved Roads		Total
	Fig	%	Fig	%	
Accra	775 km	54	658.37 km	46	1433.37 km
Country	1935.10 km	47.6	2128.85 km	52.4	4062 km

Source: Department of Urban Road, 2002

There are about 775 km of paved roads and 658.37 km unpaved roads (Table 4.6) and 75 km of the paved roads are the main arterial whilst the rest are minor arterial, collectors and local roads. These have being estimated to be 300 – 400kms of formed road not yet engineered or constructed. Some of the latter form vital missing links in the arterial network.

With the relationship between the amount of motor vehicles and the total length of roads, the researcher estimated the ratio of the amount of motor vehicles to the total length of roads. Because this figure obtained using the total amount of motor vehicles, can't exactly show the road occupation of vehicles, 10% was assumed to be the motor vehicles

left in parking lots each day. According to the fuzzy theory, this study assumed 180 unit/Km as the highest limitation of the below ratios and uses it to evaluate the usage of road infrastructure. If the value of the ratio is higher than 180 unit/Km, It means more traffic congestion will occur in the Metro road systems and as such it will call high energy demand which will not order well for our economy.

Table 4.7 ROAD OCCUPANCY OF VEHICLES

YEARS	NUMBER OF REGISTERED VEHICLES	PASSENGER CAR UNIT PER KILOMETER
1997	108435	126
1998	135497	158
1999	135753	158
2000	160742	186
2001	172552	201
2002	176652	205
2003	180710	210
2004	181541	211
2005	186698	217
2006	228396	266
2007	229782	266

Source: field Survey 2009

Considering the usage of roads that, table 4.7 and figure 4.4 show the eleven year (1997-2007) period ratio of "the number of motor vehicles over total length of roads" in Accra Metropolis. Numbers(1-11) in figure 4.4, represent the years 1997-2007 whiles the

vertical axis depicts the length of road, which most of them(2000-2007) the vehicles on were much higher than 180 unit/Km, the bench mark adopted from the fuzzy theory. This confirms the severe traffic congestion on the roads of Accra Metropolis. The reason being that, the growth of motor vehicles is not strictly controlled in Accra Metropolis and for that matter Ghana as a whole.

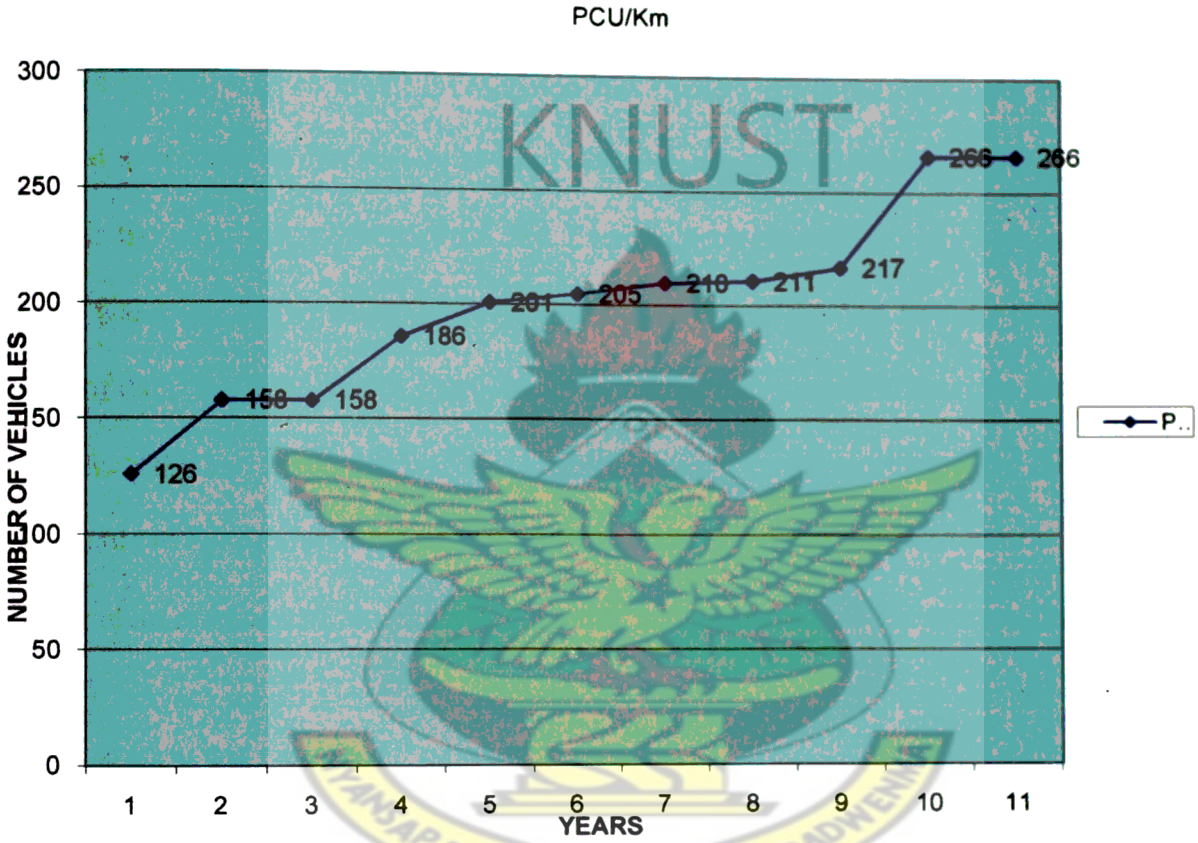

Figure 4.4 ROAD OCCUPANCY OF VEHICLES Source: Field Survey

Though each day there are more vehicles which are not driven on roads in the Metropolis, the load on roads in the city is still very high as portray by the figure 4.4. Therefore if nothing is done to these trends of increase in passenger car unit per kilometre, then there is going to be a sever traffic congestion on our roads which will lead to high fuel consumption not as expansion of our economy but inefficiency in the transport sector.

According to classification of Department of Urban Road forty- five percent (45%) of Accra roads are in poor condition. This figure is higher than the national average of forty-three percent (43%). The primary road network in Accra radiates out from the Kwame Nkrumah Circle (Accra Central, Ofanko barrier, Medina, Spintex road, Malam Junction Road corridor). It is estimated that about eighty percent (80%) of vehicular traffic has this road corridor as their destination. Traffic during peak hours, when the network is the heaviest loaded, was carefully investigated and studied. Evening peak hour traffic was selected according to the counts at the cordon stations. Period (with morning) 6:30 – 10:00 is the most loaded time of the day. Evening peck hour (EPH) in Accra metropolis matrix was extracted by using the count distribution during the day. In order to get a large range of data, the EPH matrix was birth up by taking into account trip origin destinations between 16:00 and 20:00 and which is slightly longer than the morning trips. Indeed, it is reasonable to consider that production and attraction in the evening peak hour which have similar characteristics of respectively attraction and production of the morning peak hour.

4.2.3 URBAN TRANSPORT SERVICE LEVEL

Analysis of travel speed survey for the purposes of calibrating the traffic model and traffic management aspects, floating vehicle journey-time surveys were conducted in major road links. Results for the average morning and evening peak hours are schematiced in table (4.8) and detailed analyses of travel times for all road links are summarised as follows.

The Table (4.8) depicts the distances of the five principal arterial roads under study and the congestion costs which is the difference between real transport times and transport

times, which would be possible without any congestion, at a very low traffic. The main difficulty involved in the valuation of these costs is that there exists a large spectrum of values of time, according to the personal characteristic of the user and the purpose of the travel. But whichever way is being assess the cost is the time lost due to congestion per passenger-kilometer and it shows additional use of fuel which is also additional cost of operation to the user and the nation as a whole through it imports.

In additional impacts of these congestion on motorized travel, including the delay and the travel foregone, which are usually ignored, although they are often significant compared with costs that are considered, particularly in urban areas ("Barrier Effects," Litman, 2005a cited in Tiwari, 2007). They represent a horizontal inequity (motorists impose far more delay and risk on nonmotorized travelers than nonmotorized travelers impose on motorists), and to the degree that people who are transportation disadvantaged drive less and rely more on nonmotorized modes, this represents a vertical inequity. With the average speed level that the researcher observed from private vehicles on all the five principal arterial roads from the Kwame Nkrumah Circle was, with no traffic congestion, every one(1) minute they can cover an average of 3km and with traffic condition every Seven(7) minutes they can cover an average travel distance of a Kilometer. The operational results are based on the worst of the averages of the peak traffic periods.

TABLE 4.8 COMPARISON OF URBAN TRANSPORTATION SERVICE LEVEL

ROADS	DISTANCE FROM NKRUMAH CIRCLE (KM)	AVERGE TRAVEL TIME WITHOUT TRAFFIC (MINUTES)	AVERAGE TRAVEL TIME WITH TRAFFIC (MINUTES)	CONGESTION COST
CBA	3.4	30	70	40
SPINTEX ROAD	16.4	45	105	60
MADINA	13.0	60	180	120
OFANKOR BARRIER	7.7	20	55	35
MALAM JUNCTION	8.7	75	148	73

Source: Modified from Urban Road-Accra (2009)

4.2.3.1 CHARACTERISTICS OF THE VARIOUS PRINCIPAL ARTERIAL ROADS UNDER STUDY

Ofankor Road is very busy road with most sections experiencing serious congestion for most part of the day. The congestion can be partly attributed to the intersection control at the intersections along the route and inadequate link capacity. Moreover, the Achimota lorry terminal abutting the road also adds to the congestion. Achimota market is situated very close to the road encouraging a lot of abuses at that section of the road. Heavy Vehicles Park by the roadside to off load foodstuffs, while shoppers also park on the shoulder/sidewalk, thereby obstructing the free flow traffic which at the end compels other users of the road to use more fuel to cover less distance. This is contrary to the Litman, (2007) accession in the literature, that congestion impacts that motor vehicles

impose on other road users is horizontally inequitable to the degree that High-Occupant Vehicle (carpools, vanpools and buses) passengers are delayed by congestion, although they use less road space and so impose less delay on others per passenger-mile.

Central Business Area is another principal arterial road from Kwame Nkrumah Circle through to UTC (Mokola). The road is mostly single carriageway with only 10 percent being 2-lane dual carriageway UTC area and it is paved throughout its entire length. It is very busy road, which is congested throughout the day. This is due to commercial, social and institutional facilities abutting the road, which attract a lot of traffic. It is common to see vehicular queues moving at snail pace during most times of the day. There is heavy pedestrian activity due to commercial activities along the route which is also contributed to waste of fuel.

On Medina Road which is a principal arterial, covering an urban (study) length of about 13km from Nkrumah circle with 70 percent being dual carriageway and is paved throughout its entire length. But now the remaining 30 percent is under construction for 4-lane dual carriageway that is from Medina to Tetteh Quashie roundabout. All is to easy traffic and for that matter to save substantial amount of fuel that is wasted as a result of traffic congestion.

Spintex road is about 16km from Kwame Nkrumah circle. The roads are paved for the entire length and comprise both single and two-lane dual carriageway. It is a very busy road, congested throughout the day with it peak being morning and the evening in the

week days. It is common to see vehicular queues moving at snail pace during morning and the evening.

4.2.4 THE KINDS OF FUEL USE BY URBAN TRANSPORT

The figure 4.2 demonstrates the number of vehicles and the kind of fuel they use in Accra Metropolis. From the figure 4.2, 500 vehicles that were sample 22.2 percent uses premium whiles 13.2 percent uses LPG with the remaining 64.6 all using diesel, which also confirm the proportional trend of national consumption rate (table 4.13.0), that is diesel is the highest consumption fuel of the petroleum products followed by premium and LPG in Accra.

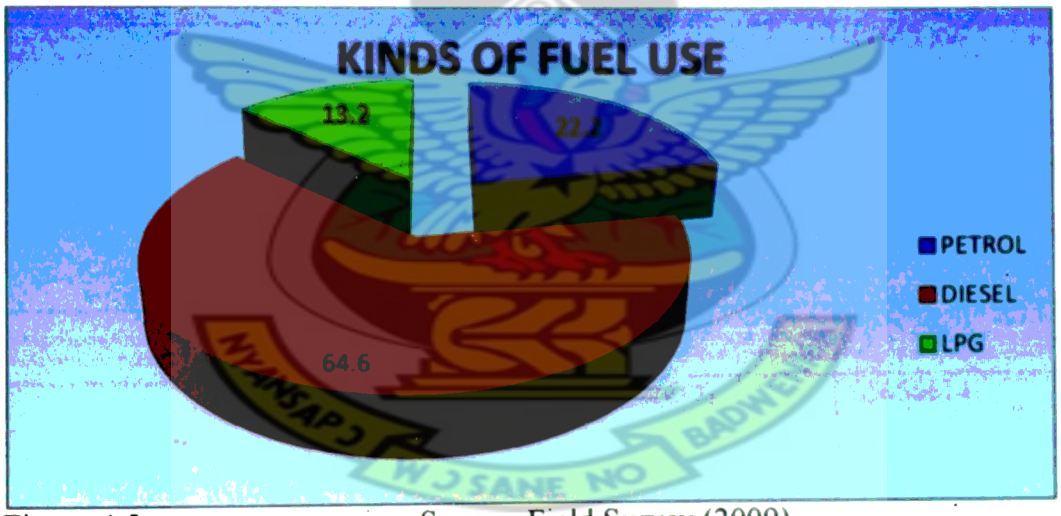

Figure 4.5 Source: Field Survey (2009)

Figure 4.5 shows transport energy consumption per capita against urban density with data derived from the National Petroleum Authority Database (2009). With the average population density of 69.3 percent (AMA, 2008) one was expecting to see less consumption rate of the fuel but is the other way round. The graph indicates a negative relationship between transport fuel consumption and urban density. Such a relationship is

supported by intuitive logic: In denser cities travel distances are shorter, the share of walking and cycling trips is larger and a compact public transport network that provides an alternative to car usage can be more easily sustained. Evidence from the literature is also consistent with this negative relationship concerning transport fuel use, and population density, he concluded that the concentrated nucleated settlement in which all population from the hinterland of the city is relocated in the central urban area is the most fuel efficient(Hickman and Banister, 2007).

4.2.4.1 NATIONAL PETROLEUM CONSUMPTION AND IMPORT

Table 4.9 COMPARISM OF NATIONAL PETROLEUM CONSUMPTION

YEARS	DIESEL	PREMIUM	LPG
1999	821106489	605810210	43502800
2000	790695840	707879250	44999648
2001	813926690	722377200	42519123
2002	852512318	769763190	49954999
2003	896957186	647761842	56707826
2004	908389400	777086900	65666614
2005	918033600	726024190	70460665
2006	921302668	691106350	87956676
2007	1131544950	734713850	93286000
2008	1073833237	688733170	117577231
TOTAL INCREASE FOR THE TEN YEARS	**252 726 748**	**82 922 960**	**74 074 431**

Source: National Petroleum Authority

Furthermore, the limited parking space in Accra Metropolis (see appendix i) could contribute to the results of this high rate of fuel consumption, as it always compel drivers to drive to far distances where they are assured of getting better parking place. Also the composition of the type of vehicles use contributes greatly to this high consumption rate of fuel. In that, there are too much over age and used vehicles (figure 4.2) in the system and as we know, the older the vehicle the more fuel it turns to consume. Also vehicles manufactured long ago does not have proper fuel efficient components like these modern vehicles (2000 models), which some are even a hybrid of both fuel and electricity and as such uses less fuel for their operations.

Another contributing factor to high consumption rate of fuel and fuel import is as a result of more use of cars within the city instead of sometimes substitute some of the trips by cycles and walking. From table 4.5, one will relies that, the patronage of cycles in Accra metropolis is very low compare to Northern Region of Ghana our sister city. Also walking is not part of our life as a way of exercising the body. With short distances we turn to move the car and that has result to high rate of fuel consumption and import which in the nutshell shows how inefficient use of transport and energy in our part of urban transport system. Furthermore, in denser city like Accra, one expect more compact public transport buses to exist that could provide an alternative for car trips to reduce the amount of fuel consumption by the transport sector due to large number of passenger it can take at a time and it's less fuel consumption.

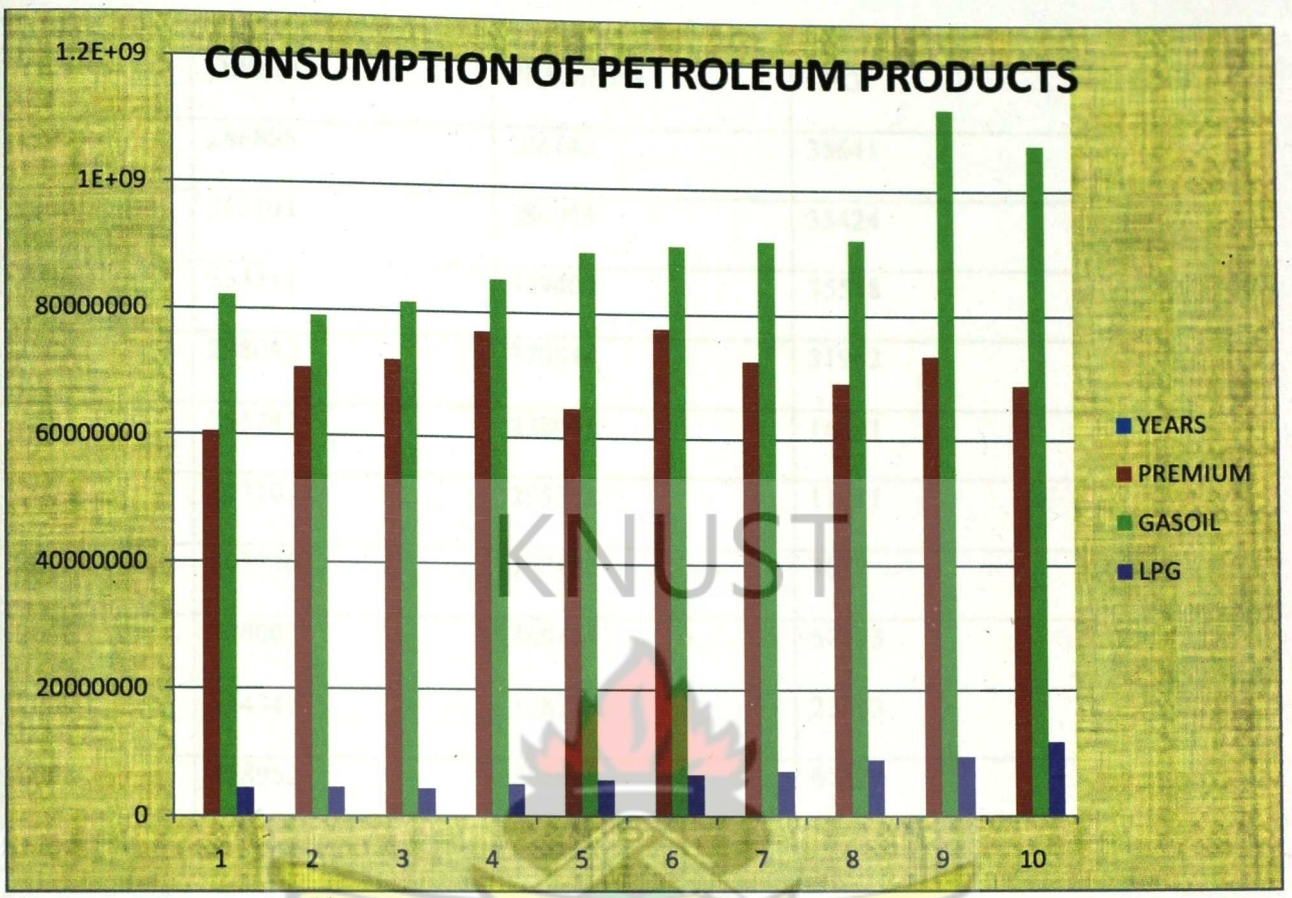

Figure 4.6 Source: National Petroleum Authority

But there is a few that is there (metro mass transit) and with these few it's not working within the city but to the outside the city such as to Tema, Kasoa,Ashiaman, Kpond and the likes. These high figures of petroleum consumption illustrate that transport has not substitute out of petroleum, in contrast to other sectors; combined with the test that petroleum is relatively highly taxed in transport, this suggests that technological substitution to other sources of energy is particularly difficult.

Table 4.10 COMPARISM OF NATIONAL PETROLEUM IMPORT

YEARS	DIESEL	PREMIUM	LPG
1999	286885	386142	35641
2000	363191	386995	35424
2001	354311	389400	35558
2002	298042	370844	31962
2003	285747	232051	16691
2004	313104	255361	11011
2005	403730	167482	7077
2006	780003	360464	67775
2007	434347	128778	23283
2008	578952	228088	67822

Source: National Petroleum Authority 2009

GLOBAL OIL DEMAND

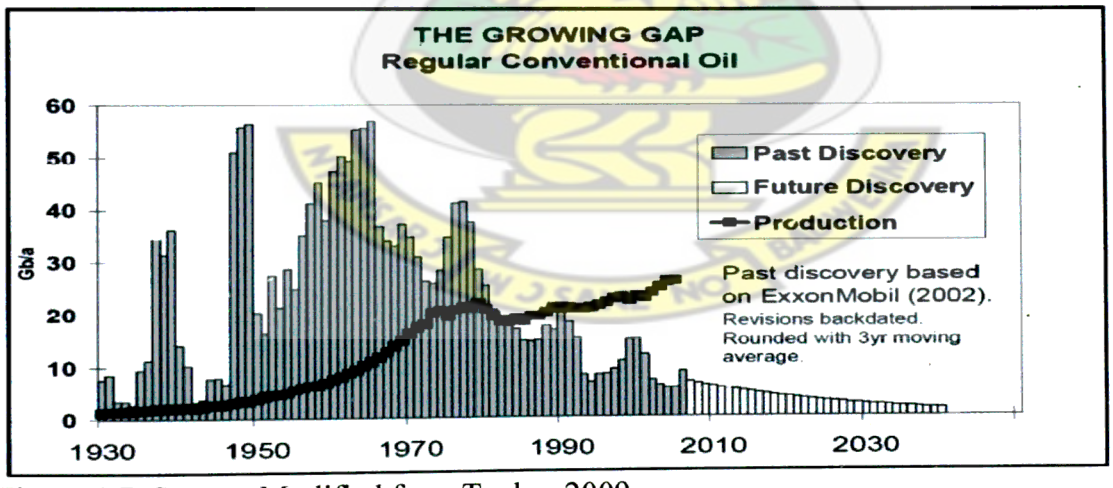

Figure 4.7 Source: Modified from Taylor, 2009

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 INTRODUCTION

This section of the study draws conclusion in the light of the findings and makes appropriate recommendations based on data and information gathered from the drivers in Accra Metropolis, Urban Roads, DVLA, National Petroleum Authority and Ghana Statistical Service, as well as empirical research carried out by logistics researchers and practitioners and also from a large base of accumulated scientific knowledge only accessible through a thorough review of relevant literature.

5.1 SUMMARY

In summary, it is significant to note that without well developed transportation systems, logistics could not bring its advantages into full play. Besides, a good transport system in logistics activities could provide better logistics efficiency, reduce operation cost, and promote service quality. The improvement of transportation systems needs the effort from both public and private sectors. A well-operated logistics system could increase both the competitiveness of the government and enterprises.

Non probability sampling methods were used with a convenient sample size of five hundred drivers from the five arterial principal roads sample from Accra Metropolitan Area and analysed using Statistical Package for Social Scientist and adoption of some aspect of fuzzy set theory.

From the above analysis it was established that, the absence of rail based transport system and inadequate city buses in Accra Metropolis has led to frequent use of cars lending to congestion in city roads. Public transport buses and train services have declined in the face of increasing use of cars, reducing the mobility of disadvantaged groups and causing extremely unpleasant traffic congestions leading to high energy demand.

The rapid increase in vehicular trips without corresponding increasing in road space is causing heavy congestion in many parts of the city. During the past 10 years (1997-2007), the length of road has not seen any significant increased, while the number of road worthy vehicle registrations increased by more than double. The imbalance in growth of road length and vehicle registration has resulted in serious traffic congestion. The effect of this is more consumption of fuel energy on our roads.

From the Table 4.7, road occupancy of vehicles shows that dwellers in Accra city would seek for greater use of cars for their mobility and greater share of the city energy demand come from transportation sector and how to manage passenger vehicle energy demand would become a critical element for the energy security and sustainable development.

There were various traffic studies being conducted on roads from Kwame Nkrumah Circle to Ofankor barrier, CBA, Medina, Spintex, and Malam Junction and the traffic volume survey reveals that traffic volumes are high in Medina and Spintex roads, because of the shops and offices. For CBA and Ofankor barrier roads, because of bulk trading activities during most part of the day and this concentration shifts itself to residential

areas like Malam Junction and Spintex during evening till 8 p.m. Direction wise analysis also explains that nearly 50% of the locations of the traffic volume is almost double the capacity. The core areas of the city going or coming in are characterized by insufficient with which do not permit smooth flow of traffic.

The immense cost of our present urban transport system is not only involves money for provision of roads, public transport and transport governance, but also involves expenses for each private vehicle owner, multiplied by the vehicle-owning population of the city due to the subsidies on our petroleum products flowing to vehicle owners by the government. This attracted huge sum of hardship on our economy due to the continuous rise of oil prices in the world market. It is found from the evaluation results that improper land-use pattern and transportation structure are the main factors restraining the improvement of urban transportation energy demand.

5.2 CONCLUSION

From the above discussions, impart of efficient logistics on urban transport energy demand is the key factor which determines the capacity of urban transportation systems and the balance between transportation demand and supply. The transportation input (i.e. construction of transportation facilities) cannot increase within a short period of time, but the demand of transportation is growing rapidly. Therefore to improve the efficiency of urban transportation systems is the best way to effectively utilize the existing inputs, enhance the capacity of the systems and relieve urban traffic congestion and for that matter high transport demand on energy.

From the above analysis it was established that, the absence of rail based transport system and inadequate city buses has led to frequent use of private cars leading to congestion in Accra city roads. Public transport buses and train services have declined in the face of increasing use of cars, reducing the mobility of disadvantaged groups and causing severe traffic congestions leading to high energy demand.

The rapid increase in vehicular trips without corresponding increasing in road space is causing heavy congestion in many parts of the city. During the past 10 years (1997-2007), the length of road has not seen any significant increased, while the number of passenger vehicle registrations increased by more than double. The imbalance in growth of road length and vehicle registration has resulted in serious traffic congestion. The effect of this is more consumption of fuel energy on our roads.

The road occupancy of vehicles shows that dwellers in Accra city would seek for greater use of vehicle for their mobility and greater share of the city energy demand come from transportation sector and how to manage passenger vehicle energy demand would become a critical element for the energy security and sustainable development.

As a result, we should not expect to see dramatic changes in modal shares or in the nature of transport system. Furthermore, this unresponsiveness suggests that it is costly to reduce energy use in transport, relative to other economic activities, and thus the efficient policies will probably not extract as much energy savings (in percentage terms) from transport as from other sectors. The effects of urban land-use pattern and transportation

structure and transport energy demand are chronic and long term, while those of urban transportation infrastructure urban transport services and traffic management systems are obvious and short term. This has resulted that the evaluation of impart of efficient logistics on urban transport energy demand may involve many indices, of which many are highly uncertain or complex.

The cost of oil dependency are essentially the total cost to a national economy (specifically that of Ghana) of various features of the world oil market that cause problem to a nation relying heavily on oil imports. There is a considerable scope to improve the fuel efficiency of vehicle fleets, not mainly through technological changes but also to some extend through consumer choices among the number of vehicle in system, vehicles size and types, maintenance culture and the use of right fuel. As a result, we should not expect to see dramatic changes in modal shares or in the nature of transport system. Furthermore, this unresponsiveness suggests that it is costly to reduce energy use in transport, relative to other economic activities, and thus the efficient policies will probably not extract as much energy savings (in percentage terms) from transport as from other sectors.

5.3 RECOMMENDATIONS

Based on the data analysis, results or findings and conclusions, the following recommendations were made:

5.3.1 Urban Roads Structure

The Accra Metropolitan Authority should embark on a mission to re-introduce an effective and dependable city bus service for mass transportation services. These bus services could be complemented by fast modern train services which will operate over distances up to about 80 miles from the city centre and along the existing radial road arteries. The metro mass transit company should consider operating separate urban/sub-urban metro routes in Accra Metropolis. It is anticipated that this will boost the patronage from the urban dwellers, which can result in the more efficient use of the limited road space. More people will then be moved instead of the use of commercial cars, as it is the current situation.

The following congestion-based strategies or measure are proposed:

- Assign the outer lane to public buses during the peak periods
- Buses should be regular and reliable. Proper bus schedules should be develop.
- Locate proper bus stops with sheds at favourable places to motivate people to use them

Stops should be properly defined, well constructed and bus stop signs installed at such places. Drivers should stop to drop off and pick passengers at designated bus stops. This would reduce the travel time and compel passengers to walk to the bus stops to board.

5.3.2 Technological development to

a. Improve efficiency

b. Alternative fuels

(i) Improve Efficiency

A hybrid car is a new technology of passenger cars, which is the most efficient used-energy vehicle in road transportation. It presents the significant reduction of the fuel consumption and the emissions comparing to the conventional vehicles in the similar sizes of the vehicle. Nowadays, the hybrid car is used in several advanced countries, such as in the United Stated, the European Union, and Japan, particularly in urban areas, in order to reduce the emissions. The government should make a policy that will support the manufactures as well as those who will buy such vehicles for use.

(ii) Alternative fuel

Over the next few decades, Ghana needs to diversify its sources of transport fuels, in order to reduce the high level of dependence on oil imports. Using alternative fuels in vehicles could also help to combat global warming and improve air quality in our cities. Therefore research must be start aiming at helping to promote cleaner vehicles and fuel.

In recent years, there has been promotion and implementation for the utilization of compressed natural gas (CNG) and biofuels in the road transport. The CNG can be used in spark ignition (SI) engine, gasoline engine, and compress ignition (CI) engine, diesel engine. The CNG equipments are installed in the SI engine called bi-fuel engine and installed in the CI engine called diesel dual fuel (DDF) engine. People have started

cultivating those plants and governments needs to make a national policy for it,s use and support of those farmers.

5.3.3 Urban traffic Management

It is a known fact that traffic is a function of land use. The implementation of a policy geared towards decongestion of the Central Business Area (CBA) through relocation of certain services which attract considerable traffic will be a step in the right direction

An individual or group who intend to operate an urban transport service in Accra must first procure a vehicle that satisfies the requirements of Government of Ghana Legislative Instruments 952 and 953 titled, .Road Traffic Regulations, 1974. Containing 47 and 96 sections respectively dealing in detail with issues like registration, licensing, construction and use of vehicle, and driver behaviour etc.

5.3.3 Urban Transport Services

The creation of a Metropolitan Transport Authority to establish modern transport facilities as well as superintend over existing ones, to help improve service delivery would be useful for the attainment of a vibrant, safe and comfortable city life in Accra.

5.3.5 Urban Road Infrastructure

- Regional and city Mayor need to oversee the location planning and co-ordination of interchanges. This will help to synchronies services through the interchanges and guide investment priorities for public transport.

- Intersection improvements signalize should be install to improve the capacity at the following intersections.
  - Legon police station-Medina main road
  - Alajor overhead- Ofankor main road
  - Dansoman Junction-Malam Junction main road
- Some over pass must be build in addition to the existing ones at some junction like Darkoman junction on Malam road, Achimota station on Ofankor road and UTC on CBA to easy human abstracting for vehicular flow.

- The inter-districts routes, connecting Accra Metro and passing through the city centre having with their terminals also in the city centre should be directed to other outskirts area, for commuters not necessary driving through the city centre thus operating in a concentric way, in order to reduce the congestion in the city.

5.3.6 Education conducive to changes in life style of the drivers

There should be a minimum education level of at least Senior High School Certificate before one is issued with a driving license. This will facilitate training programmes

design to improve traffic regulation, proper maintenance of vehicles and ideal energy saving methods.

5.3.7 Other useful measures

The importation of old used vehicles, tyres, engines must all be ban to drastically reduce our energy consumption and import which is the main drain of our national coffers.

There is no simple strategy that will dramatically reduce levels of urban congestion and for that matter high demand of energy in the short to medium term. Therefore there is strong interest in the use of policy to change patterns of land-use in the longer term, aimed at reducing the extent of vehicle movements and its importation. For instance, this may involve requiring major new commercial developments to include good public transport links.

The distinctiveness of this study has been brought to bear, as it was carried out in a developing country with data from a native sector and institutions in a developing country. There is no doubt in my mind that this study will whip up interest in the field of transport and encourage more research in this area under similar conditions, so that they will be of benefit to stakeholders and investors to know the benefits and challenges associated with logistics systems in developing countries.

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APPENDIX 1

KNUST SCHOOL OF BUSINESS

MASTER OF BUSINESS ADMINISTRATION

QUESTIONNAIRE

As part of the requirements for the award of MBA Degree, Logistics and Supply Chain Management at Kwame Nkrumah University of Science and Technology, the researcher is undertaking a research work to ascertain the **Impact of Efficient Logistics on Urban Transport Energy Demand.** This work is purely for academic purposes and the data collected and the results will not be used in any way to jeopardize the interest of your organisation. We guarantee your anonymity and complete confidentiality.

(DRIVERS WITHIN THE ACCRA METROPOLIS)

PART 1: Personal background data

1. What is your age?

☐ <=20 years ☐ 21–30 years ☐ 31–40 ☐ 41–50 ☐ >50

2. Your gender? ☐ Female ☐ Male

3. What is your level of education?
☐ MSLC ☐ JHS ☐ SHS ☐ Tertiary ☐ Illiterate

3. What category of car do you drive? (Please tick the appropriate box)

☐ Taxi ☐ 'Trotro' ☐ Private ☐ Bus
☐ other, please specify _____

4. Which of the following routes do you drive along?

- ☐ Circle to CBA
- ☐ Circle to Spintex
- ☐ Circle to Medina
- ☐ Circle to Malam Junction
- ☐ Circle to Ofankor

5. How long have you been driving along this
   ☐ <= 1 year ☐ 1 – 2 years ☐ 2 – 3 ☐ 3 – 4 ☐ > 4

PART 2: Energy efficiency through the vehicle

6. How old is the vehicle you are driving?
   ☐ < 5 years ☐ 5 – 10 years ☐ 10 – 15 years
   ☐ >15 years Other, please specify _____

7. What type of vehicle do you drive? ☐ Heavy duty ☐ Light duty

8. Was your vehicle bought as a ☐ brand new ☐ a second-hand?

9. What type of fuel do you use?
   ☐ Petrol ☐ Diesel ☐ Gas
   ☐ Other(s), please specify _____

10. What is the vehicle's fuel consumption rate? _____

11. What average amount of fuel does your car consume per day?
    ☐ < 1 gallon ☐ 1–3 gallons ☐ 3- 6 gallons ☐ 6–9 gallons
    ☐ Other(s), please specify _____

12. Do you use fuel additives for your engine? ☐ Yes ☐ No
    If yes, how frequent? _____

13. How often do you change the vehicle's engine oil?
☐ >2000 miles covered ☐ 2000 – 4000 ☐ > 4000
☐ Other, specify _____

14. What are the criteria for oil change?

☐ Too much friction

☐ Engine breakdown

☐ When oil is dirty

☐ When oil is exhausted

☐ When prompted

☐ Other(s), please specify_____

_____

15. What type of engine oil do you use?
☐ Extra ☐ Super ☐ Extra super

16. Which source do you buy your engine oil from?
☐ Certified oil companies ☐ Mechanic shops
☐ Individual sellers ☐ other(S), specify_____

17. What is the tank capacity of the vehicle?
☐ 1.6 litres ☐ 1.8 litres ☐ 2.0 litres ☐ 2.5 litres
☐ other, please specify _____

18. What kind of tyres do you normally buy?
☐ Brand new tyres ☐ Second-hand tyres ☐ Repaired tyres

19. What are the criteria for changing the vehicle tyres?
- ☐ When it bursts
- ☐ When prompted
- ☐ When there is a flat tyre
- ☐ When it loses its threads
- ☐ According to plan schedule
- ☐ Other(s), please specify _____

_____

20. Is your engine model the same as your car model? ☐ Yes ☐ No

21. Is your vehicle currently using the originally manufactured engine? ☐ Yes ☐ No If no, was the engine bought as a,
☐ Brand new model? ☐ Second-hand model? ☐ Locally manufactured model?

22. What is/are your peak traffic period(s)
☐ Morning ☐ Afternoon ☐ Evening

23. What average time does it take you to cover the distance (ticked in question 2) under no traffic condition?
☐ Morning _____
☐ Afternoon _____
☐ Evening _____

24. What average time does it take you to cover the distance (ticked in question 2) above under traffic condition?
☐ Morning _____
☐ Afternoon _____
☐ Evening _____

PART 3: Energy efficiency through the driver behavior

25. Have you attended any refresher course(s) in driving? ☐ Yes ☐ No
If yes, how many times? _____

26. Do you have a driver's license? ☐ Yes ☐ No

27. If yes, which category?
A ☐ B ☐ C ☐ D ☐ E ☐ F ☐

28. Under no traffic condition, what is your average speed level? _____

29. Where do you usually pick passengers?
☐ Only at a bus stop ☐ Anywhere along the road
☐ Within the traffic ☐ other (s), please specify? _____

30. To what extent do you follow road signs?
☐ Poor ☐ Good ☐ Very good ☐ Excellent

PART 4: Energy efficiency through maintenance culture

31. How often do you service your vehicle?
☐ Once every 3 months ☐ Once every 6 months
☐ Once every year ☐ As and when it breaks down
☐ Other(s), specify _____

32. Where do you service your vehicle?
☐ Recognized institutions ☐ Individual specialists
☐ Self servicing ☐ Others, please specify _____

33. What informs your decision to service the vehicle?
☐ When a fault is detected
☐ According to my maintenance plan schedule
☐ When there is a total breakdown
☐ Others, please specify _____

34. Do you usually have the entire vehicle serviced? ☐ Yes ☐ No
If no, which part(s) are your main focus?
☐ Engine ☐ Tyres ☐ Tank ☐ Body
☐ Others, please specify _____

PART 5: Energy efficiency through other factors

35. To what extent do these factors delay your distance coverage on this route?

1 – not important – 7 very important; N/A – don't know/not applicable

	1	2	3	4	5	6	7	N/A
Traffic congestion	☐	☐	☐	☐	☐	☐	☐	☐
Poor road network	☐	☐	☐	☐	☐	☐	☐	☐
Poor car condition	☐	☐	☐	☐	☐	☐	☐	☐
Road checkpoints	☐	☐	☐	☐	☐	☐	☐	☐
No. of traffic lights	☐	☐	☐	☐	☐	☐	☐	☐
Pedestrian obstruction	☐	☐	☐	☐	☐	☐	☐	☐
Trading obstruction	☐	☐	☐	☐	☐	☐	☐	☐
Picking of passengers along the road	☐	☐	☐	☐	☐	☐	☐	☐
Narrow traffic lanes	☐	☐	☐	☐	☐	☐	☐	☐
Reserved parking lots	☐	☐	☐	☐	☐	☐	☐	☐
Other(s), specify _____	☐	☐	☐	☐	☐	☐	☐	☐

36. In your own opinion, what do you suggest for the improvement of the transport system along the following areas:

Road _____

_____

Traffic management system _____

_____

Number of vehicles _____

_____

_____

_____

Fuel _____

_____

Other(S) _____

_____

_____

APPENDIX 2

KNUST SCHOOL OF BUSINESS

MASTER OF BUSINESS ADMINISTRATION

QUESTIONNAIRE

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(GHANA STATISTICAL SERVICE)

PART 1: Personal background data

1. Name of department _____

2. What does your department primarily focus on?

_____

PART 3: Registry

3. What is the total number of registered vehicles for the city in the following years?

Years	Private	Taxi	Trotro	Truck	Total
2008					
2007					
2006					
2005					
2004					
2003					
2002					
2001					
2000					
1999					

4. Are you limited to specific number of vehicles per period per area? ☐ Yes ☐ No
   If yes, what are the limits for each category for the city?

	Limited number per period
Private	_____
taxi	_____
trotro	_____
bus	_____
truck	_____
other, specify	_____

PART 3: Road worthiness

5. What criteria are used in the issuance and how are they important are they:

1 – not important – 7 very important; N/A – don't know/not applicable

		1	2	3	4	5	6	7	N/A
a.	_____	☐	☐	☐	☐	☐	☐	☐	☐
b.	_____	☐	☐	☐	☐	☐	☐	☐	☐
c.	_____	☐	☐	☐	☐	☐	☐	☐	☐
d.	_____	☐	☐	☐	☐	☐	☐	☐	☐
e.	_____	☐	☐	☐	☐	☐	☐	☐	☐
f.	_____	☐	☐	☐	☐	☐	☐	☐	☐
e.	_____	☐	☐	☐	☐	☐	☐	☐	☐

6. Your comment about the rate of vehicle importation, road worthiness and issuance of license

_____

_____

_____

_____

APPENDIX 3

KNUST SCHOOL OF BUSINESS

MASTER OF BUSINESS ADMINISTRATION

QUESTIONNAIRE

As part of the requirements for the award of MBA Degree, Logistics and Supply Chain Management at Kwame Nkrumah University of Science and Technology, the researcher is undertaking a research work to ascertain the **Impact of Efficient Logistics on Urban Transport Energy Demand.** This work is purely for academic purposes and the data collected and the results will not be used in any way to jeopardize the interest of your organisation. We guarantee your anonymity and complete confidentiality.

(DEPARTMENT OF URBAN-ROADS-GREATER ACCRA)

PART 1: Personal background data

1. Name of the organisation _____
2. What does your organisation primarily focus on? _____
   _____
   _____
   _____
3. For how long has this organisation been working in this field?
   [.] <=2 years [ ] 2-5 years [ ] 6-9 years [ ] =>10 years

PART 2: Efficiency of Transportation infrastructure

1. What is the distance /Km of the following road, from:
   a. Circle to Ofanko Barrier.....
   b. Circle to CBA (Mokora Market).....
   c. Circle to Madina.....
   d. Circle to Malam Junctiom.....
   e. Circle to Spintex.....

2. What is the average time coverage for the following distances under no traffic condition?

   a. Circle to Ofanko Barrier.....

   b. Circle to Mokora Market.....

   c. Circle to Madina.....

   d. Circle to Malam Junctiom.....

   e. Circle to Spintex.....

3. What is the average time coverage for the following distances under traffic condition?

   a.Circle to Ofankor Barrier.....

   b. Circle to CBA (Mokora Market).....

   c. Circle to Medina.....

   d. Circle to Malam Junctiom.....

   e. Circle to Spintex.....

4. What will be the state of these roads above, in the near future?

   a. Expansion.....

   b. Modification.....

   c. Other(s) specify.....

APPENDIX 4

KNUST SCHOOL OF BUSINESS

MASTER OF BUSINESS ADMINISTRATION

QUESTIONNAIRE

As part of the requirements for the award of MBA Degree, Logistics and Supply Chain Management at Kwame Nkrumah University of Science and Technology, the researcher is undertaking a research work to ascertain the **Impact of Efficient Logistics on Urban Transport Energy Demand.** This work is purely for academic purposes and the data collected and the results will not be used in any way to jeopardize the interest of your institution. We guarantee your anonymity and complete confidentiality.

(NATIONAL PETROLEUM AUTHORITY)

PART 1: Personal background data

1. Name of department _____

2. What does your department primarily focus on?

   _____

   _____

   _____

3. For how long has this department been working in this field?

   ☐ <=2 years ☐ 2-5 years ☐ 6-9 years ☐ =>10 years

PART 2: Trends in oil demand

4. What kinds of oil are imported into the country?

   ☐ Petrol ☐ Gas ☐ Diesel

   ☐ Other(s), please specify _____

5. How mauch oil was imported in the following years?

	Petrol	Gas	Diesel	Other(s)	Total
2008					
2007					
2006					
2005					
2004					
2003					
2002					
2001					
2000					
1999					

6. How much oil was distributed in the following years?

	Petrol	Gas	Diesel	Other(s)	Total
2008					
2007					
2006					
2005					
2004					
2003					
2002					
2001					
2000					
1999					

7. What percentage of oil was consumed by transport in the following years?

	Petrol	Gas	Diesel	Other(s)	Total
2008					
2007					
2006					
2005					
2004					
2003					
2002					
2001					
2000					
1999					

8. What amount of oil was supplied to the Greater Accra Region in the following years?

	Petrol	Gas	Diesel	Other(s)	Total
2008					
2007					
2006					
2005					
2004					
2003					
2002					
2001					
2000					
1999					

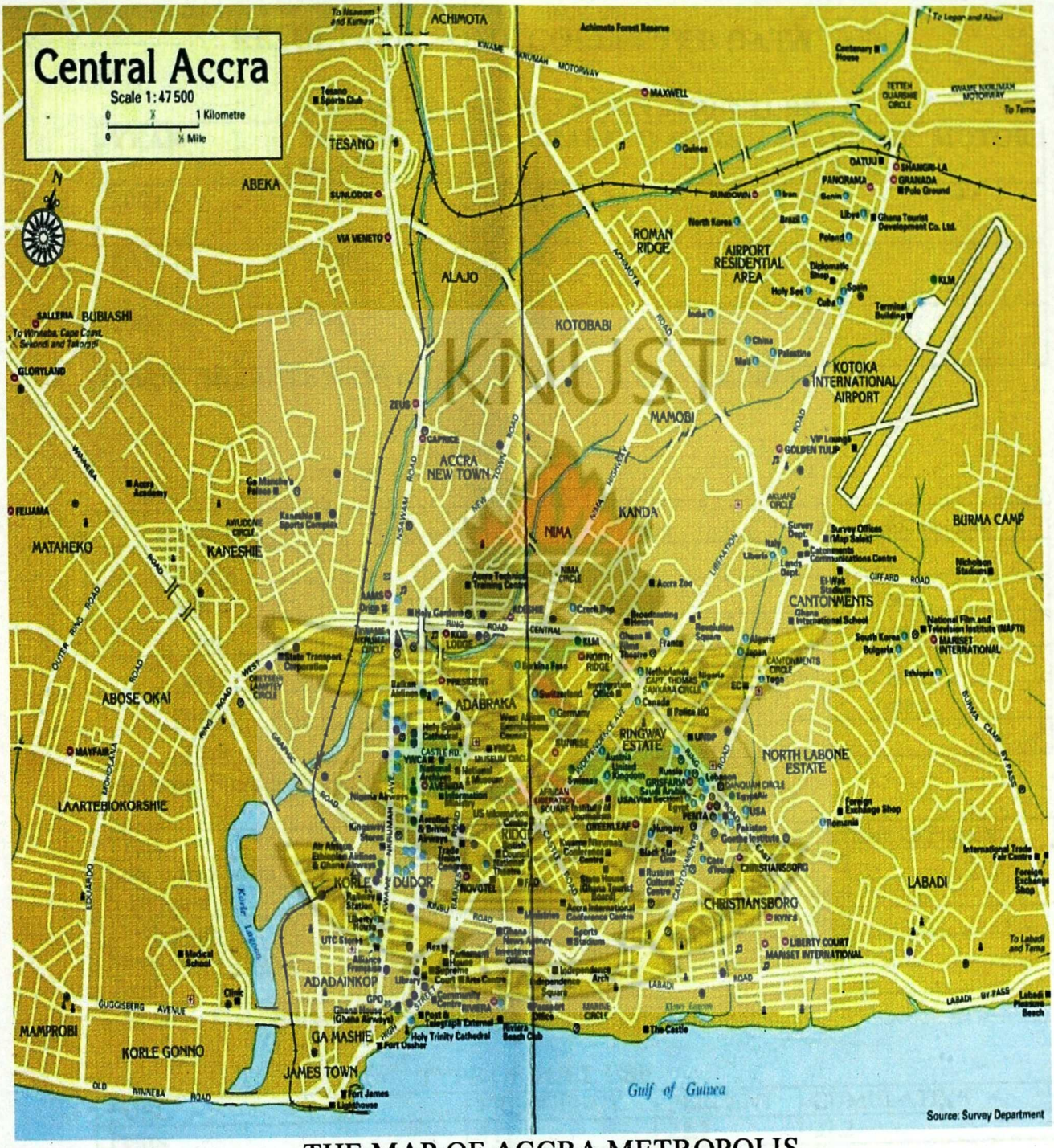
9. What has been the growth rate of oil import in the last ten years?

10. What has been the growth rate of oil consumption in the last ten years?

11. What has been the growth rate of oil price in the last ten years?

12. Comment on Ghana consumption rate of fuel

APPENDIX 5



THE MAP OF ACCRA METROPOLIS

APPENDIX 6

RESULTS OF SOME COLLECTED DATA

URBAN TRANSPORTATION STRUCTURE

YEAR	SHARE OF BUSES	SHARE OF CARS	SHARE OF MOTOR CYCLES
2003	3.7%	95.1%	1.2%
2004	3.1%	93.4%	3.5%
2005	3.1%	95.4%	1.5%

SOURCE: (MODIFIED FROM GHANA STATISTICAL SERVICE, 2009)

EDUCATION LEVEL

Education	Frequency	Percent	Cumulative Percent
Illiterate	39	35.0	35.0
MSLC	175	25.8	60.6
JHS	129	24.8	85.6
SHS	124	6.6	92.2
Tertiary	33	7.8	100.0
Total	500	100.0	

Source: Field Survey, 2009

AGE OF VEHICLES

Years	frequency	Percent	Cumulative Percent
Less than 5 years	98	19.2	19.2
5-10 years	126	25.2	44.4
11-15 years	159	31.8	76.2
More than 15 years	119	23.8	100
Total	500	100.0	

Source: Field Survey, 2009

TYPE OF FUEL USE

FUEL	FREQUENCY	PERCENT	CUMULATIVE
Petrol	111	22.2	22.2
Diesel	323	64.6	86.8
LPG	66	13.2	100
Total	500	100	

Source: Field Survey, 2009

THINGS THAT INFORMS SERVICE DECISION

	Frequency	Percent	Cumulative Percent
When a fault is detected	407	81.4	81.4
According to my maintenance plan schedule	58	11.6	93.0
Others	35	7.0	100.0
Total	500	100	

Source: Field Survey, 2009

TRAFFIC CONGESTION

	Frequency	Percent	Cumulative percent
Important	48	9.6	9.6
Very important	452	90.4	100.0
Total	500	100	

RESERVED PARKING LOTS

	Frequency	Percent	Cumulative Percent
Fairly Important	99	19.0	19.0
Important	201	40.0	60.0
Very Important	100	20.0	80.0
A/N	100	20.0	100.0
Total	500	100.0	

Source: Field Survey, 2009

PICKING OF PASSENGERS ALONG THE ROAD

	Frequency	Percent	Cumulative Percent
	99	19.8	19.8
Fairy important	250	50.0	69.8
Important	50	10.0	79.8
N/A	101	20.2	100.0
Total	500	100.0	

Source: Field Survey, 2009

PEDESTRIAN OBSTRUCTION

	Frequency	Percent	Cumulative Percent
Fairy important	100	20.0	20.0
Very Important	100	20.0	40.0
N/A	300	60.0	100.0
Total	500	100.0	

Source: Field Survey, 2009