

**THE POTENTIAL OF INCORPORATING LOCAL TRAVEL ROUTE
INFORMATION IN ADDRESSING SYSTEMS DEVELOPMENT TO
IMPROVE URBAN MOBILITY IN KUMASI, GHANA**

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BY

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DECLARATION

I hereby declare that, with the exception of literature duly acknowledged by means of referencing, this dissertation is the result of my own original research undertaken with the guidance of my supervisor and that this dissertation, neither in part nor in whole has been presented elsewhere for the award of another degree.

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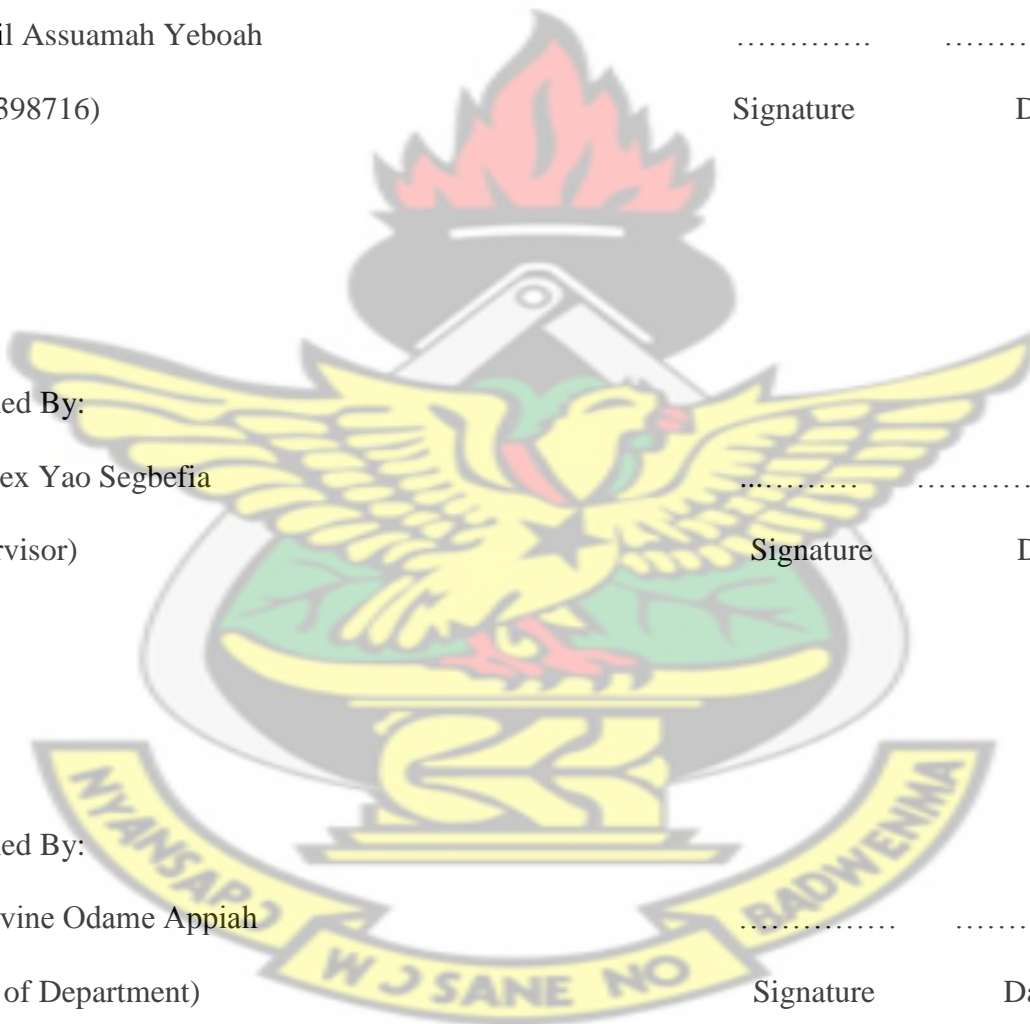
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ABSTRACT

Despite the vital roles of Street Addressing Systems (SAS) and Local Travel Route Information (LTRI) in urban mobility requirements, the scholarly consensus on knowledge, attitudes and practices about SAS and the relationship with urban mobility remains unclear. Like many other sub-Saharan African cities, SAS in Kumasi barely consider the utility of LTRI in bridging the formal and informal addressing gap. The current study therefore, investigates the possibility of incorporating local travel route information in addressing systems development to improve urban mobility in Kumasi. The theoretical perspectives draw on the knowledge-attitude-practice model. Using theoretical and multi-stage cluster cross-sectional survey data of informal transport operators and road users (N = 390), Chi-square tests and logistic regression models were employed in estimating the associations among study variables of interest. The study recorded low levels of knowledge about SAS and negative attitudes towards its use among the study cohort. The results of the study again revealed significant associations between respondents' knowledge and attitude, knowledge and practice and attitude and practice. The study showed that knowledge, attitude and education were significant predictors of street addressing systems' use for road navigation. However, no relationship was found between the availability of resources and access to services and use of SAS for meeting navigational needs. Using QGIS, a total of 120 stops (alighting points) were mapped along the selected trotto routes, converted to a shapefile, and overlaid on the study area map. The study concludes that, capitalising on GIS technology, LTRI could be successfully incorporated in SASs to increase accessibility and improve urban mobility in Kumasi. Recommendations are suggested to inform policy directions on addressing systems development, management and utilisation. The information derived from the outcome of the study is useful for future research and is currently being applied to create a digital travel aid (routing infrastructure) based on LRTI to guide local travel.

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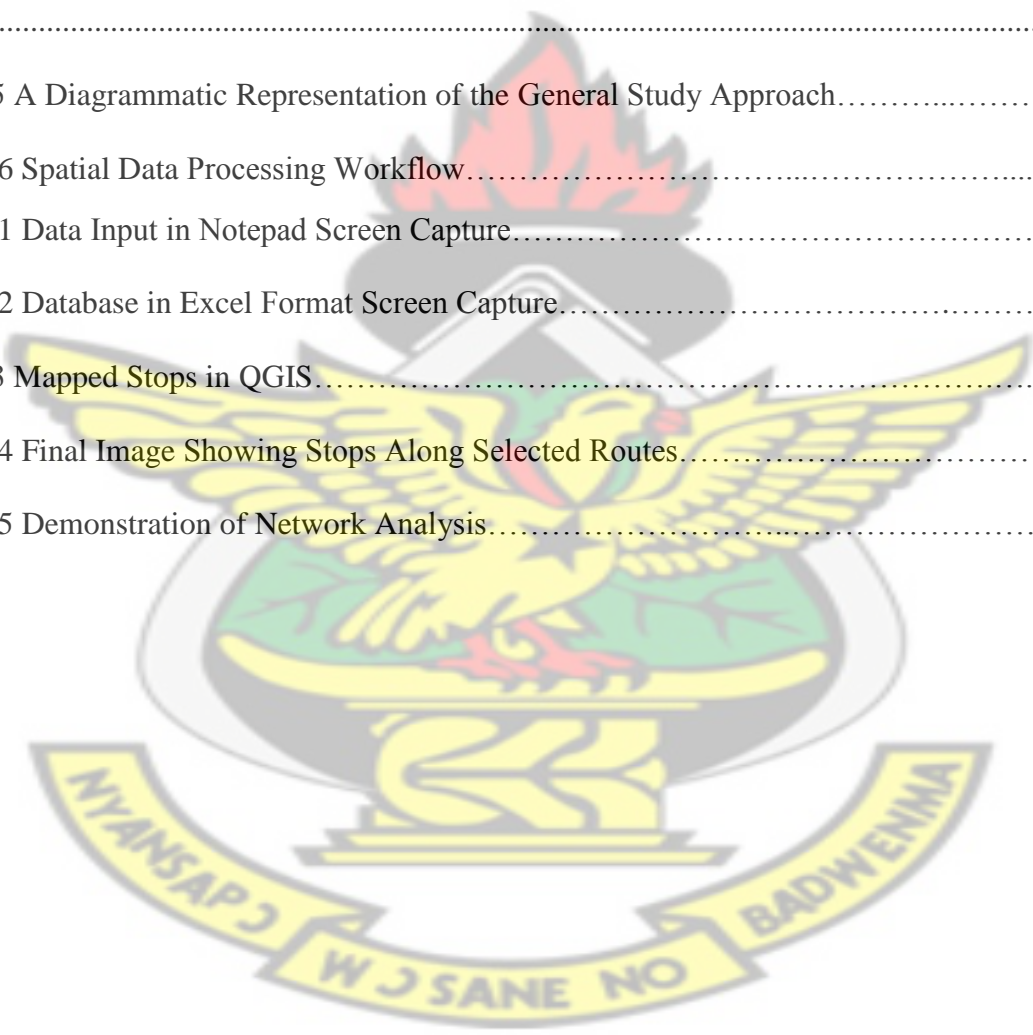
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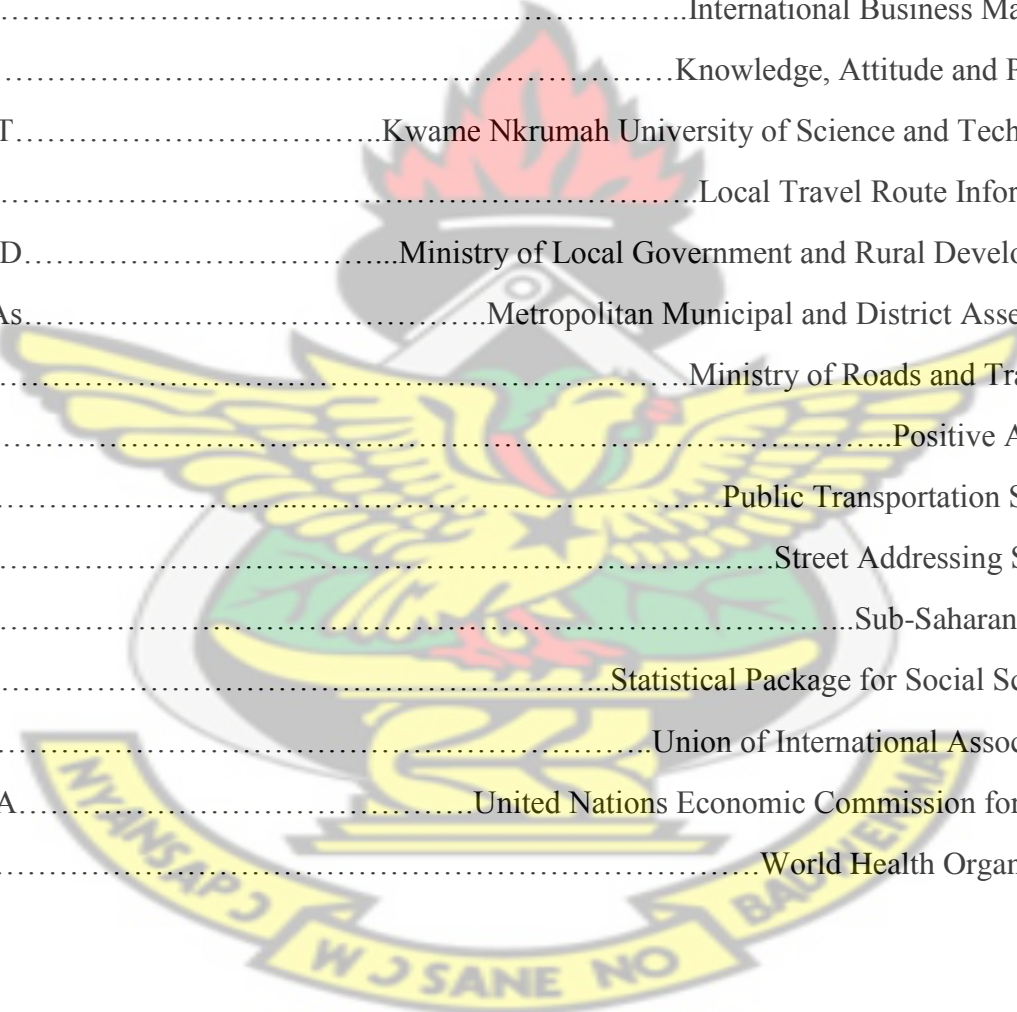


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LIST OF ABBREVIATIONS



ADABAS.....	Adaptable Database System
CBD.....	Central Business District
GES.....	Ghana Education Service
GIS.....	Geographic Information Systems
GPS.....	Global Positioning System
GSS.....	Ghana Statistical Service
IBM.....	International Business Machines
KAP.....	Knowledge, Attitude and Practice
KNUST.....	Kwame Nkrumah University of Science and Technology
LTRI.....	Local Travel Route Information
MLGRD.....	Ministry of Local Government and Rural Development
MMDAs.....	Metropolitan Municipal and District Assemblies
MRT.....	Ministry of Roads and Transport
PA.....	Positive Attitude
PTS.....	Public Transportation Service
SAS.....	Street Addressing System
SSA.....	Sub-Saharan Africa
SPSS.....	Statistical Package for Social Sciences
UIA.....	Union of International Associations
UNECA.....	United Nations Economic Commission for Africa
WHO.....	World Health Organization

DEDICATION

I dedicate this work to my father, friend and backbone, **Mr. Isaac Yeboah**. I love you dearly

Dad. Thank you for everything.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction

Globally, transport and mobility in most cities are associated with difficulties and inefficiencies in accurately identifying places and essential services, especially in developing countries like Ghana (World Bank, 2005). Traffic congestion, transport infrastructural inadequacies, unsafe road conditions and high risks of traffic accidents are other examples of the countless challenges associated with transport and mobility in many parts of the world today (Anin et al., 2013; Aderamo, 2012; Tiwari, 2011). These challenges are exacerbated by the current rapid rate of urbanisation, particularly, in developing countries where most transport infrastructure are poorly developed and barely maintained (Tarapiah et al., 2014).

According to the United Nations, developing countries especially in Asia and Africa are the fastest urbanising regions with rapidly increasing urban populations (United Nations, 2014). Sub-Saharan Africa for instance, has over the last few decades, experienced a dramatic demographic shift from rural areas to cities (World Bank 2005). In Ghana today, 55% of the entire population reside in urban areas (United Nations, 2018). A basic characteristic associated with this demographic shift is the increase in demand for mobility and the associated need for the provision of adequate mechanisms to support passenger and freight mobility requirements (Rodrigue et al., 2009). However, in Ghana, urban mobility is associated with numerous challenges including difficulties in identifying and accessing places and essential facilities due to the lack of appropriate addressing systems.

Despite the galloping increase in urban populations in Sub-Saharan Africa, urban planning and management lags behind (Sietchiping et al., 2012). An example of the traits of poor urban management in the midst of demographic explosion in the sub-region is the total lack or inadequacy of appropriate addressing systems for identifying streets, buildings and other

essential facilities resulting in a battery of mobility and service delivery challenges encountered by all and sundry (World Bank, 2005). The total lack of and or poor implementation of well-planned locational street addressing systems present daunting challenges or in some cases, total impossibilities for navigation in ever growing cities (Van Audenhove et al., 2014; World Bank, 2005).

In Ghana, specific transport and mobility challenges include traffic congestion in major cities, poor road networks, difficulties in locating places, buildings and essential facilities due to unidentifiable routes and the lack of an effective locational addressing system (Anin et al., 2013; MLGRD, 2011). The transportation system in Ghana is further characterised by poor transport infrastructure management and inadequate maintenance. The national picture mirrors the situation in the study area which is the second largest city in Ghana (GSS 2012).

Despite the short-comings associated with urban mobility management in Ghana, particularly, challenges relating to accessibility, some progress and improvements have been implemented in recent years. One of such positive initiatives undertaken by the Government of Ghana is the street naming and property addressing project (MLGRD, 2011). The outlined purpose of the street addressing system project is to serve as a tool of spatial planning and management of cities and towns. Again, the project is intended to enable quick and effective service delivery as well as to improve accessibility to properties and businesses (MLGRD, 2011). In order to achieve its objectives and ensure the effective implementation of the street naming and property addressing project, a policy framework was launched by the Ministry of Local Government and Rural Development (MLGRD) in 2011 with the aim of regulating and guiding street addressing system efforts across the country.

Whiles the utility of a street addressing system cannot be deemphasized, the potential of this facility in addressing urban mobility challenges in the Ghana is currently far-fetched. Although

the ultimate aim of the street addressing project according to the policy framework is to improve navigation, the initiative is yet to achieve this aim across the nation. Moreover, the usefulness of this SAS in improving road navigation is in doubt as the official names assigned to streets are at variance with local travel route parlance and use. Questions as to when the project would be completed entirely and whether the street naming and property identification process is being carried out according to the laid down principles and standards also remain unanswered.

Another recent initiative in street addressing efforts in Ghana is the introduction of GhanaPostGPS. GhanaPostGPS is a digital addressing system that assigns a unique address to every location in the country based on the global grid system which divides Ghana into grids of 5m x 5m squares. The utility of such a system is not in doubt. However, road users' awareness and familiarity with the system and their attitudes towards its use for road navigation may impede the successful utilisation of the street addressing system in meeting urban mobility needs in Ghana.

There exist substantial evidence on the implementation and application of locational street addressing systems in most developed countries such as France and Canada and some developing countries such as China and Senegal (World Bank 2005). However, the full implementation and application of an effective locational street addressing system in Ghana is yet to materialise. The innumerable challenges associated with accessibility and service delivery in Ghana amplifies the need to consider issues relating to addressing system development and utilisation in Ghana. Local Travel Route Information (LTRI), which is derived from locally assigned street and stop names plays a vital role in bridging the formal and informal addressing gap in Ghana and could contribute considerably to the successful implementation and use of Street Addressing Systems in achieving navigational needs.

Road transport is the predominant mode of transportation in Kumasi with “trotro” serving as the major means of public intra-city movements (GSS 2012). “Trotro” is the local nickname for mini-buses that offer public transportation services for a larger proportion of the city’s population. Many people patronise the services of trotro operators for both economic and social purposes. Other means of public transportation in Kumasi include taxicabs and buses. Trotro services as compared to the taxicabs are relatively cheaper and hence, has a higher patronage. Being the principal means of public transportation in Kumasi, trotro services cover the entire city. Major trotro routes extend from the central business district (Adum) to the outmost parts of the city including areas of sprawl. The large extent and varied nature of the operation of trotros in the metropolis and the magnitude of local locational information which could be derived from trotro operators and road users present the opportunity to gather relevant information about various stops along major trotro routes in the metropolis. In Kumasi, many people rely on trotro operators, mostly trotro drivers and their conductors for locational information in identifying various places and facilities in the metropolis. This wealth of indigenous knowledge could be acquired, stored and transformed into a form that could be successfully incorporated in addressing systems. This knowledge could be further transformed and used for the development of a locational travel route infrastructure for identifying routes and essential facilities in the city.

The identification and mapping of stops (alighting points) along trotro routes could also go a long way to complement and aid the existing and on-going street addressing system (SAS) project. This is so because the use of trotro routes would help identify popular but unmapped streets in the metropolis. Again, the mapping of these routes would help provide current data on road infrastructure, which in turn would help inform policy decisions on the provision and maintenance of transportation infrastructure in the city. With the ultimate aim of increasing accessibility to places and essential facilities, incorporating local travel route information

(LTRI) in the development and upgrading of SAS would result in the development of an integrated locational street addressing system which would not only benefit road users but also service delivery agencies including government and courier services, emergency services such as ambulance services and fire services and also businesses. It would also be an effective tool which could aid crime mitigation by the security and law enforcement agencies.

Furthermore, an effective locational street addressing system would help better targeting and service delivery to citizens and facilitate effective management of public facilities, thereby improving the quality of life in a community and business environment (MLGRD. 2011). The private sector would also benefit from such an integrated street addressing system as it would be enabled by the system to provide targeted services to clients as well as tracking their locations for the relevant follow-ups and business transactions. More so, the system would facilitate easy location of critical facilities such as health facilities, thereby increasing accessibility and curbing urban mobility challenges (World Bank2005).

From the above, it could be stated categorically that incorporating LTRI in developing an integrated SAS would help to improve accessibility of people and places and contribute substantively to improving urban mobility in Kumasi. This study, therefore, aimed at investigating and unearthing the possibilities of incorporating local travel route information in addressing systems development to improve urban mobility in Kumasi with the aid of Geographic Information Systems (GIS).

1.2 Problem Statement

Mobility is a fundamental need in modern societies. It is a prerequisite as well as a precursor for economic success, social prosperity and general satisfaction of all actors in society. Reliable, efficient and effective mobility is essential for individuals' well-being and for social and economic development. Good transport and mobility enable people to access essential

services, participate in social and recreational activities and also to communicate effectively within their community (Harris and Tapsas, 2006). However, there exist a plethora of transport and mobility challenges in the Kumasi Metropolis, paramount among which are difficulties in identifying places and essential facilities due to the lack of appropriate street addressing systems. The social and economic impacts associated with the lack of appropriate street addressing systems for successful travel plans are evidenced in the numerous challenges associated with service delivery, business transactions and revenue collection in Ghana (UNECA, 2009; Ofori-Atta, 2015).

The successful application of Geo-referenced street addressing systems in most developed countries and some developing countries has aided in curbing these challenges (World Bank, 2005). However, the potential of incorporating Local travel route information (LTRI) in developing an integrated SAS to curtail urban mobility challenges in Ghana remains unexamined. While many studies have focussed on the utility of the conventional methods of street naming and property addressing in overcoming urban mobility challenges, this study explored the potential of incorporating LTRI in the development of an integrated locational street addressing system. Local travel route information plays a critical role in informal addressing as many people rely on this locally acquired information for identifying people and places as well as essential facilities. This locational information is mostly acquired from “trotro” operators who ply known routes across the length and breadth of the city. “Trotro” operators in the Kumasi metropolis possess a wealth of local locational information which when extracted and transformed, would be useful in developing an integrated locational addressing system with the aim of curbing urban mobility challenges in Kumasi.

The questions as to how this knowledge could be transformed into formal usable forms and also how it could be made available to stakeholders in overturning these challenges was the task which this study sought to undertake. The development of an integrated locational addressing system through the use LTRI could be achieved with the aid of Geographic Information Systems (GIS).

The existence and application of an integrated locational street addressing system which incorporates LTRI would not only increase accessibility to places and people but also enhance economic development. The system would also serve as a catalyst for improving social relationships and networks. Private automobile users, public transport operators, courier services, government revenue agencies, public service delivery agencies, for example, the police and fire service, utility services, locals, tourists and many other people and agencies would benefit substantively from the integrated locational street addressing system.

Again, although some facilities for street addressing exist today, for example, GhanaPostGPS, little to nothing is known about road users' knowledge, attitudes and practices relating to SAS generally and specifically for road navigation. Investigating road users' knowledge, attitudes and practices concerning street addressing systems is critical for creating awareness about the existence and utility of SAS (Kaliyaperumal, 2004). It would also help inform policy directions on the implementation, acceptance and utilisation of SAS.

1.3 Research Questions

Considering the depth of the research problem, the following research questions were posed to guide this investigation:

- i. What are the major travel means for daily commuting and the characteristics of commuters in Kumasi metropolis?

- ii. Do road users in Kumasi possess knowledge about maps and street addressing systems and utilise them for road navigation?
- iii. What are the relationships between road users' level of knowledge, attitude and use of Street addressing systems in Kumasi Metropolis?
- iv. What are the barriers to map and street addressing system use for road navigation in Kumasi metropolis?
- v. What are the means through which Local Travel Route Information (LTRI) could be acquired, stored and mapped?

1.4 Objectives

The overarching objective of this study was to investigate the potential of incorporating local travel route information in addressing systems development to improve urban mobility in Kumasi and to inquire about road users' knowledge, attitudes and use of Street Addressing Systems (SAS). To answer the broad research question and to inform policy directions on dealing with utilization of SAS among road users, the study focused on the following specific objectives to:

- i. Identify urban mobility means and road travel behaviour of road users in Kumasi Metropolis.
- ii. Ascertain road users' knowledge and use of maps and Street Addressing Systems (SASs) in Kumasi Metropolis.
- iii. Find out the relationship between road users' level of knowledge, attitude and use of street addressing systems.
- iv. Examine the barriers that impede access to and the use of maps and SASs in Kumasi Metropolis.

- v. Acquire, store and map Local Travel Route (LTR) data on selected trotro routes in Kumasi Metropolis.

1.5 Hypothesis

The study hypothesised that:

- i. There is no statistically significant association between Road users' level of map and addressing system knowledge and use for navigation.
- ii. There is no statistically significant association between knowledge, attitude and use of Street Addressing System (SAS) use for road navigation.
- iii. There is no statistically significant association between education and the use of digital maps and SAS use for road navigation.
- iv. There is no relationship between road users' access to services and resources and SAS use for road navigation.

1.6 Significance of the Study

There are various transport and mobility challenges in Ghana and Kumasi Metropolis is no exception. Residents, tourists and service delivery agencies in the metropolis encounter numerous problems in identifying places and facilities due to the absence of an effective locational street addressing system. To solve this urban mobility problem, this study focussed on examining the potential of incorporating local travel route information (LTRI) in addressing systems development to improve urban mobility in Kumasi. The study also investigated road users' knowledge, attitudes and use of SASs for road navigation. The findings of the study has contributed to advancing knowledge on addressing system utilisation and the challenges and opportunities associated with public transportation in Kumasi and Ghana as a whole.

This information is critical for decision making concerning transportation management in Kumasi and possibly, other parts of Ghana. Again, the results from the study may serve as an important tool in future advancements in street naming and property addressing projects in the metropolis and beyond. Lastly, the relevance of the study is evident in helping to eliminate many urban mobility challenges relating to inaccessibility of places and essential facilities by providing the data needed for the development of a digital routing system based on LTRI.

1.7 Organization of the Study

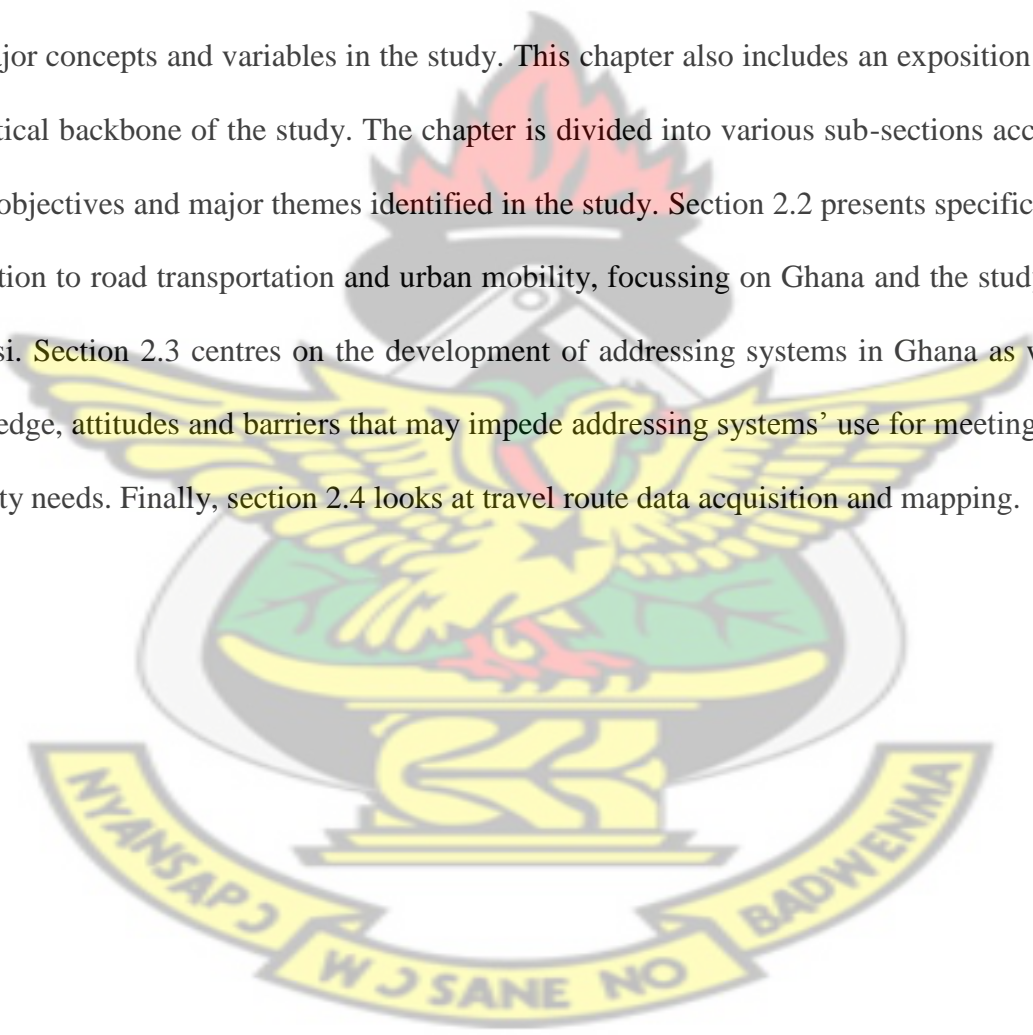
This study has been organized into five chapters. Chapter one considered the study background, problem statement, rationale of the study and the study objectives. Chapter two reviews relevant literature on the subject matter in addition to the theoretical and conceptual framework of the study. Chapter three presents the methodology adopted for the study while chapter four presents the results and discussions based on the objectives of the study. Chapter five summarizes the findings of the study and includes recommendations for enhancing SAS use for road navigation in Kumasi.

CHAPTER TWO

REVIEW OF LITERATURE AND CONCEPTUAL ISSUES

2.1 Introduction

Chapter one provided a general overview of the study with emphasis on the background of the study, problem statement and justification for the study. The research questions from which specific objectives were derived were also highlighted. This chapter focusses on exploring relevant literature related to the study in order to provide a comprehensive understanding about the major concepts and variables in the study. This chapter also includes an exposition on the theoretical backbone of the study. The chapter is divided into various sub-sections according to the objectives and major themes identified in the study. Section 2.2 presents specific issues in relation to road transportation and urban mobility, focussing on Ghana and the study area, Kumasi. Section 2.3 centres on the development of addressing systems in Ghana as well as knowledge, attitudes and barriers that may impede addressing systems' use for meeting urban mobility needs. Finally, section 2.4 looks at travel route data acquisition and mapping.



2.2 Road transportation and Urban Mobility

2.2.1 Overview of Transport and Mobility

Mobility is a fundamental human activity and need. It is simply defined as the ability to move or be moved. Transportation as differentiated from but intrinsically linked to mobility is clearly defined as the movement of people, freight, services or information through a particular mode. The purpose of transportation is to fulfil the demand for mobility. Thus, transportation exist to supply the basic need of mobility as it hinges on the concept of derived demand. In other words, transportation does not exist for its own sake but to make possible the linkages of locations in space. Transportation is therefore a key component of every economy and plays an essential role in spatial relations (Rodrigue et al, 2016).

Transportation is undoubtedly a vital function in every human society. To a greater extent, the transportation systems of every nation, mostly consisting of infrastructures, modes and terminals serves as the fulcrum around which the wheels of economic and social development revolve (Rodrigue et al., 2016; Anin et al, 2013). Transportation also plays a critical role in the realization of global trade objectives and as such the prosperity of the global economy. As engines of economic integration, transport infrastructure and service facilities constitute a precondition for facilitating trade and the movement of goods and persons (UNECA, 2009). The total absence, insufficiency, ineffective functioning or total breakdown of the transportation system in any society has detrimental consequences on the economic and social functioning of that society. Poor road networks for example, impedes the flow of services, goods and people. This in turn obstructs development in the expanded context. Poor transport network again tends to retard the growth of industrialisation or inhibit it altogether (UIA, 2017). As mobility is associated with a plethora of positive advantages such as providing access to jobs and a sense of personal freedom, so is it associated with some negative outcomes and

challenges such as costs and congestion (Bouton et al., 2015). In developed and developing countries alike, road transportation stands as an essential means for urban mobility despite the countless challenges and negative impacts it breeds. A critical look at road transportation and its associated challenges is therefore imperative as it serves a principal means of meeting urban mobility requirements in most developing countries, specifically, Ghana and also the study area, Kumasi (GSS, 2014).

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2.2.2 Road Transportation in Developing Countries with Special Reference to Ghana

Transportation enables movement without which economic needs cannot be satisfied and social networks and relationships cannot be fortified. Transportation provides the means of satisfying mobility demands but this is achieved at a cost. Traffic congestion causing delays in travel, environmental pollution and traffic accidents are few of the many examples of challenges associated with transportation (Rodrigue, 2017; Wit et al., 2002). As most developed nations concentrate on finding solutions to these negative impacts of transportation, developing countries and especially Sub-Saharan Africa (SSA) countries are not only required to double their efforts to avert these impacts which are worse in these countries but also to deal with basic structural and infrastructural challenges. Examples of these are poor road conditions and the lack of appropriate street naming and addressing systems for the identification of places, people and facilities within highly congested and structurally complex cities (World Bank, 2005).

Challenges associated with the transportation systems in most developing countries include poor road conditions and inadequacy of transport infrastructure, poor management, lack of maintenance, limited road network, narrow roads, primitive or non-existing traffic management system, and unsafe driving behaviours (Anin et al., 2013; Iles, 2005). These challenges are mostly attributed to the high levels of urban growth (Nuessgen, 2015). Inadequate human and institutional capacity, increased negative environmental impacts due to

poor road conditions and over-aged vehicles, high transport costs, poor transport safety and security are further identified as the major challenges of the transportation system in Africa (UNECA, 2009).

Poor and under-developed transportation infrastructure stands as the most persistent challenge associated with the transportation systems in SSA (Tancott, 2014). The poor and dilapidated nature of many roads render them non-motorable especially in the rainy seasons (UNECA, 2009.) Traffic congestion and unaffordable transport are also typical road transportation challenges in SSA countries (Middleton, 2016). Generally, the transportation system in Ghana is plagued with peculiar challenges including inadequate transport infrastructure, poor management, traffic congestion, to mention but a few (Anin et al., 2013; Ofori-Dwumfuo and Dankwah, 2011). The national picture mirrors the situation in the study area as indicated by Anin et al, (2013). The availability and proper functioning of transport infrastructure is essential in ensuring the effectiveness of transport systems (Eddington 2006). It is further noted that the success and effectiveness of transport infrastructure is undoubtedly linked with the efficient utilisation of these resources through proper management, a basic ingredient lacking in the planning process of many African cities.

Road transport is the most dominant mode of motorized transport in Africa, accounting for 80% of the goods and 90 percent of the passenger traffic within the continent (UNECA, 2009). Road transport is the backbone of economic relations and social integration. There is therefore, the need for continual investment in transportation in order to ensure effectiveness and efficiency (UNECA, 2009). Many developing countries lack integrated transportation system plans and infrastructures which would coordinate all means of transport to satisfy the needs of development. Road and rail networks are inadequate; and if inland waterways exist their use may be primitive if they are used at all (UIA, 2017).

2.2.3 The Role of Public Transportation in Urban Mobility

Public transportation plays a critical role in enabling mobility and creating accessibility for everyone especially the urban poor. Most particularly, in developing countries with high levels of poverty and low income levels, public transport provides the means of affordable and easily accessible transportation for most city dwellers. As such, the demand for public transportation in cities in developing countries is always high outstripping supply (Faiz 2011; World Bank, 2000). Although private automobile ownership continue to increase in most cities, the majority of urban dwellers in SSA who do not own private vehicle and therefore have limited transportation options rely on available public transportation options for their daily commuting. Again, public transport provides people with mobility and access to employment, education, retail, health and recreational facilities. Shapiro et al (2002) agree that public transportation serves as a strong anchor which ensures effectiveness in urban transportation systems.

Public transport is beneficial for achieving environmental sustainability through the reduction of fossil fuel usage and reducing environmental pollution. Public transportation also helps in building strong a economy by creating mobility for workers and ensuring the distribution of goods, services and information (Stjernborg and Mattisson, 2016; Newman, 2011). Public transport again is in itself a solution to an array of transportation problems including excessive traffic congestion due to over-usage of private automobiles. Moreover, Public transportation provides the means of improving energy efficiency due to the high passenger occupancy rate and fuel saving potentials. It also serves as a perfect means of meeting transportation and mobility needs especially in ever- growing urban centres (Nuessgen, 2015; Shapiro et al., 2002). To ensure an effective public transportation system however, the various means of public transportation in developing countries must be available, adequate and reliable (Anin et al., 2013). Again, in order to reduce the rate of motorisation by cutting down reliance on private

motorized transport, cities need to develop attractive, accessible, and affordable public transport systems which are within the geographical and financial reach of all residents, especially the urban poor (UN-Habitat, 2012).

Public transport in most areas includes the use of trains, buses, ferries and taxis. In Ghana, public transportation service provision is dominated by the informal or private sector. This is differentiated from the situation in most developed nations where public transportation services are largely provided by the government. Although the provision of Public Transportation Services (PTSs) by private individuals is advantageous for the progress of the informal/private sector, Middleton (2016) opine that, there are some challenges associated with informal transport services. These include; unpredictable fares, schedules and routes, poor maintenance, lack of licensing (drivers and vehicles), recklessness, and safety concerns ranging from harassment to armed violence. Poku-Boansi and Adarkwa (2013) agree that, the quality of public transportation in Kumasi is generally poor with very low maintenance standards.

In Ghana, the means of public transportation includes taxicabs, busses and mini-busses which are locally referred to as “Trotro”. In the big cities such as Accra and Kumasi, taxis and trotro dominate PTSs. A recent development in some cities especially in the northern parts of Ghana is the use of tricycles for public transportation. Most users of this readily available means of transportation testify that it is a cheap and convenient means of navigation as compared to taxicabs. However, there are many questions to be answered about the safety of this seemingly convenient means of transport. In the Kumasi metropolis, trotro and taxicabs are the major means of public transportation especially for intra- city movements (Poku-Boansi and Adarkwa, 2013). On the basis of cost, trotro services are cheaper as compared to taxi services. Some people however prefer taxis to trotro due to comfort. Trotro dominates PTSs in major

communities in the metropolis while in some sub-urban communities such as Boadi and some areas of sprawl, taxis are most common because trotros do not ply such routes.

2.2.4 Urban Mobility and Associated Challenges

2.2.4.1 The nature and characteristics of urban mobility

Urban mobility traditionally concerns moving people from one location to another location within or between urban areas. Policy makers and urban development agencies expend a lot of resources in efforts to improve urban mobility based on the assumptions that: first of all, people need to move in order to access housing, jobs and urban services, such as education and entertainment. Again, that, people prefer motorized mobility to non-motorized mobility because the former is economically more efficient than the latter, especially as cities grow and the society becomes more affluent (World Bank, 2015). Urban mobility is basically characterised by car-centred mobility including private automobile usage and public transport (UN-HABITAT, 2012). Public (commercial) transportation is however, the basic means of satisfying urban mobility demands.

Urban areas represent highly complex settings where passenger and freight mobility continually takes place. In most cases, passenger and freight movements are complementary to one another. In other situations, there assumes a competition between passenger and freight movements for markets, the usage of available land and transport infrastructures. Collective, individual and freight transportation make up the major categories of urban mobility. Collective Transportation, in other words, public transit seeks to provide publicly accessible mobility over specific parts of a city. Public transport systems are usually owned and operated by an agency with open access to all who employ the services at a cost. The efficiency of public transit systems is based upon transporting large numbers of people and achieving economies of scale. It mostly includes modes such as tramways, buses, trains, subways and ferryboats. In Ghana,

however, as is the case of many developing countries, public transport services are commonly provided by private individuals with little central control.

Individual transportation emanates from personal choices determined by different rationales. Means such as the automobile, walking, cycling and the motorcycle are usually employed to achieve this purpose. The majority of people walk to satisfy their basic mobility, but this number varies according to the city considered. For instance, in Japan and the USA walking accounts for 88% of all movements in Tokyo, and only 3% in Los Angeles respectively. Freight Transportation basically involves the movement of freight from one point to another using a particular mode. This is a common feature in urban centres as cities are dominant centres of production and consumption. Freight mobility is mostly characterized by delivery trucks moving between industries, distribution centres, warehouses and retail activities as well as from major terminals such as ports, railyards, distribution centres and airports. The growth of e-commerce has been associated with an increase in the home deliveries of parcels (Rodrigue, 2017).

Rapid urban development occurring in most parts of the world continues to breed increased quantities of passenger and freight movements within urban areas. These movements are often characterised by long distance trips. However, it has been proven that commuting times have remained relatively similar through the last hundred years; approximately 1 to 1.2 hours per day is spent on average commuting. This is a result of the existence of faster transport modes enabling quicker means of reaching places and thus narrowing the time-distance gap. Societal evolution over the years has seen major innovations in different transport technologies and infrastructures. This has resulted in a wide variety of urban transport systems around the world.

2.2.4.2 Challenges of urban mobility

A principal purpose of mobility is to enable access to destinations, activities, services and goods (UN-HABITAT, 2012). Although there has been tremendous improvements in urban mobility worldwide, access to places, activities and services has become increasingly difficult (UN-Habitat 2017). The situation in Africa and for that matter Ghana is worse due to low levels of planning and poor institutional frameworks. The lack of appropriate street naming and addressing systems greatly inhibit accessibility to places and facilities as investigated by the World Bank (2005).

Urban mobility is currently of great concern to governments and developers in most cities in sub-Saharan Africa (SSA). As a basic developmental cancer in the sub-region, population continues to outstrip planning, spatial and infrastructural development, specifically, transport infrastructure. Inadequate planning and deteriorating transport infrastructure and services continue to mark many cities in the sub region despite the galloping rate of population growth and rapid urbanisation (Sietchiping, Permezal, and Ngomsi, 2012; World Bank, 2005). In many parts of Africa, however, transport services remain entirely inadequate for user needs (Porter, 2014). Many cities in SSA lack efficient public mobility systems. The poor public transport systems in existence are also characterised by high access costs, lack of reliability, and deficiencies in safety and security. This strongly impacts people's access to important services mostly in remote areas (Porter, 2014; Sietchiping et al., 2012).

It is argued that, "The rise of e-commerce, e-business and various on-line services is telling us: you don't have to move to get services anymore, and services could be accessed remotely or even "moved" to you, regardless where you are" (World Bank, 2015). Although there is a higher level of truism in this statement, the wide applicability of accessing services remotely in Africa and for that matter Ghana, is difficult to achieve if not entirely unfeasible. The big question is, how do service providers and mailing services reach customers with their products

and services when appropriate addressing systems do not exist and even when they exist, they are limited to being used only for official documentation purposes?

“Urban mobility is no longer just about moving people around by motorized vehicles. What people really need is the accessibility to various urban services” (UN-Habitat, 2012). On this basis, it is important that much attention is paid to the means of providing accessibility to places and essential facilities as this would help improve urban mobility in general.

2.3 Addressing Systems in Ghana: Knowledge, Attitude and Barriers to Use

2.3.1 Overview of Addressing system development and use in Ghana.

Street addressing is defined as an organized, structured or formal means of assigning an ‘address’ to properties or dwellings on the ground. Street addressing systems (SAS) provide the means of locating people, places and properties by the means of a system of maps and signs through which numbers or names are generated for streets, buildings and other properties. The idea of Street addressing is not limited to buildings or plots of land. The concept also makes it possible for assigning addresses to urban networks and services that is, specific urban features such as streetlights, taxi stands, public standpipes, to mention but a few (World Bank, 2005). Street addressing does not only provide a means of assigning street names and property numbers but also serves as an important tool for urban management taking into consideration the fast rate of urban growth, especially, in SSA countries (MIT, n.d).

The existence and use of street addressing systems all over the world provide ample evidence that the benefits of street addressing especially in urban centres cannot be overstated. Movement of people and tangibles and the delivery of services is highly impossible or extremely difficult without the existence of street addressing systems especially in ever growing urban centres. Road navigation in cities of many African countries, specifically,

Ghana, is a nightmare due to the absence of a formalised system of identifying streets, properties and essential facilities (World Bank, 2005). With the absence of an appropriate street addressing system to ensure easy movement in and around cities, questions arise as to how the efficient delivery of mail and emergency services, identification of places and essential facilities and identification of travel routes could be achieved.

Ghana until recent times could not boast of a fully functioning computerized and internet-based addressing system. However, it is noteworthy that over the years, there has always been some form of street and property addressing in Ghana. These include; the assignment of house numbers, the traditional system of naming streets, the official street naming and property addressing project by the Ministry of Local Government and Rural Development (MLGRD) in 2011 and most recently, the introduction of GhanaPostGPS. In spite of these, Ghana is yet to have a generally accepted and widely used addressing system especially for road navigation.

In 2017, Ghanaians witnessed the birth of a new addressing system called GhanaPostGPS. GhanaPostGPS is a digital addressing system that assigns a unique address to every location in the country. It is based on the global grid system and divides Ghana into grid of 5m x 5m squares. Based on this, a digital address is generated based on a person's specific location at a particular point in time (<https://www.ghanapostgps.com>). The GhanaPostGPS addressing system (GAD) uses specific codes for regions and districts which serve as the prefix for every digital address. Street names are incorporated in the GAD and are displayed below a digital address, including the district, postcode and region. To locate a given address, one would need to key in the digital address in a search column provided and search for the address. The mobile application provides a route option which relies on Google maps to help to navigate to a specified address location.

Although there has been several criticisms against this addressing system, critical attention is drawn to the fact that one cannot access the application offline. As such, in emergency cases where one cannot access the internet, the addressing system becomes totally useless. Again, questions arise as to how familiar people are with the application and their attitudes towards its use for navigational purposes.

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2.3.2. Knowledge, Attitudes and Barriers of Street Addressing System use.

Knowledge refers to the acquisition, retention, and use of information or skills. Knowledge acquisition is related to both education and experience (Rav-Marathe et al, 2016). Attitude is defined as a “psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour” (Eagly and Chaiken, 2007 as cited in Wan et al., 2017). In simpler terms, attitude relates to a person’s perception, feeling or beliefs about a certain phenomenon that could inform their practice (behaviour). Practice on the other hand, refers to the ways in which knowledge and attitudes are demonstrated through actions. In other words, practice relates to the application of rules and knowledge that leads to action (Bano et al., 2013; Kaliyaperumal, 2004). Knowledge and attitude are related to behavioural outcomes (Rav-Marathe et al., 2016). As such, lack of knowledge and favourable attitudes concerning a problem or phenomenon may greatly inhibit practice. In relation to maps and street addressing system use for navigation, the lack of knowledge about a navigational facility, thus, maps and SAS facilities in this context, may influence road users’ attitudes and use of these facilities for road navigation.

The investigation of knowledge attitude and practices concerning a specific phenomenon is critical for policy direction and implementation. Identifying and understanding the levels of Knowledge, Attitude and Practice in relation to maps and addressing systems would provide a

more efficient grounds for awareness creation (Kaliyaperumal, 2004). Again, investigating road users' knowledge, attitude and practices concerning SASs would provide the premises for unearthing specific barriers that impede the successful utilisation of SASs in Ghana. As outlined by Legare et al., (2008), barriers such as lack of resources and lack of access to services could greatly influence practice.

2.3.3 The Current State of Road Navigation in Ghana; the case of Kumasi metropolis.

Ghana is a rapidly urbanising. Currently, the country has an urban population of 51% (GSS, 2012). Accra and Kumasi are the fastest growing cities in the country. As a basic characteristic of many developing countries, especially, in Sub-Saharan Africa, the level of urban planning in Ghana lags significantly behind the level of urban growth in the country (World Bank, 2005). As such, infrastructural development, specifically road networks and other transportation facilities are not adequate to meet the needs of the growing populace. These infrastructural challenges coupled with the absence of appropriate addressing systems continues to make accessibility to places and essential facilities extremely difficult and in some cases, utterly impossible. Problems also arise with the ascending degrees of urban sprawl in our major cities especially Accra and Kumasi leading to unplanned settlements and hence haphazard dwellings, and irregular road networks.

The transportation sector in Ghana is dominated by the informal/private operators who operate in groups or as individuals. In relation to intra-city movements, as is the case of Kumasi Metropolis, private individuals provide an array of transportation services for a significant proportion of the city's population. Apart from providing the means for the transfer of goods and services, the road transport sector provides employment for many people who are employed as taxicab drivers, trotro (minibus) drivers and conductors ('Mate' as they are locally called), "loading boys" and station masters who are generally responsible for the management

of informal transport terminals (stations). Although public transportation in Kumasi plays a significant role in meeting urban mobility needs, the quality of services of public transport operators are generally poor. Low maintenance standards for roads and vehicles and inaccessibility of places and essential facilities also characterise road transportation in Kumasi (Poku-Boansi and Adarkwa, 2013; Anin et al, 2013). The deplorable state of many roads within the metropolis is enough distress for road navigation, not to talk of the absence of street names and signs which could aid navigating around the populous city.

Before the recent advent of digital addressing in Ghana, the common practice of moving from one location to another has been, asking for directions from anyone who could provide such information. In urban centres like Kumasi, the best “move-around technique” that has been practised since time immemorial has been the act of asking people for directions. The shop owner and the ‘waakye’ seller can simply not get tired of hearing people ask: please how do I get to the Kejetia terminal? Could you kindly direct me to Pampaso? Where exactly is central market located? Could you please give me directions to Harper road? Is the post office far from here? And so on. A typical example in Kumasi is in the case of the central business district, Adum and its environs, with a complex network of shopping centres, institutional facilities, large markets and formal and informal transport terminals without any clear boundaries.

A basic method of addressing facilities in Ghana has also been through the use community names, road names and major landmarks. It is not surprising to see on a business advertisement; “Locate us at Ayeduase, Opposite the *African Child School*. Addressing homes in Ghana has always been through the use of the traditional house numbering systems, for example, Plot X, Block Y, traditionally assigned street names such as ‘*Barima Nkwan*’ street and the typical routine of making references to major landmarks, ordinary buildings, trees, retail shops and even food vendors.

With the current introduction of a digital addressing system referred to as the GhanaPostGPS which has been made available to all and sundry through an easily accessible mobile phone application, one would have expected that the way of navigating and addressing would change but is this the case? What knowledge do people have about maps and addressing systems? What are their attitudes towards the use of these computerised facilities? How often do people use these facilities for road navigation? Finding solutions to these question is highly imperative to improving the use of addressing systems for road navigation in Ghana.

2.4 Travel Route Data Acquisition and Mapping

Travel route information simply refers to information provided to guide successful travel along a particular route. It mostly includes information about the nature of the route, major stops along the route and possible barriers along the route. Travel route information is important for effective road navigation. In relation to public transportation, travel information does not only encourage the use of public transportation services but also help travellers to make effective travel plans (Loden and Brechen, 2004). In whichever form it is made available to the traveller, whether through an application, a travel information service or given orally as is the practice in Ghana, Travel Route information helps efficient transportation from one destination to another. In this study, Local Travel Route Information (LTRI) is conceptualised as informal travel information that is orally acquired from public transport operators, specifically, “trotro” drivers and their conductors and as one travels along a particular route from an origin to a destination. This information is based on informal addressing means, including locally assigned street and stop names and which has over the years been instrumental in intra-city navigation.

In order to successfully transform this information into a usable form in a computerised environment, there is first the need to create a database for the storage and retrieval of such information. The creation of transportation databases provide the means of capturing and storing information on transport network, condition of transport infrastructure and transportation projects This information is useful for the planning and management of transportation especially in urban centres (RRPDC, 2012). Transport networks physically exist in space. As such, a useful database for successful transportation planning must incorporate the use of spatial technology in capturing and archiving the specific locations and extent of transport infrastructure and also data on transportation projects. Acquiring information on a particular travel route for example, includes capturing information about the spatial extent of the route, the various stops along the route, street names as well as other useful information relating to the route such as important landmarks along the route.

Geographic Information systems (GIS) and Global Positioning System (GPS) technology are effective tools for the capturing, storing, analysing and displaying such geographic data (Mintsis et al., 2004). A GIS is able to provide hitherto unknown intelligence and sophistication to transportation database (Simkowitz, 1989). Again, GIS provides the ability to analyze and present spatial information in a clear and concise manner. As such, it has become an important tool in transportation planning processes (RRPDC, 2012). A GPS technology has been applied in a lot of transportation studies and has been instrumental in solving a myriad of urban transportation problems (Charlton et al., 2011; Zheng et al., 2010; Harvey et al., 2008; Mintsis et al., 2004; Hatipkarasulu et al., 2000). Focusing on transportation database creation, the use of GPS technology allows the capturing of travel route data including accurate position of stops and the position of associated landmarks as it enables the accurate positioning of an object using satellite signals (Mintsis et al., 2004). It operates based on satellite ranging or

trilateration, which is a basic geometric principle that allows a GPS receiver to calculate its precise location and time-base as a function of the knowledge of its distance from other locations, thus, satellite locations. The concept requires at least four satellites to accurately position a receiver in three-dimensional space thereby, making it possible for the receiver to calculate its two-dimensional position on the earth surface as well as its altitude (Kumar and Moore, 2002). In this study, a handheld GPS device was utilised in recording the accurate positions of stops (alighting points), recorded as X, Y coordinates, after which the information was inputted in a GIS software (QGIS) for analysis and mapping of local travel route data.

This study examines the possibility of improving urban mobility through the incorporation of local travel route information in the development of street addressing systems. The study sought to achieve this purpose through the collection and presentation of local travel route information and the investigation of people's knowledge and use of existing addressing systems and other navigational facilities.

2.5 Literature Gaps

Most of the recent studies on urban transportation especially in Africa have focussed on transport infrastructure upgrading, challenges of road transport in urban centres and suggested solutions to these (Nuessgen, 2015; Tancott, 2014; Ajay et al., 2008). Also, major studies have been conducted on the Health impacts of increased motorised transportation including road crashes and exposure to traffic-generated air pollution which were recently reported to be among the top 10 leading causes of death throughout sub-Saharan Africa (GRSF, 2014).

In Ghana, studies have looked at the problems and solutions of urban transport (Addo, 2005) without looking at accessibility challenges related to urban transport. Most studies conducted on urban transportation and mobility in the study area, Kumasi metropolis, have focused on

urban transportation challenges in the city, sustainability of the urban transport systems, the quality of urban transportation services and the factors affecting public transportation services in the city (Anin et al, 2013; Agyemang, 2013; Poku-Boansi and Adarkwa, 2013; Okyere, 2012). Literature is replete with evidence on various urban transportation challenges with various solutions suggested (UN-HABITAT, 2015; Swartz et al., 2015; Suzuki et al., 2013). However, there is no evidence in available literature on the role of street addressing systems in increasing urban accessibility and improving urban mobility in general. Also little to nothing is known about road users' knowledge, attitudes and practices concerning SAS. This study therefore sought to investigate how urban mobility could be improved through the incorporation of local travel route information in the development of SASs in Kumasi.

2.9 Theoretical Basis and Conceptual Framework

2.9.1 Theoretical Framework

The study adopts the Knowledge, Attitude and Practice model in explaining road users' knowledge base and use of maps and addressing systems for road navigation. The model was first developed in the 1950s and further restructured by Schwartz in 1976. The model has been widely used in health studies, especially, in health education (Rav-Marathe et al, 2016). The fundamental assumption underlying this model is that there is a linear association between knowledge, attitude, and behavioural change (Warwick, 1983). The model is used in measuring Knowledge, Attitude and Practice and several studies have adopted the model for achieving such purpose (Poudel et al., 2018; - et al., 2017; De Pretto et al., 2015; Wang et al., 2015; Sibiya and Gumbo, 2013).

The model simply helps in explaining people's knowledge, perceptions or feelings and their behaviour or practice in relation to a specific phenomenon. Knowledge simply refers to individuals' understanding of a given topic. Attitude refers to their feelings towards the

subject, as well as any preconceived ideas that they may have towards it. Practice relates to the ways in which they demonstrate their knowledge and attitude through their actions (Bano et al., 2013; Kaliyaperumal, 2004). Figure 2.1 shows a pictorial presentation of the knowledge, attitude and practice model. Based on this model, a conceptual framework is adapted for the study to measure respondents' knowledge, attitude and practice as shown in figure 2.3 and 2.4 below. The framework was adopted from Legare et al., 2008 (Fig.2.2).

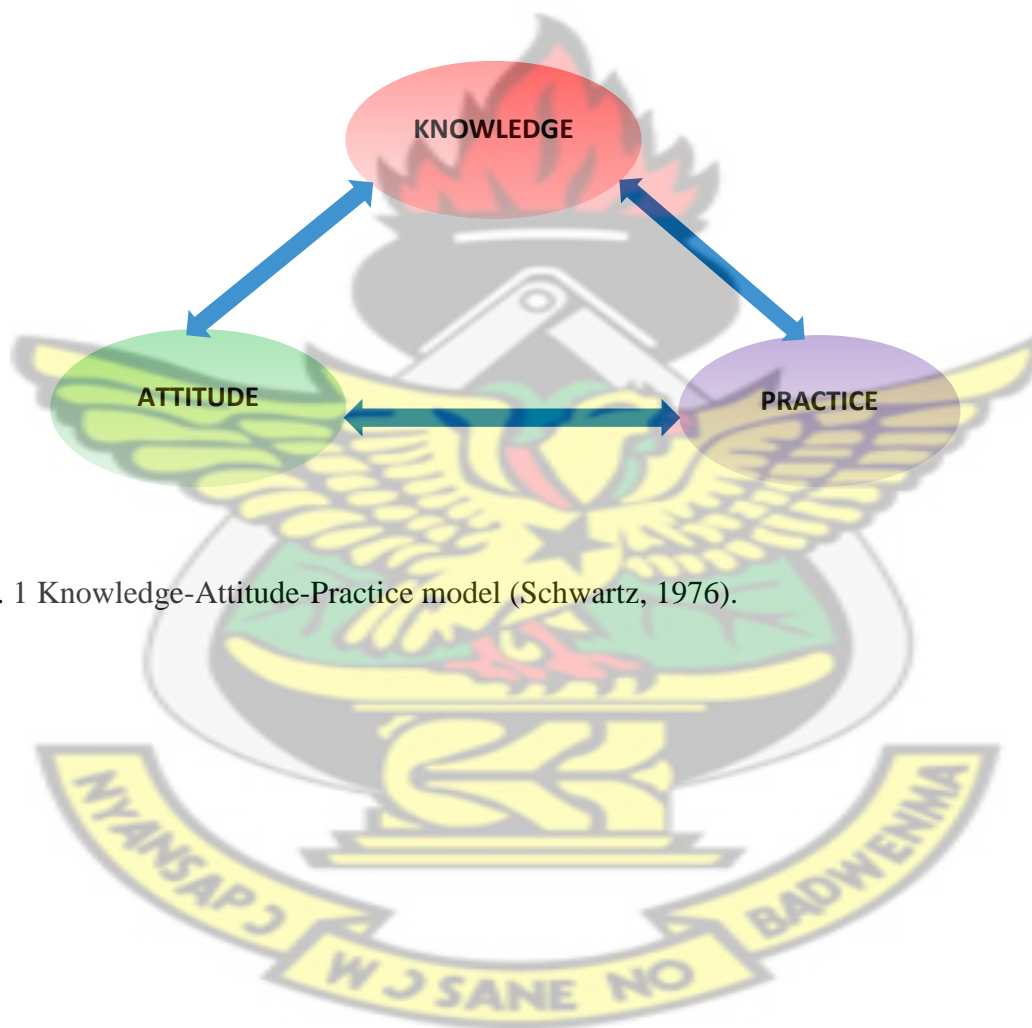


Fig. 2. 1 Knowledge-Attitude-Practice model (Schwartz, 1976).

2.9.2. Conceptual Framework

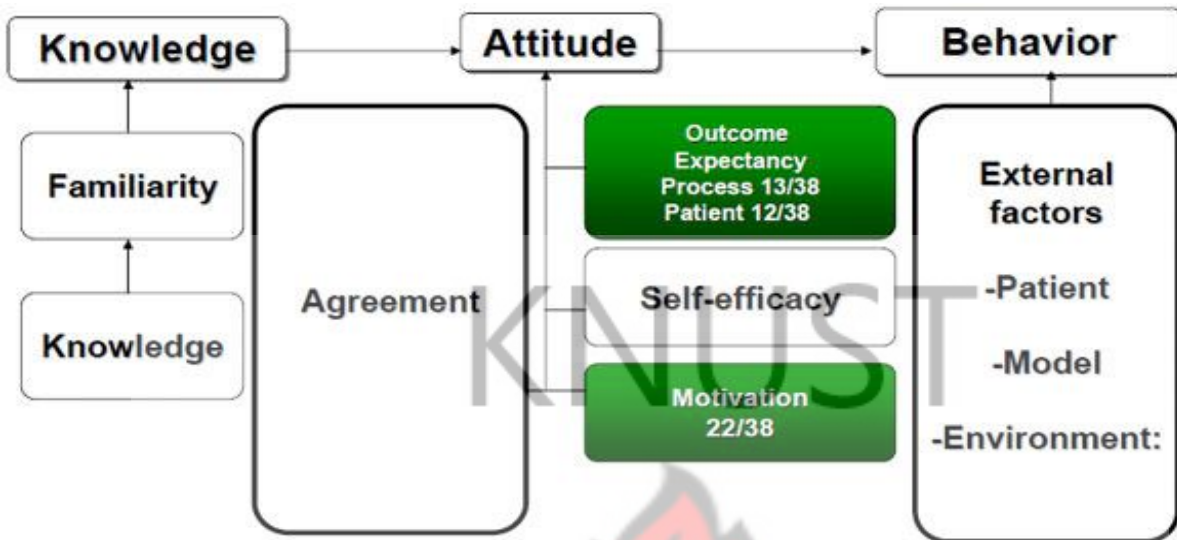


Fig. 2.2 Knowledge-Attitude-Practice Framework.

Source: Légaré, Ratté, Gravel and Graham (2008).

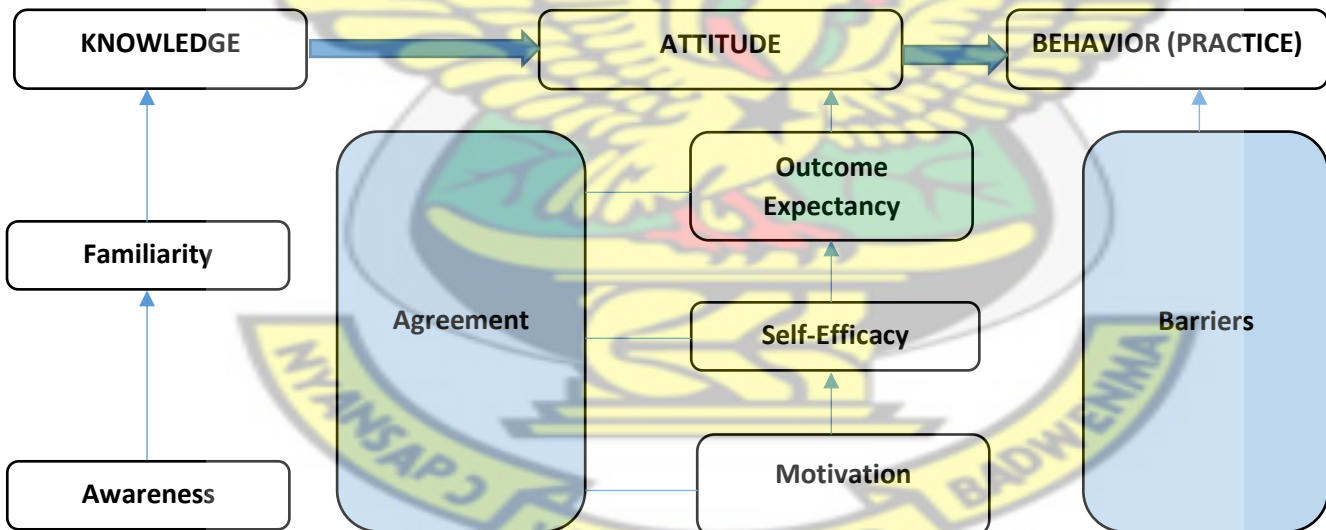


Fig.2.3: A Conceptual framework of Knowledge Attitude and Practice of SAS use for road navigation.

Source: Adapted from Légaré, Ratté, Gravel and Graham (2008).

2.9.3 Defining the Framework Context

Knowledge

In this study, measurement of knowledge was concerned with assessing the levels of individuals' awareness and familiarity with maps and addressing systems. This includes individuals' personal assessment of their level of knowledge about maps, their ability to read and use maps and their opinions about the general uses of maps. Specific questions were asked about one's familiarity with maps and addressing systems.

Attitude

Attitude in the context of this study relates to individuals' feelings and perceptions about the use of maps and addressing systems specifically for road navigation as well as their willingness to access and use these facilities. The study also considered individuals' perception about the necessity of addressing systems for road navigation. Motivation, self-efficacy and outcome expectancy are identified as major influences on Attitude. Perceived Self efficacy explains the extent to which an individual believes that he/she possesses sufficient skills to use maps and addressing systems for road navigation. Outcome expectancy also looks at the perceived benefits that one believes would accrue to the use of maps and addressing systems for road navigation.

Practice

Practice measures the extent of an individual's usage of maps and addressing systems. The study also identified some general practices related to road navigation in general including the extent to which Individuals' rely on public transportation for daily commuting and how often individuals use a particular means of public transport. In order to identify and assess the extent of personal and external hindrances to practice, various challenges encountered in the use of maps and addressing systems were identified. Practice is influenced by possible barriers examples of which in this study included personal barriers such as inability to read maps and

external barriers such as difficulties in downloading maps and addressing applications for road navigation.

Understanding the levels of Knowledge, Attitude and Practice would help create the avenue for a more efficient process of awareness creation (Kaliyaperumal, 2004). This is critical for knowledge creation and acquisition which would in turn favour behaviour (practice). Drawing from the assumptions of the KAP model, it could be assumed that higher levels of knowledge about maps and addressing systems leads to positive or favourable attitudes which would subsequently lead to the use of maps and addressing systems specifically for road navigation.

The study adds that, awareness creation and the incorporation of Local Travel Route Information (LTRI), for example, traditionally assigned street names into our street addressing systems would help easy acquisition of knowledge about the SASs and also increase familiarity with the system. This would help favour a more positive attitude towards SASs and as such improve Practice (Usage) of these addressing systems for road navigation. The achievement of these would help easy navigation and therefore increase accessibility to places and facilities, leading to a general improvement in urban mobility in Kumasi as depicted in figure 2.4.

Table 2.1 Description of Constructs

KNOWLEGDE	
Awareness	Ability to correctly acknowledge the existence of SASs.
Familiarity	Ability to correctly answer questions about SAS including its relevance for road navigation and urban mobility. Self-reported level of familiarity
ATTITUDE	
Outcome expectancy •user's outcome	Perception about the possible benefit that one could derive from the use of SAS for road navigation

Self-efficacy	Belief that one is equipped with the necessary knowledge and skills to uses an addressing system for road navigation.
Motivation	Motivation to use SAS for navigation or to change from the traditional way of addressing and navigating
BARRIERS /CHALLENGES	
Knowledge Base	Lack of awareness and familiarity with Addressing systems
Lack of resources	Lack or insufficient resources to use SAS for road navigation (for example, phones, laptops,)
Lack of access to services	Inadequate access to services that would enable the use of SAS for road navigation (For example, internet access)

Source: Author's construct, 2018.

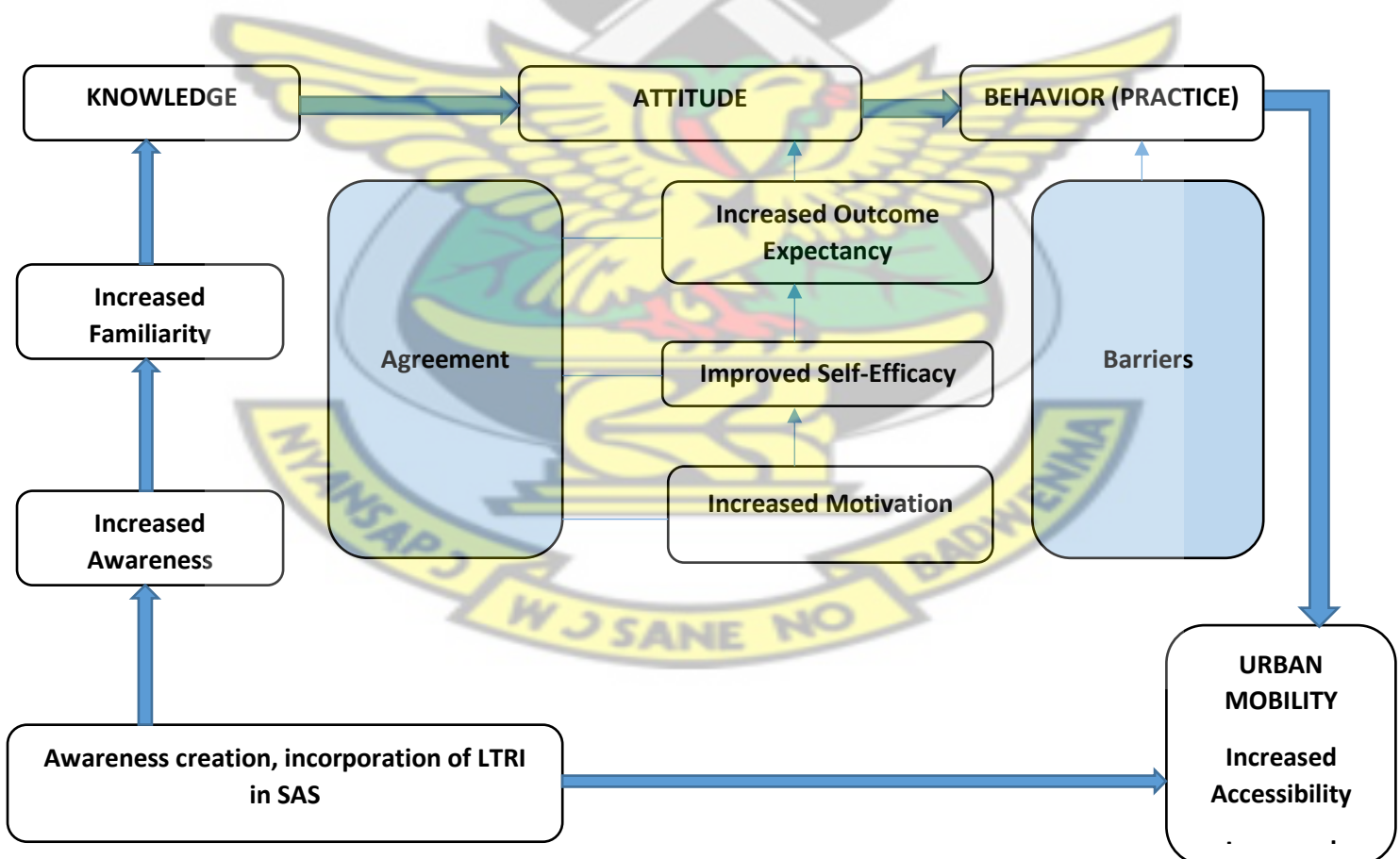


Fig.2.4: A Conceptual framework of KAP reflecting outcome of integrating LTRI in SAS development.

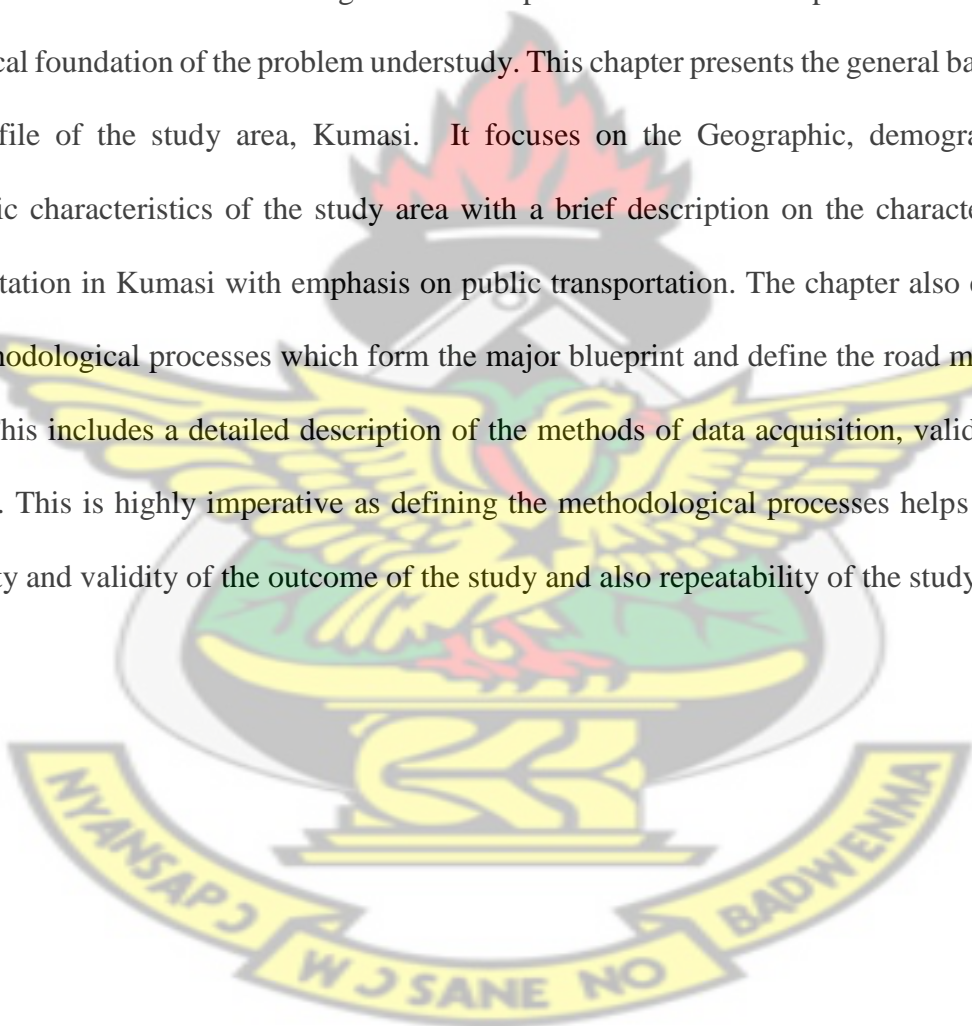
CHAPTER THREE

PROFILE OF STUDY AREA AND METHODOLOGY

3.1 Study Area Profile

3.1.1 Introduction

The previous chapter dealt with a review of existing literature on the problem under investigation. The works of various scholars were carefully examined and the major themes and patterns of their works with regards to the topic identified. The chapter also looked at the theoretical foundation of the problem under study. This chapter presents the general background and profile of the study area, Kumasi. It focuses on the Geographic, demographic and economic characteristics of the study area with a brief description on the characteristics of transportation in Kumasi with emphasis on public transportation. The chapter also explicates the methodological processes which form the major blueprint and define the road map for the study. This includes a detailed description of the methods of data acquisition, validation and analysis. This is highly imperative as defining the methodological processes helps to ensure reliability and validity of the outcome of the study and also repeatability of the study process.



3.1.2 Geography of Study Area

Kumasi metropolis is now the largest and most populous among the 30 districts in Ashanti Region. Kumasi is located between Latitude 6.35°N and 6.40°S and Longitude 1.30°W and 1.35°E and elevated 250 to 300 meters above sea level. Kumasi shares Eastern, Northern, Western and Southern boundaries with Kwabre East and Afigya Kwabre, Atwima Kwanwoma and Atwima Nwabiagya, Asokore Mampong and Ejisu-Juaben Municipality, and Bosomtwe Districts respectively. Kumasi is located 270km north of Accra, the capital city Ghana. The metropolis covers an area of about 214.3 square kilometres. This constitutes almost 0.9 percent of the total land area of Asante Region (GSS, 2014).

Ashanti region in general and Kumasi metropolis in particular serves as an important nodal point and a linking thread between the northern and southern parts of Ghana. There exist to a larger extent, a symbiotic relationship between Kumasi and its adjoining districts as well as Accra, the national capital. The metropolis could be described as the hub of all commercial activities and trading in the country due to the presence of large markets and transportation avenues linking the city to all other parts of the country. Adjoining districts serve as bread baskets for the metropolis by providing farm produce for the city's inhabitants. Kumasi in turn provides the avenue for marketing these produce to consumers from all other parts of Ghana and beyond. Apart from providing marketing avenues for sale of agricultural and other products, the metropolis also provides an array of services for residents from adjoining districts and from other parts of the country. These include healthcare services, education and training, financial services, inter-city transport services and wholesale and retail trade.

3.1.3 Population of Study Area

Reports from the 2010 Population and Housing Census indicate that the population of Kumasi Metropolis is 1,730,249. This represents 36.2 percent of the total population of Ashanti Region. Thus, the metropolis serves as an abode for about 36.2 percent of the region's population. The

Metropolis has a sex ratio of 91.4. The age dependency ratio for the Metropolis in general is 58; while the age dependency ratio for males is 59.9 for females and 56.3.

Kumasi has a high population with an ascending rate of growth estimated to be 5.4% annually (GSS, 2012). The city is also the most commercialized centre in the region. Other reasons for the high population and ascending rate of growth include the centrality of Kumasi as a nodal city with major arterial routes linking it to other parts of the country and also the fact that it is an educational centre with a lot of educational institutions including three state universities, private universities, teacher training colleges, senior high schools and large number of basic schools.

A display of Kumasi's population pyramid shows a broad based structure which is an indication of a large number of children and young adults especially below the age of 24 (GSS, 2012). The Metropolis has an active labour force numbering up to 1,095,190 out of the total population of 1,730,249. This indicates a highly mobile population who commute daily for educational and commercial purposes. This also implies a higher demand for transportation and especially public transportation which is the dominant means for transporting over 70 percent of the City's population (Poku-Boansi and Adarkwa, 2013).

3.1.4 Socio-Economic Characteristics

According to the 2010 housing and population census reports, the total number of households in Kumasi metropolis is 440,283 households with an average household size of about 4 persons. Children constitute the largest proportion of the household members accounting for 39.7 percent and spouses 9.9 percent. The percentage of population aged 11 years and older who are literate is 89.5 percent while 10.5 percent are not literate. Among the literates, 72 percent could read and write in English and at least one Ghanaian language. This indicates higher literacy levels which could have a direct bearing on the levels of knowledge about maps and addressing systems as well as their use in Kumasi Metropolis.

66.5 percent of the population of Kumasi metropolis aged 15 years and older is economically active while 33.5 per cent is economically not active. 91.4 percent of the economically active population is employed while 8.6 percent is unemployed. About 49.2 percent of the workforce is self-employed without employees with females and males proportions as 60.1 percent and 37.9 percent respectively. The high levels of employment implies higher levels of mobility and therefore the need for increased accessibility to work places and other essential facilities and services.

3.1.5 Transport

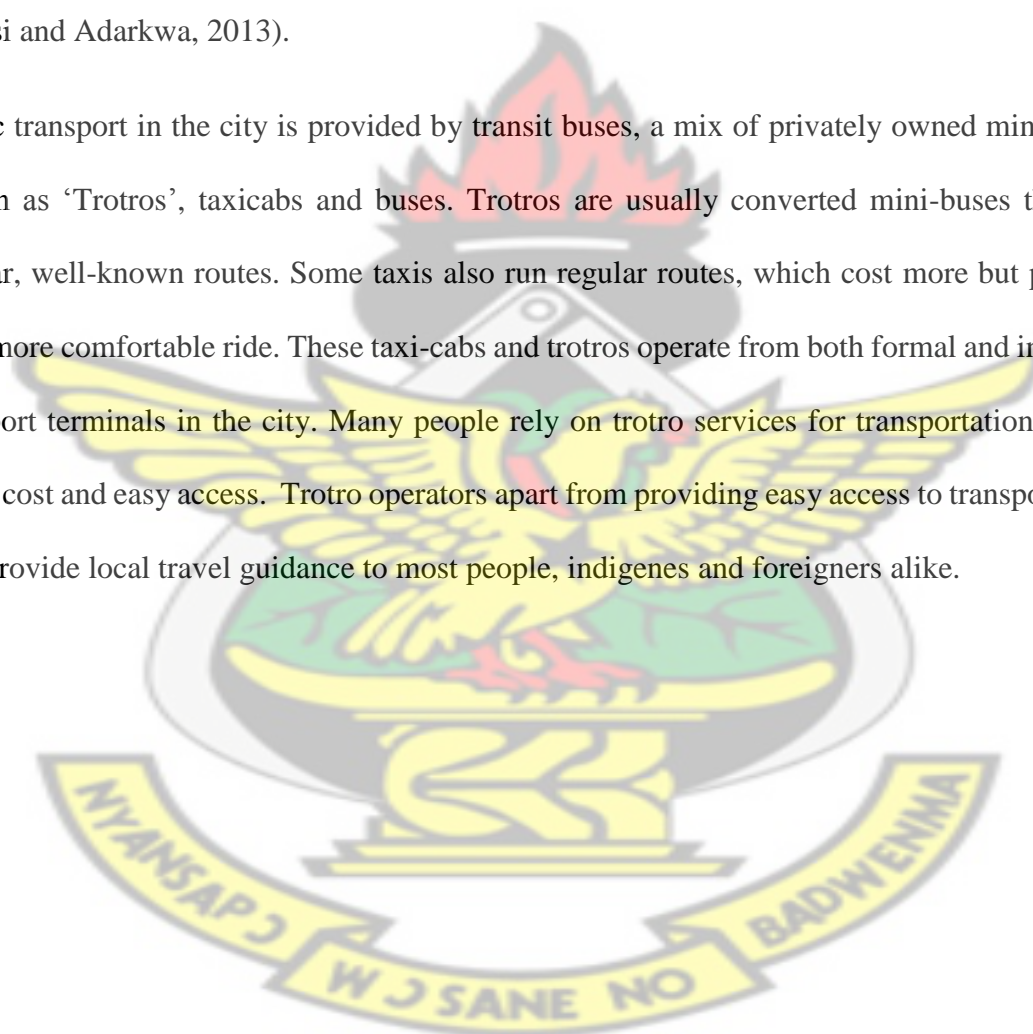
Road transport is the predominant mode of transportation in Kumasi metropolis. Presently, the city's inventoried road is in excess of the 1,931km in length. The road networks link Kumasi to Accra (the national capital). They also link it to the country's natural resource centres at Obuasi in Ashanti Region, Cape Coast in the Central Region, and Takoradi in the Western Region (GSS, 2014). Kumasi serves as the convergent point of five major arterial trunk roads and national highways. There are also major transport terminals in the metropolis which serve as interchange points for both passengers and cargo destined for different parts of the country (Adarkwa and Tamakloe, 2001 as cited in Poku-Boansi and Adarkwa, 2013).

Another mode of transportation that serves the metropolis is air transport. Major airlines namely, Antrak, Unity, Fly 540 and African Way Airlines operate from Kumasi to other cities including Accra, Sunyani, Takoradi and Tamale. Kumasi has one airport located in the Manhyia Sub Metropolitan Area. Road Transportation in Kumasi is mostly characterized by the use of private automobiles as well as public transportation services. The high rate of growth of the city and the increasing rate of sprawl has resulted in an increase in the use of automobiles leading to increasing levels of congestion in the city. Although Public transport services

provide the mobility needs of more than half of the city's population, the sector is faced with many challenges that greatly affect efficiency and reliability.

The overall quality of services of public transport services in the metropolis is poor. Most vehicles that ply major roads are old with very low maintenance standards. There is a lot of congestion and therefore increased waiting hours especially during peak hours due to low capacities and low service quality in the public transport sector. These challenges do not only affect daily intra and intercity movements but also affect urban transportation in general (Poku-Boansi and Adarkwa, 2013).

Public transport in the city is provided by transit buses, a mix of privately owned mini-buses known as 'Trotros', taxicabs and buses. Trotros are usually converted mini-buses that run regular, well-known routes. Some taxis also run regular routes, which cost more but provide for a more comfortable ride. These taxi-cabs and trotros operate from both formal and informal transport terminals in the city. Many people rely on trotro services for transportation due to lower cost and easy access. Trotro operators apart from providing easy access to transportation also provide local travel guidance to most people, indigenes and foreigners alike.



MAP OF KUMASI METROPOLIS

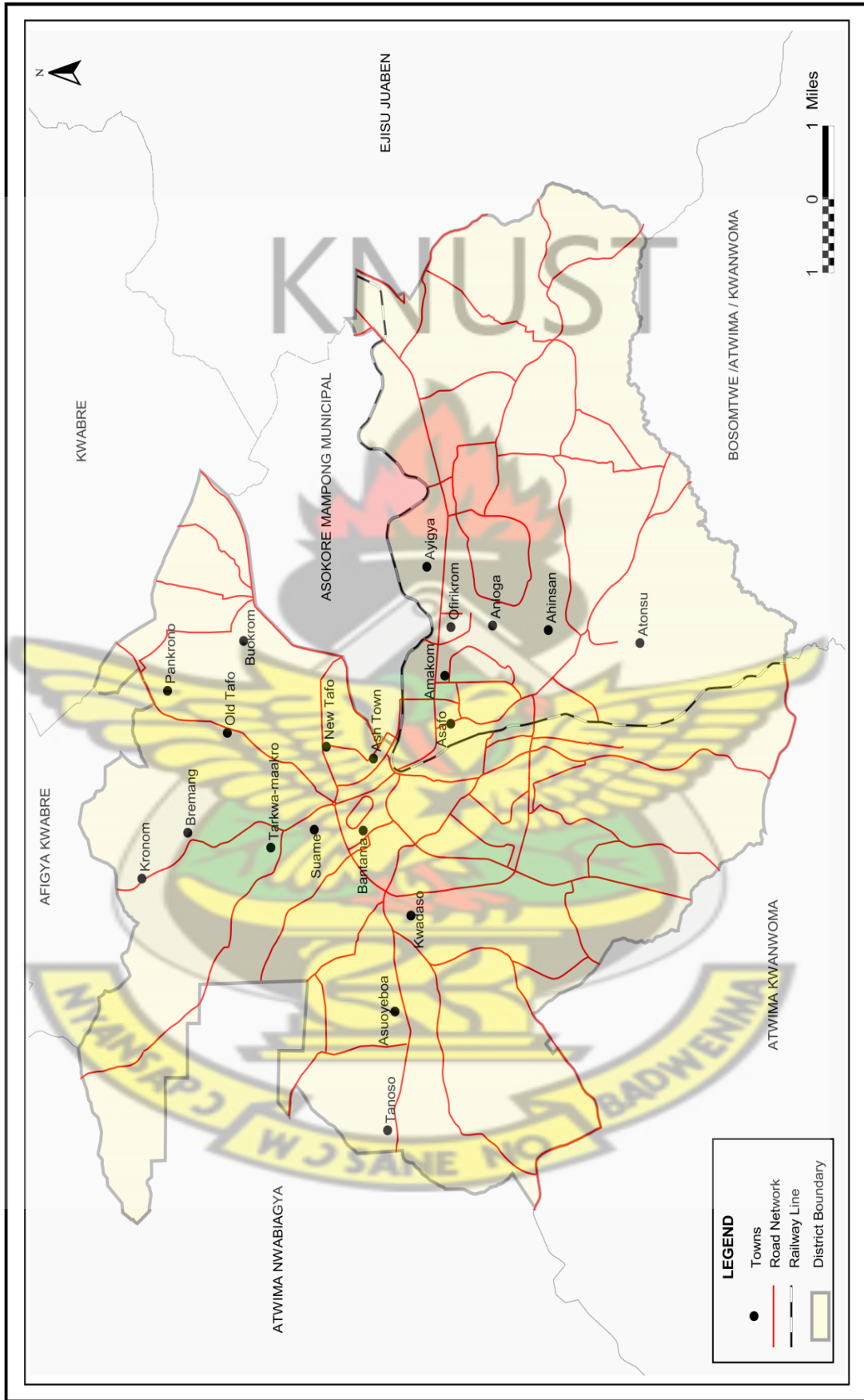


Fig 3.1 Map of Kumasi Metropolis.

Source: GSS. 2014.

A MAP OF THE SELECTED COMMUNITIES AND SELECTED ROUTES

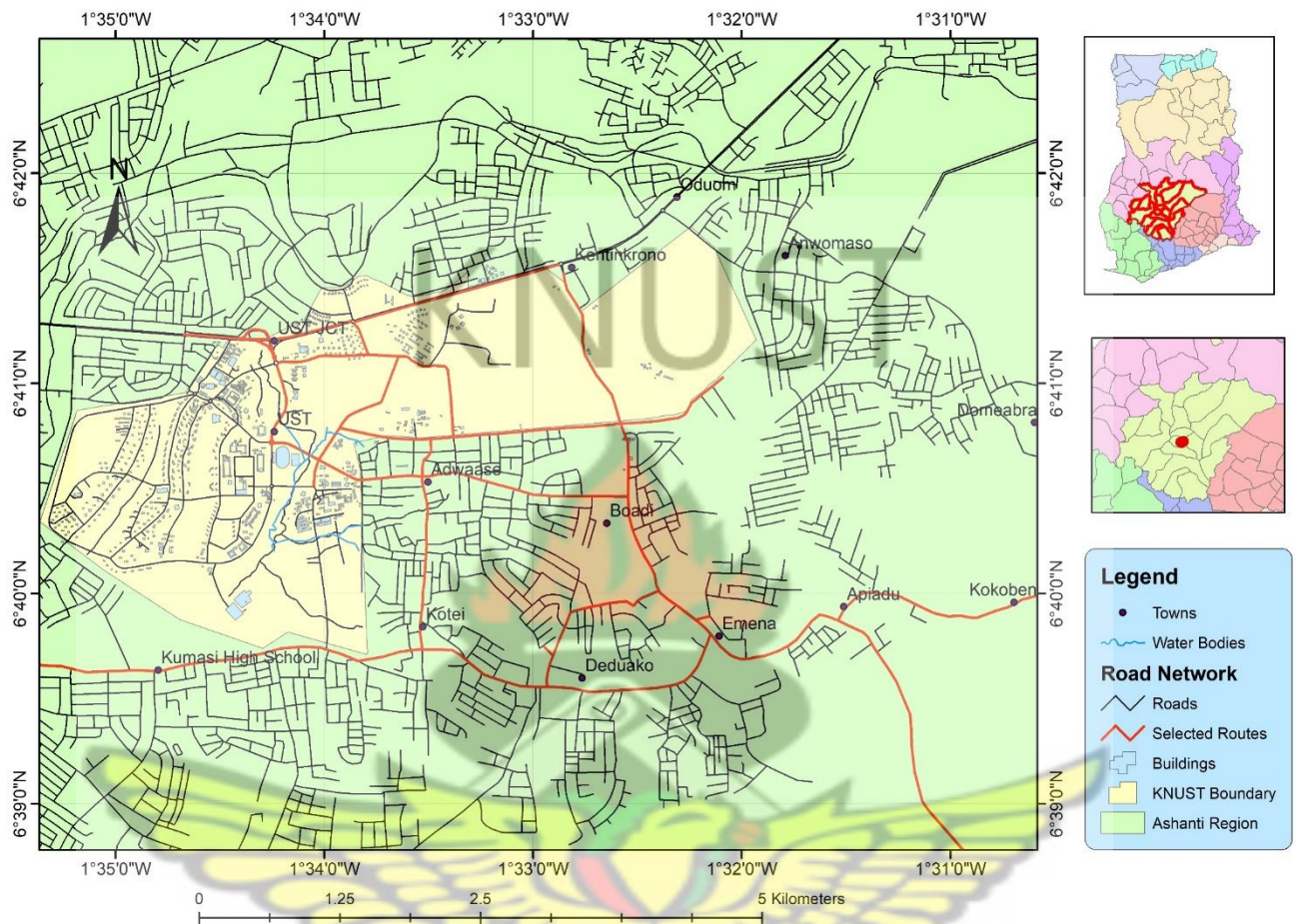


Fig 3.2 A map of selected communities highlighting selected routes.

Source: Author’s construct, 2018

3.2 Methodology: General Study Design and Approach

3.2.1 Research Design

The cross-sectional design was adopted for this study. Cross-sectional study is a type of observational study that analyses data from a population, or a representative subset, at a specific point in time. This study design was carefully chosen as it is particularly suitable for estimating the prevalence of a behaviour in a population (Sedgwick, 2014). Again, with this study design, the researcher sought to obtain a representative sample by taking a cross-section of the population. Other advantages that accrue to the use of this research design are that; cross-

section studies are capable of using data from a large number of subjects and unlike other observational studies, it is not geographically bound. Again, the use of this study design is helpful in estimating prevalence of an outcome of interest because the sample is usually taken from the whole population. Using this design, both spatial and non-spatial (survey) data were collected once from a representative sample of the study population. The data were analysed using QGIS and SPSS Version 22 respectively.

3.2.2 Research Approach: GIS and Quantitative Techniques

For the purpose of achieving the objectives of the study, both spatial and non-spatial data were collected and analysed using quantitative techniques appropriate for each data type. This approach has its basis in the philosophical arm of positivism which emphasises the use of quantitative techniques in arriving at empirical conclusions. Quantitative methods mostly employ surveys and experiments in the investigation of phenomena (Harrison et al, 2017). Spatial data collection and analysis mainly involved the collection of vector data in the form of points followed by a sequential mapping process and analysis in QGIS. The use of this spatial analytical tool for the study was necessitated by its ability to aid the collection and analysis of the appropriate data needed for this study. Moreover, the successful application of GIS in solving an array of transportation problems across the globe cannot be overstated (Hanson and Giuliano, 2004). The collection of non-spatial data involved a field survey which was aimed at eliciting responses on respondents' knowledge and use of maps and addressing systems, particularly for road navigation. The survey was conducted in eight communities which were purposively selected for the study. Figure 2.5 and 2.6 show the general study approach and the spatial and attribute data acquisition and transformation processes respectively.

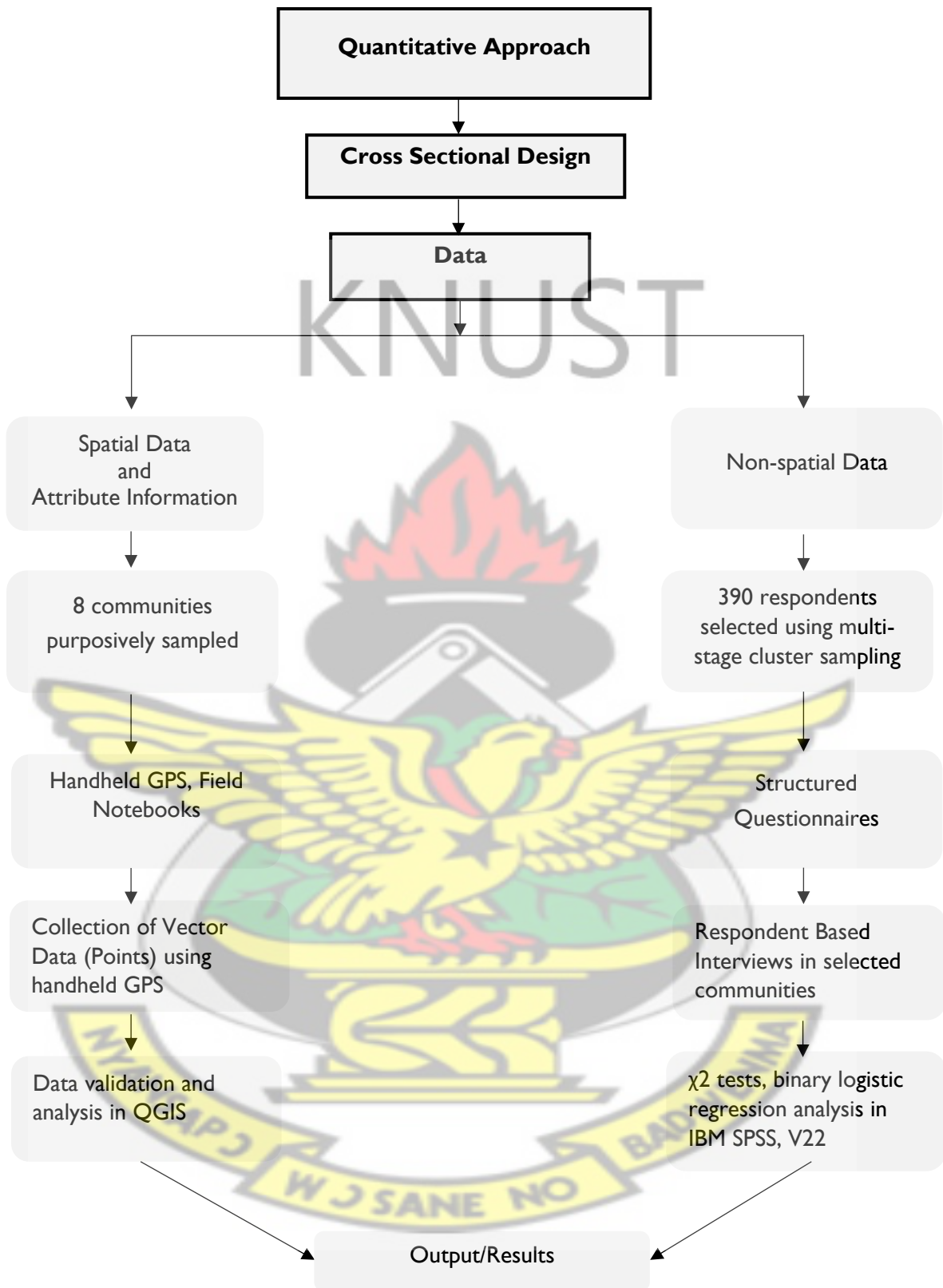


Fig.3.3 Diagrammatic representation of the general study approach

Source: Author's construct, 2018.

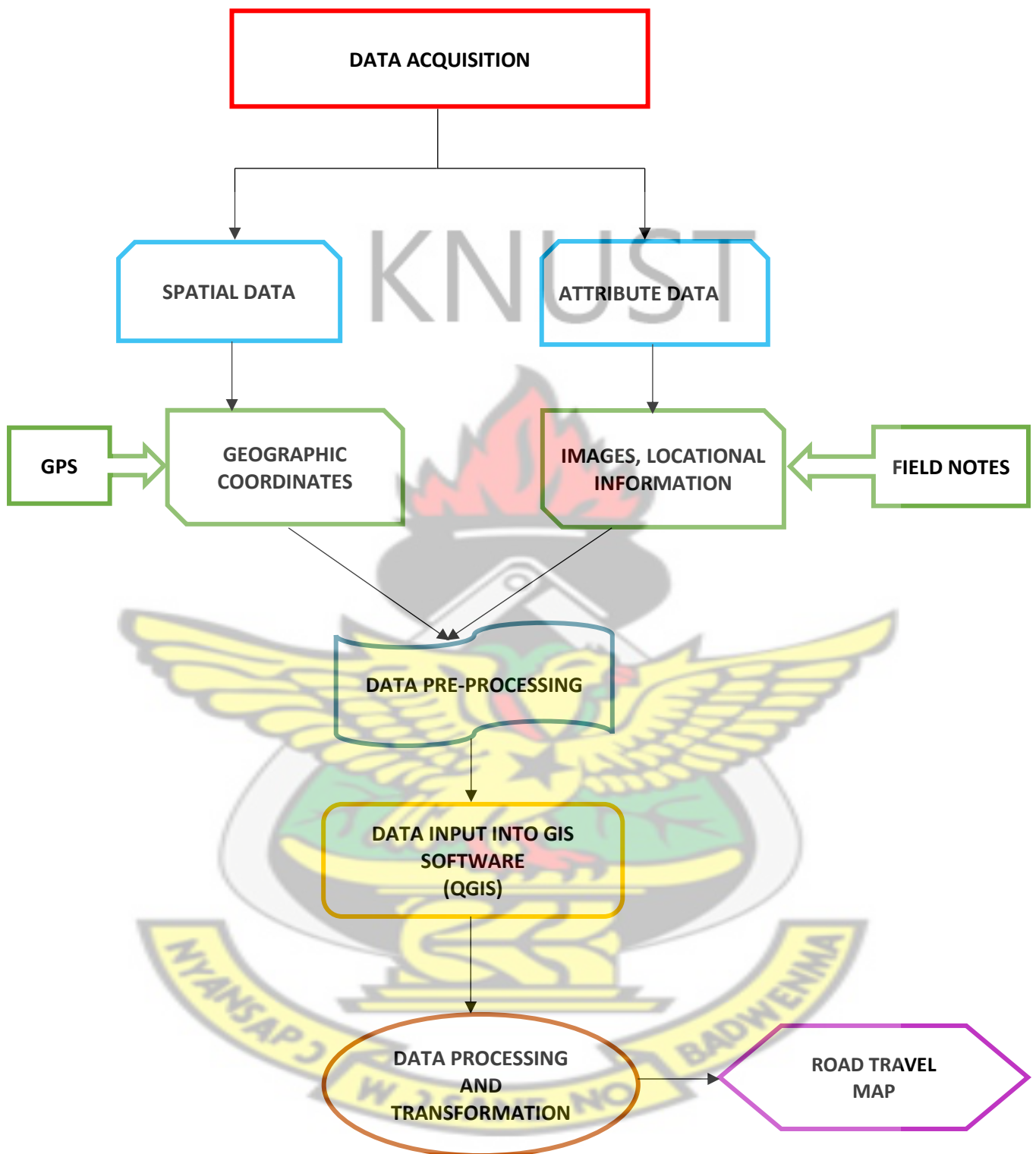


Fig. 3.4 Spatial and attribute data processing workflow

Source: Author's construct, 2018

3.2.3 Data Acquisition Methods- Spatial Data

Specifically, eight communities were covered in the study. These areas were purposively selected to allow for in-depth data collection and analysis and also to ensure the repeatability of the mapping process in other areas. These communities also form a complete road network loop with the Kwame Nkrumah University of Science and Technology (KNUST) campus as the upper boundary. Many people living in these areas make daily commutes to the central business district (CBD) for a plethora of purposes. The KNUST commercial terminal serves as an important transit point linking the sub-urban communities and the CBD. A hub of activities also link the KNUST community to these surrounding communities where a greater proportion of the student populace reside. Using the KNUST commercial transport terminal (Tech Junction) as the radiating point, data were collected along major trotro routes emanating from the terminal to surrounding communities, specifically; Oduom, Boadi, Emena, Kotei, Ayeduase, Apemso, Appiadu and Kokoben.

Primary field data collection involved the use of GPS technology in collection of vector data in form of points representing alighting points along selected trotro routes. Data on key landmarks such as schools, hospitals, financial institutions, etc. and major trotro stops were also collected and represented as points using a handheld GPS. The choice of a handheld GPS for the collection of the data was to ensure the accuracy of spatial data.

The field data collection also included the collection of attribute data pertaining to the routes and their major stops as well as the key landmarks. Information on local knowledge of Trotro routes, for example, local names assigned to various stops were acquired from trotro drivers and their conductors (mates), passengers, pedestrians and community dwellers who voluntarily participated in the study. The source of secondary data for this study was mainly open street data on roads and major points such as communities in the selected areas.

3.2.4 Spatial Data Acquisition Process

Spatial data needed in order to achieve the objectives of the study basically constituted secondary data in the form of open street maps and primary field data. In order to appropriately map major trotro travel routes and their stops, primary field data collection focussed on the acquisition of point data pertaining to the major trotro alighting points (stops) and major landmarks associated with these stops. Information on local knowledge of Trotro routes, for example, local names assigned to various stops and the various communities along these major routes were acquired from trotro drivers and their conductors (mates), passengers, pedestrians and community dwellers. The major landmarks that were considered included schools, hostels, financial institutions, hospitality facilities and law enforcement facilities. The data collection materials used included a handheld GPS, a field booking sheet, a field notebook, pencils and erasers.

Trotro drivers and their conductors (mates) who ply the major routes in the selected areas were actively involved in the field data collection. One trotro was used for every major route with the driver stopping at every single stop along the route. At a stop, the geographical coordinates of the stop were taken and stored with the handheld GPS. The field booking sheet was also used to record the same information and other relevant information including the local name assigned to the stop, street names, community names and road names. The geographical coordinates of any significant landmark as listed above were recorded and the name or type of landmark was also recorded in the field booking sheet. Any information recorded in the field notebook began with the point ID and name of the stop.

Table 3.1 Spatial data acquisition plan

MAJOR ROUTES	DATA COLLECTION INSTRUMENTS/MATERIALS	LANDMARKS
R1. Tech Junction - Boadi Junction (shell)	Handheld GPS	Schools
R2. Boadi Junction -Boadi Community	Field booking sheet	Hostels
R3. Tech Junction – Boadi	Field notebook	Financial Institutions
R4. Boadi – Kokoben	Pencil	Hotels
R5. Tech junction – Emena	Pen	Guesthouses
R6. Tech junction- Boadi (mango road)	Eraser	Churches
R7. Ayeduase- Mango road	Camera	Mosques
All other minor but significant routes		Hospitals Clinics Police Station

Source: Author’s construct, 2018.

3.2.6. Respondent-based Data Acquisition

3.2.6.1 Data collection

Respondent-based primary data needed for the study were collected through the use of structured questionnaires. The use of the structured questionnaire was to ensure the acquisition of standardised data for quantitative analysis (Bryman, 2004 as cited in Boateng et al., 2017). The data was collected from sampled respondents in the selected communities with the help of trained enumerators who assisted in administering the questionnaires. This helped to minimize ambiguities which could result from the wrong interpretations or understanding of questions by respondents. Permission was sought from individual respondents to ensure total voluntary participation by respondents.

3.2.6.2 Sampling

Purposive sampling was used to select 8 communities from which respondents were sampled.

A representative sample size was determined using the World Health Organization validated sample size estimation formula (Lwanga and Lemeshow, 1991) at a confidence level of 95%:

$$n = \frac{Z^2 P(1-P)}{d^2},$$

KNUST

where n = Sample size, Z = Z statistic for a level of confidence, P = expected prevalence or proportion and d = Precision.

For the purpose of this survey, $Z = 1.96$ at 95% confidence level, $P = 0.5$ (estimated prevalence, that is, the proportion of the population that rely on public transportation. There is no accurate estimation of public transportation users, specifically, taxi and Trotro users in Kumasi Metropolis. As stated by Lwanga and Lemeshow (1991), an estimate of 50% (0.5) was chosen for the study to ensure a larger sample size and appropriate representation of the entire population.

$1-P = P_2$, where P_2 (0.5) is the proportion of the population that does not rely on Trotro and Taxis as a major means of public transportation in Kumasi and $d = 0.05$. The final sample size for the survey was estimated to be $368.77 \sim 384$, representing the minimum sample size for the study.

$$n = \frac{(1.96)^2 * 0.5(0.5)}{(0.05)^2}$$

$$= \frac{0.9604}{(0.05)^2} = 368.7936$$

Table. 3.2. Community sample allocation based on population size

<i>COMMUNITY</i>	<i>TOTAL POULATION</i>	<i>SAMPLE</i>
Ayeduse	21816	112
Kotei	17751	91
Emena	2470	13
Boadi	7994	41
Deduako	13152	68
Appiadu	5100	26
Kokoben	2956	15
Oduom	3447	18
Total- 8Communities	Total- 74686	Total Sample Size- 384

Community sample calculation- $\text{Total Sample} / \text{Total Population} * \text{Community Population}$

Source: Author's construct, 2018.

With regards to sample size allocation to the selected communities, the population allocation approach was used to distribute sub-samples among the various communities on the basis of their respective population sizes as shown in table 3.2 above. This was done to ensure full representation and reduce the tendency of bias. A multi-stage cluster sampling technique was used in selecting respondents from each community. This was also necessary to ensure representativeness by giving each eligible community member, an equal chance of being selected. The first step involved a cluster sampling procedure in each community. The procedure involved the division of a community into a North-South-East and West clusters of 4 zones. An equal number of respondents, that is, the community sub-sample divided by 4 was selected on house basis. In each house, one adult was randomly selected and interviewed.

Respondent eligibility was based on a minimum statutory age of 18 years or older. This minimum age threshold was based on the constitutional basis that persons aged 18 years and

above are considered matured and could make personal decisions and to participate in national and political decisions (Republican Constitution of Ghana, 1992).

3.2.6.3 Data Analysis

Prior to the quantitative analysis, the data collected were checked for errors and inconsistencies and the necessary corrections were made. Where necessary, cross-references were made to the original questionnaires to aid with corrections. The analysis of data was presented in three stages. First, descriptive statistics using frequencies and proportions and cross tabulations were used to summarise the sample characteristics. Second, Pearson's χ^2 tests were calculated to determine the bivariate associations between the knowledge, attitudes and practices of maps and SAS domains. Finally, logistic regression models were built to estimate the relationships and associations between selected outcome and exposure variables. A *p*-value less than 0.05 was considered statistically significant and all analyses were performed using SPSS v.22.0 (IBM, Armonk, NY).

In addition, the analysis of spatial data focussed on processing and transforming local locational information with the aid of Geographic Information Systems (GIS). This was achieved using QGIS software. Locally acquired locational route information was pre-processed to eradicate any errors and transformed through a sequential mapping process. Data on stop names, community and road names as well as information on important landmarks were first entered using notepad and then transferred to M.S Excel format to create a database. This information was then used to create a map and an associated attribute table.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The previous chapter introduced the study area and the methodology of the research work. This chapter aims at providing critical analysis of spatial and survey data gathered in the study for the purpose of investigating the potential of incorporating local travel route information in addressing systems development to improve urban mobility in Kumasi, Ghana.

Spatial data was gathered through the use of a handheld GPS to ensure accuracy while non-spatial primary data was gathered through the use of structured questionnaires. In all, 390 out of 400 administered questionnaires were validated and analysed. Specifically, this chapter consists of five sections. The first section comprises of a description of the socio-demographic characteristics of study participants while sections 4.2-4.6 provide answers to specific research questions on which basis the objectives of the study were set. These included questions on the means of urban mobility (modal choice) and travel behaviour of study participants, knowledge and use of maps and addressing systems, the relationships between Knowledge, attitudes and SAS use for road navigation and finally, local travel route data acquisition and mapping.

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4.2 Socio-Demographic Characteristics of Study Participants

Table 4.1 summarises the socio-demographic characteristics of the 390 respondents in the study with respect to sex, age, marital status, ethnicity and level of formal education. Males formed the majority of the study population with a proportion of 75%. This pattern is observed in all the communities except Kokoben where the percentages for male and female respondents were the same (50%). This trend in sex distribution is a deviation from the observed trend in some previous studies in Kumasi Metropolis. For example, in their studies, Sam et al., (2018) and Poku-Boansi and Adarkwa (2013) reported Female majorities of 54.4% and 54.3% respectively among participants.

With respect to age, persons aged 20-29 years formed the majority among the respondents followed by those aged 30-39 and then those less than 20 years representing 16% and 8 % respectively. Whiles persons aged 40-49 years represented 5% of the entire respondent population, Ages 50-59 had the least proportion of 2%. Among the communities however, some differences where observed. In Emena for instance, majority of the respondents were between the ages of 30 and 39. This is different from Ayeduase where 98% of the respondents were between the ages of 20-29 most likely as a result of the high student population in Ayeduase (see Table 4.1). Majority of the respondents representing 79% were not married, whiles 21% were married. This trend is observed throughout all the communities. A larger proportion of the respondents (65%) were Akans whilst 35% were from other ethnic groups such as Ga, Kusasi, Dagomba, Ewe, to mention but a few. This pattern comes as no surprise as the study area is dominated by Akans, mostly Ashantis, Bonos, Akuapems and Fantes. This pattern was however not observed in Ayeduase where 57% of the respondents were not Akans. This could also be explained on the basis of the high student population in Ayeduase.

The educational background of respondents reveal that, majority of the respondents, constituting more than 95% had had at least middle school formal education with less than 5% having primary education or no formal education. The higher levels of formal education recorded, especially College/Tertiary education making up 70% of the entire respondent population is expected as most of the selected communities serve as dormitory towns for students and homes for many workers in the Kwame Nkrumah University of Science and Technology (KNUST). The educational levels of respondents have direct implications on trip making and daily commuting. As asserted by Poku-Boansi and Adarkwa (2013), people who have acquired formal education generally undertake activities that may result in increased number of trips.

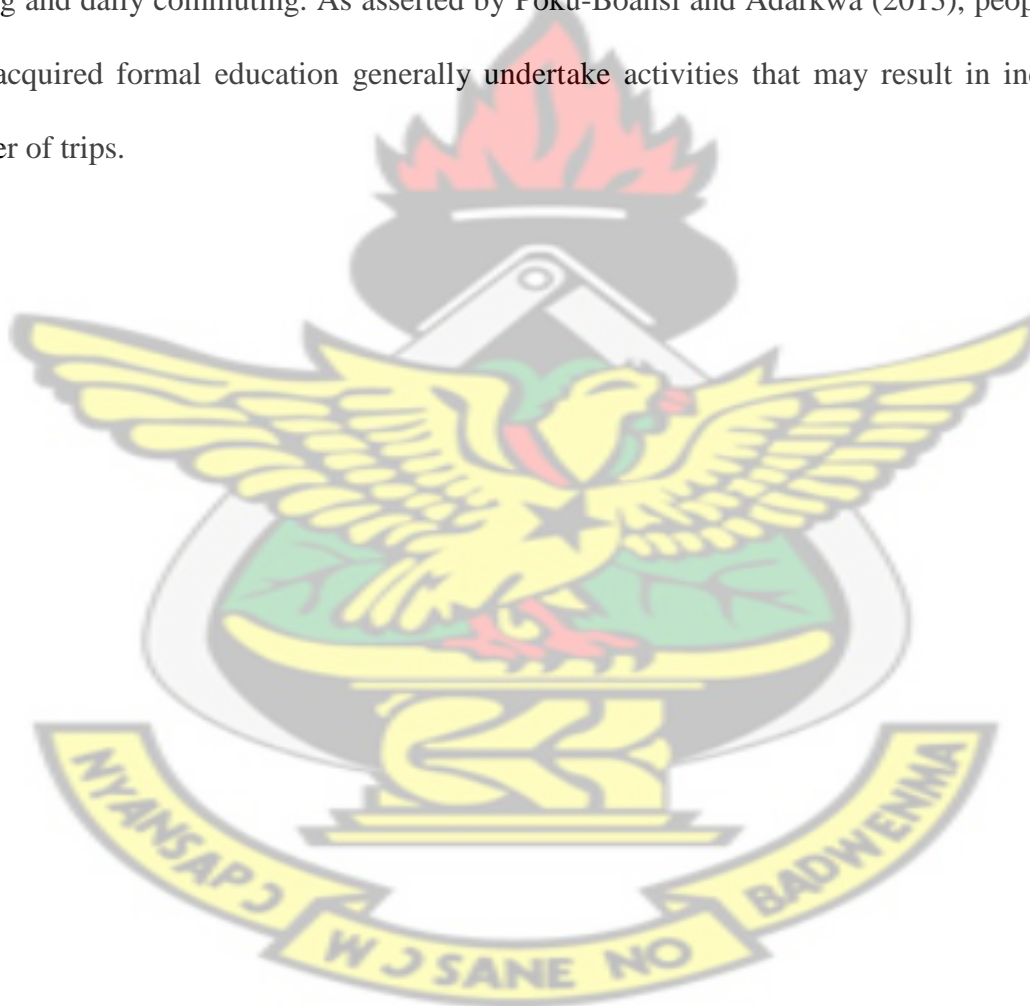


Table 4.2 Urban mobility means and travel behaviour of respondents by Community

Characteristics	Sub-Category	Frequency (N)	Percentage (%)
Most frequent travel means	Private Automobile	26	6.7
	Minibus (Trotro)	245	62.8
	Taxi cab	20	5.1
	Cycling	12	3.1
	Walking	87	22.3
Means Preference	Lower Cost	233	59.7
	Easy Access	186	47.7
	Convenience	127	32.6
	Comfort	18	4.6
Frequency of Trotro Use per Week	Not at all	5	1.3
	1- 3times	65	16.7
	4-6 times	75	19.2
	More than 7times	245	62.8
Number of trips per day	2	311	79.7
	3	48	12.3
	4	24	6.2
	5	7	1.8
	Time per Daily Commuting	Less than 30 minutes	271
30 minutes- 1hour		68	17.4
1- 2 hours		40	10.3
2-3 hours		11	2.8
Other trips with preferred means	Church	270	69.2
	Social Gatherings	61	15.6
	Market	39	10.0
	Recreational Facilities	20	5.1

Source: Field survey, 2018.

4.3 Modal Choice and Daily Travel Behaviour of Respondents

Identifying respondents' travel behaviours was deemed necessary due to the need to understand how respondents' navigate and the possible ways in which their travel behaviour may influence their use of maps and street addressing systems. When asked about their most frequently used means of transportation (modal choice) for commuting daily to work, school and other activities, 245 respondents accounting for 63% indicated that they used commercial mini-buses (Trotro) for their daily commuting. This proportion of daily trotro commuters is more than three times the percentage of taxi cab users. This results is consistent with the findings of Okyere (2012) but also contradicts the findings of Poku-Boansi and Adarkwa (2013) where it was revealed that, taxi was the dominant means for commuting among study participants. These observed differences in modal choice preference in this study and previous studies may be attributed to differences in characteristics of respondents and differences due to the specific communities within which the studies were undertaken. A cross tabulation of modal choice by community as shown in table 4.2 revealed that, in all the communities, "trotro" dominated as the most frequent means of commuting.

When viewed from the public transport services (PTS) patronage perspective however, Trotro and Taxi together formed the dominant means of transportation for most respondents (68%). This result is in tandem with the findings of Okyere (2012), where Trotro and Taxi services were revealed as the most frequently used means of travel for all intra-city movements in the Kumasi Metropolis. A percentage share of 3% of the respondents resorted to cycling whilst 22% of respondents walked to school/work daily. Walking and cycling are identified as indispensable means of daily transport for many city dwellers in Africa (Sietchiping et al., 2012). Evidence from physical health studies support these two means of daily commuting as they serve as a means of exercising daily. The increased use of these two means of travel is also beneficial for reducing automobile dependency. This may however, not be beneficial for

public transport operators whose services these people could have patronised. The relatively high percentage share of non-motorised travel, that is, walking and cycling could be explained as a result of the proximity of respondents' workplaces to their residences as well as location of schools (Okyere, 2012). Private automobile for frequent daily commuting was also recorded at 8% with a total count of 26 although every respondent in the study was a user of public transportation means (Trotro and Taxi Cab) whether on daily basis or occasionally (at least 1-3 times a week). This dependence on private automobile usage is only expected to increase as populations continue to grow and urban sprawl continue to upsurge in Kumasi Metropolis and specifically the selected communities (Cobinnah and Amoako, 2012; Asamoah, 2010). Evidence of this is found in the results where Appiadu and Kokoben, two sub-urban communities, recorded the first and second highest percentage share of private automobile users respectively (Table 4.2).

Studies show that, generally in Ghana, the percentage of people who rely on private automobiles for daily travel continue to increase as urban populations continue to grow. Further research would be beneficial to investigate the ways through which public transportation services, especially informal transport services could be improved in order to reduce reliance on especially private automobiles which is currently becoming a basic characteristic of urban mobility in many cities around the globe (Kenworthy, 2017). Cutting reliance on automobile usage and improving public transportation systems in Ghana would help to reduce congestion and as such help to improve urban mobility.

Table 4.3 Modal Choice by factors influencing modal Choice

Modal Choice	Factors Influencing Modal Choice			
	Cost N (%)	Availability N (%)	Convenience N (%)	Comfort N (%)
Private automobile	10 (38.5)	6 (23.1)	17 (65.4)	9 (34.6)
Minibus (Trotro)	184 (75.1)	131 (53.5)	53 (21.6)	2 (0.8)
Taxicab	2 (10.2)	11 (55.0)	10 (50.0)	6 (30.0)
Cycling	6 (50.0)	5 (41.7)	5 (41.7)	0 (0.0)
Walking	31 (35.6)	33 (37.9)	42 (48.3)	1 (1.1)
Total	233 (59.7)	186 (47.7)	127 (32.6)	18 (4.6)

Source: Field Survey, 2018

On a multiple response scale, respondents expressed various reasons for the preference of a particular modal choice. Lower cost and availability stood as the paramount motivations for modal choice preference whilst comfort recorded the lowest proportion of 5% (see table 4.2). In table 4.3 above, most trotro commuters (75%) agreed to lower cost being the major motivating factor for selecting trotro. In a previous study by Okyere (2012) however, most respondents placed premium on convenience as the major influencing factor in choosing a particular means of transport for daily commuting.

A cross tabulation of modal choice and factors influencing modal choice (Table 4.3) further indicates that, half of the respondent population (9 out of 18) who answered yes to comfort as a reason or motivation for modal choice preference were private automobile users. Taxi cab recorded the next highest frequency of 6 whilst Trotro recorded only 2. It could be inferred from this results that although trotro is the dominant means of transportation for most of the respondents (63%), the quality of service especially in relation to vehicle conditions are poor. This statement is confirmed by the findings of Poku-Boansi and Adarkwa (2013) in their study on the determinants of demand for public transport services in Kumasi. Public transportation means, specifically trotros were revealed as being in poor states and having low maintenance standards resulting in much discomfort for users. This finding echoes the need for critical

attention to be paid public transportation systems management in Kumasi in order to improve the quality of services for commuters.

Table 4.4 Modal Choice by Number of Trips per Day

Daily Trip Frequency	Modal Choice					Total N (%)
	Private automobile N (%)	Minibus (Trotro) N (%)	Taxicab N (%)	Cycling N (%)	Walking N (%)	
2 trips	26 (100)	186 (75.9)	16 (80.0)	10 (83.3)	73 (83.9)	311 (79.7)
3 trips	0 (0)	37 (15.1)	1 (5.0)	1 (8.3)	9 (10.3)	48 (12.3)
4 trips	0 (0)	16 (6.5)	3 (15.0)	1 (8.3)	4 (4.6)	24 (6.2)
5 trips	0 (0)	6 (2.4)	0 (0)	0 (0)	1 (1.1)	7 (1.8)
Total	26 (100)	245 (100)	20 (100)	12 (100)	87 (100)	390 (100)

Source: Field Survey, 2018

There is much evidence in documented literature that support the claim that a higher percentage of Ghanaians in general and people in the Kumasi metropolis rely much on public transportation means for daily travel. Commercialised mini-buses, nicknamed ‘Trotro’ stand as the key means of intra- city movements (MRT and GSS, 2013; Okyere 2012). There is however little evidence on the extent of use and levels of dependency. It could be observed from Table 4.4 above that whiles in general, 63% (245) of daily commuters relied on trotro, more than 75% of Trotro users (186 out of 245 frequent users) made at least two trips to and fro every day. Trotro also recorded the maximum (6 out of 7) among the highest number of trips per day (5 trips) as shown in table 4.4. An inference could be made from this outcome that, trotro services play vital roles in meeting the mobility requirements of a substantial proportion of urban dwellers in the Kumasi metropolis. Trotros are such a basic but critical means of meeting urban mobility needs in Kumasi metropolis. Further studies could help to identify the means of improving trotro services in order to encourage patronage and widen the scope of coverage.

Table 4.5 Modal Choice by Average Travel Time

Average travel time	Modal Choice					
	Private automobile N (%)	Minibus (Trotro) N (%)	Taxicab N (%)	Cycling N (%)	Walking N (%)	Total N (%)
< 30 minutes	11 (42.3)	157 (64.1)	12 (60)	11 (91.7)	80 (92)	271 (69.5)
30 mins-1 hour	12 (46.2)	49 (20)	2 (10)	0 (0)	5 (5.7)	68 (17.4)
1-2 hours	2 (7.7)	30 (12.2)	5 (25)	1 (8.3)	2 (2.3)	40 (10.3)
2-3 hours	1 (3.8)	9 (3.7)	1 (5)	0 (0)	0 (0)	11 (2.8)
Total	26 (100)	245 (100)	20 (100)	12 (100)	87 (100)	390 (100)

Source: Field survey, 2018.

Most studies associate urban transportation and movements with long travel hours mostly due to congestion and poor traffic management (Colak et al, 2016; Cortright, 2010). Although this situation has been confirmed by some studies on urban transportation in Ghana and in Kumasi, the situation in the selected study communities differs as most respondents (70%) spent less than 30 minutes travelling to their places of work or school (Table 4.5). A closer look at the association between time spent traveling to one's destination and modal choice shows clearly that, apart from frequent private automobile users, most users of all other means of daily movements spent less than 30 minutes travelling to school or work. This could be explained on the basis of proximity as it is possible that most respondents, especially students, reside close to their schools. Apart from employing a particular means of transport to travel to work or school, respondents also engaged in other activities such as religious meetings, social gatherings, shopping and recreational activities (see table 4.2). Church attendance using a particular modal choice was the highest among other activities undertaken by the study participants.

4.3 Knowledge and Use of Maps and Street Addressing Systems.

Identifying and understanding respondents' knowledge about maps and addressing systems was crucial to achieving the general objective of the study as one's knowledge has a greater bearing on their attitude and practice as indicated in the conceptual framework of the study. Additionally, knowledge is related to one's understanding of a phenomenon and is essential in regulating one's behaviour (Matošková, 2016).

Although the study focuses specifically on addressing systems, respondents' general knowledge about maps including their ability to read and decipher a map and their opinions about the uses of maps were sought in the study. Levels of general map knowledge and knowledge about addressing systems were measured on a self-rated five-point scale ranging from poor to excellent. Although it may be argued that self-rated level of knowledge is a subjective measure of knowledge, this measure provides individuals with the opportunity to assess their own levels of knowledge based on their experiences and familiarity with the subject matter and not based on a standardised test in which individuals could falsify responses to meet a required criteria.

Table 4.6 Univariate Results of Map and SAS Knowledge, Map Reading Ability and Map Use

Variable	Response Category		Total
	No N (%)	Yes N (%)	
Map Knowledge	6 (1.5)	384 (98.5)	390 (100)
Addressing System Knowledge	84 (21.5)	306 (78.5)	390 (100)
Map use Knowledge	7 (1.8)	383 (98.2)	390 (100)
Addressing system use knowledge	139 (35.6)	251 (64.4)	390 (100)
Ability to read a map	39 (10)	351 (90)	390 (100)
Ever used a map	39 (10)	351 (90)	390 (100)

Source: Field survey, 2018.

Table 4.6 depicts study participants' responses to having knowledge about maps and addressing systems. A majority of respondents admitted to having some knowledge about maps and addressing systems. The table however shows that more respondents (99%) had some knowledge about maps in general than addressing systems (79%). This result is further confirmed through the responses given by respondents about their awareness of the use of maps and addressing systems. It is noted that although 79% of respondents agreed to having some knowledge about addressing systems, 36% of respondents did not know about the uses of addressing systems. In response to the ability to read maps, 90% of the respondents agreed that they could read a map while 10% could not. The high literacy level among study participants provides a plausible explanation for the high map reading ability recorded.

Table 4. 7 Chi-square Analysis of Map and SAS Knowledge by Sex

Source: Field survey, 2018.

Sex	MAP Knowledge			SAS Knowledge		
	No N (%)	Yes N (%)	Total Frequency	No N (%)	Yes N (%)	Total Frequency
Male	4 (1.4)	285 (98.6)	289	60 (20.8)	229 (79.2)	289
Female	2 (2.0)	99 (98.0)	101	24 (23.8)	77 (76.2)	101
Total	6 (1.5)	384 (98.5)	390	84 (21.5)	306 (78.5)	390
$\chi^2 = .176$ P-value = 0.675			$\chi^2 = .399$ P-value = 0.528			

Pearson's Chi-square test of difference was used to test the association between Knowledge and sex. The results as seen in table 4.7 above shows no statistical association between sex and knowledge of maps and addressing systems. This implies that, one's knowledge about maps or addressing systems was not dependent on their sex. In simpler terms, being male or female did not influence whether or not one had knowledge about maps or street addressing systems.

Table 4. 8 Levels of Map and SAS knowledge

KNOWLEDGE LEVEL	MAPS		ADDRESSING SYSTEMS	
	Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)
Poor	41	10.5	135	34.6
Fair	90	23.1	141	36.2
Good	137	35.1	94	24.1
Very Good	93	23.8	16	4.1
Excellent	29	7.4	4	1.0
Total	390	100	390	100

Source: Field survey, 2018.

As clearly seen from table 4.8 above, self-rated knowledge levels are generally higher for maps than addressing systems. More than 70% of respondents had low knowledge about addressing systems (indicating fair and poor). Informal interviews conducted with respondents disclosed that almost if not all of the respondents with some knowledge about maps had at least used a map in school for academic purposes either at the basic, secondary or tertiary level of education. This explains the higher frequency of map knowledge in general as noticed as compared to knowledge about addressing systems.

Table 4.9 Levels of Knowledge and the association with Map and SAS use.

LEVEL OF KNOWLEDGE	MAP USE FOR NAVIGATION			SAS USE FOR NAVIGATION		
	Non-Use N (%)	Use N (%)	Total Frequency	Non-Use N (%)	Use N (%)	Total Frequency
Poor	34 (82.9)	7 (17.1)	41	126 (93.3)	9 (6.7)	134
Fair	48 (53.3)	42 (46.7)	90	105 (74.5)	36 (25.5)	141
Good	45 (32.8)	92 (67.2)	137	25 (26.6)	69 (73.4)	94
Very Good	8 (8.6)	85 (91.4)	93	0 (0.0)	16 (100)	16
Excellent	0 (0.0)	29 (100)	29	0 (0.0)	4 (100)	4
Total	135 (34.6)	255 (65.4)	390	256 (65.6)	134 (34.4)	390
$\chi^2 = 99.560$ P-value <0.001			$\chi^2 = 152.523$ P-value <0.001			

Source: Field survey, 2018

The chi-square test of association shows that there is a highly significant association between the Knowledge levels of respondents and their use of maps and street addressing systems for road navigation. From tables 4.9 above, it is apparent that knowledge influences both Map use and street addressing system (SAS) use for navigational purposes. The results confirm the critical role played by knowledge in shaping attitude that result in action as outlined in the Knowledge-Attitude-Practice (KAP) model. This finding begets the need for education and awareness creation in order to increase knowledge levels about maps in general and especially addressing systems. This would help expose the populace to the benefits of these facilities in solving road navigation challenges and improving urban mobility in general.

Table 4. 10 Association of Map Knowledge and Level of Formal Education

LEVEL OF MAP KNOWLEDGE	LEVEL OF FORMAL EDUCATION					Total Frequency
	No F. Education N (%)	Basic N (%)	Middle/ JHS N (%)	Secondary/ Vocational N (%)	Tertiary N (%)	
Low Knowledge	7 (5.3)	8 (6.1)	27 (20.6)	28 (21.4)	61 (46.6)	131
High Knowledge	0 (0.0)	0 (0.0)	9 (3.5)	46 (17.8)	204 (78.8)	259
Total	7 (1.8)	8 (2.1)	36 (9.2)	74 (19.0)	265 (67.9)	390

$\chi^2 = 71.204$ *P-value* <0.001

Source: Field Survey, 2018

Table 4. 11 Association of SAS Knowledge and Level of Formal Education

LEVEL OF SAS KNOWLEDGE	LEVEL OF FORMAL EDUCATION					Total Frequency
	No F. Education N (%)	Basic N (%)	Middle/ JHS N (%)	Secondary/ Vocational N (%)	Tertiary N (%)	
Low Knowledge	7(2.5)	8(2.9)	34(12.3)	64(23.2)	163(59.1)	276
High Knowledge	0(0.0)	0(0.0)	2(1.8)	10(8.8)	102(89.5)	114
Total	7(1.8)	8(2.1)	36(9.2)	74(19.0)	265(67.9)	390

$\chi^2 = 35.771$ *P-value* <0.001

Source: Field Survey, 2018.

Education plays an indispensable role in knowledge acquisition and retention (Rav-Marathe et al, 2016). Tables 4.10 and 4.11 shows that there are significant statistical associations between map and addressing system knowledge and levels of formal education. Rodrigues et al, 2012 in their study on the relationship between knowledge, attitude, education and duration of disease in individuals with diabetes mellitus established that, low education levels could limit access to information due to compromised reading, writing and speaking skills. Education also has an impact on person’s ability to understand a phenomenon. In order to reduce the proportion of cells with expected counts less than five in the Chi-square test, knowledge was categorised into a dichotomous variable of low and high knowledge.

4.4. The relationship between Road users’ level of knowledge, attitude and use of SAS.

Table 4.12 Univariate analysis of level of SAS knowledge, attitude and use.

Variable	Sub-category	Frequency (N)	Per cent (%)
Level of SAS knowledge	Poor	135	34.6
	Fair	141	36.2
	Good	94	24.1
	Very Good	16	4.1
	Excellent	4	1.0
	Total	390	100
Attitude	Negative Attitude	244	62.6
	Positive Attitude	146	37.4
	Total	390	100
SAS Use for navigation	Non-Use	256	65.6
	Use	134	34.4
	Total	390	100

Source: Field Survey, 2018

Table 4.12 shows levels of SAS knowledge, respondents’ attitudes and use of SAS for road navigation. Road users had low levels of SAS knowledge (71% for poor and fair levels of knowledge) and use (34%). Basing on GhanaPostGPS as a case study, respondents’ attitudes towards the use of addressing systems for navigation were measured using items measured on a five point Likert scale (Strongly disagree, disagree, neutral, agree and strongly agree). There were six items presented each requesting a response based on the respondent’s level of

agreement. After entering the data in SPSS, the items were re-coded to assume a single direction of attitude. The scores from the attitude test were then dichotomised into negative and positive attitude based on a threshold score of Positive Attitude/PA ≥ 19 . The results are presented in Table 4.12 above. The results indicate that almost 63% of respondents showed negative attitudes towards SAS use which has a significant impact on respondents' practice (Rav-Marathe et al, 2016). A higher percentage of respondents (67%) did not utilise SAS for road navigation.

Table 4. 13 Bivariate analysis of associations between knowledge and attitude, Knowledge and SAS use and Attitude and SAS use for navigation.

Level of SAS Knowledge	Attitude				Total Frequency	P-value
	Negative Attitude	Per cent (%)	Positive Attitude	Per cent (%)		
Poor	129	95.6	6	4.4	135	<0.001*
Fair	97	68.8	44	31.2	141	
Good	16	17.0	78	83.0	94	
Very Good	2	12.5	14	87.5	16	
Excellent	0	0.0	4	100	4	
Total	244	62.6	146	37.4	390	
Level of SAS Knowledge	SAS Use for Navigation				Total	P-value
	Non- Use Frequency (N)	Per cent (%)	Use Frequency (N)	Per cent (%)		
Poor	126	93.3	9	6.7	135	<0.001*
Fair	105	74.5	36	25.5	141	
Good	25	26.6	69	73.4	94	
Very Good	0	0.0	16	100	16	
Excellent	0	0.0	4	100	4	
Total	256	65.6	134	34.4	390	
Attitude	SAS Use for Navigation				Total	P-value
	Non-Use Frequency (N)	Per cent (%)	Use Frequency (N)	Per cent (%)		
Negative Attitude	218	89.3	26	10.7	244	<0.001*
Positive Attitude	38	26.0	108	74.0	146	
Total	256	65.6	134	34.4	390	

*The Chi-square statistic is significant at the 0.05 level.

Source: Field Survey, 2018.

The knowledge, Attitude and Practice (KAP) model conceptualises a linear association between knowledge, attitude and practices. As shown in the conceptual framework adapted for this study, knowledge about addressing systems influences attitude which may in turn affect the use of SAS in satisfying navigational needs. Table 4.13 above presents the results for the Pearson's Chi-square tests of association between road users' level of SAS knowledge and attitude, knowledge and use and attitude and use. The results reveal that road users knowledge is positively associated with their attitudes ($\chi^2 = 172.125$, P-value <0.001). Again, it is evident from the results that there is a significant association between Knowledge and SAS use ($\chi^2 = 152.523$, P-value <0.001). As knowledge is linked attitude, so is attitude linked to practice as indicated in the study's conceptual framework. The statistical test of association between respondents' attitude towards SAS use for navigation and actual use again revealed a statistically significant association between Attitude and Use ($\chi^2 = 162.368$, P-value <0.001). By implication, road users' attitude towards SAS use for navigation has a direct influence on their observed practice (use) as specified in the conceptual framework. The relationship between attitude and practice has been widely established (Yahya et al., 2012; Ma and Kishor, 1997). Respondent's attitude towards SAS use reflected in their practices as observed in Table 4.14. This results provides significant evidence to reject the null hypothesis that; there is no statistically significant association between knowledge, attitude and use of Street Addressing (SAS) use for road navigation.

As knowledge is directly linked to attitude and practice, the study recommends that, much efforts be made to increase road users' knowledge on the relevance of SAS or road navigation which could have a positive impact on attitude. Ul-Haq et al., (2012) affirms that better knowledge could positively influence attitude and subsequently reflect in good practices.

4.5 Barriers to the Use of Maps and Addressing Systems for Road Navigation

Practice as linked to knowledge and attitude is influenced by certain barriers. Legare et al., (2008) identified major barriers that inhibit practice. These include but are not limited to: time constraints, lack of resources, organizational constraints, and lack of access to services. In order to provide the appropriate measure for specific barriers to the use of maps and addressing systems, the study focussed on lack of resources and lack of access to services as major barriers that inhibit practice. Apart from these, education is included as a control variable. In the first model however, the relationship between knowledge, attitude and practice (SAS use) is first established before the introduction of other covariates that may influence practice. This is deemed important because as the theory of Knowledge-Attitude-Practice (KAP) postulates, knowledge and attitude form the basis of practice without which actions are poorly exhibited. The barriers to practice are measured using binary logistic regression model.

Table 4.14 Levels of Map Knowledge by SAS Use among Road Users in Kumasi Metropolis (Logit Regression).

Indicator	OR 95% CI	P-value
Level of Map knowledge		
Low knowledge (<i>ref</i>)	1.00	
High Knowledge	6.504(4.085, 10.357)	<0.001
<i>Model fitting information</i>		P-value <0.05
-2 Log-likelihood	435.702	
Nagelkerke R ²	.219	
Model χ^2 (Significance)	.000(.0)	

OR = Odds Ratio; CI = Confidence Interval.

Table 4.15 Logistic Regression Model of Map Use and Selected Explanatory Variables

Variable	OR 95% CI	P-value
Level of Map Knowledge		
Low knowledge (<i>ref</i>)	1.00	
High Knowledge	1.985 (1.053, 3.744)	0.034
Education		
No formal education	.000 (.000)	0.999
Primary education	.168(.015, 1.937)	0.153
Middle school/JHS	.120(.040, .359)	0.000
High school education	.222(.116, .424)	0.000
College/Tertiary (<i>ref</i>)	1.00	
Map Reading Ability		
No	0.36(.010, .135)	0.000
Yes (<i>ref</i>)	1.00	
P.C/ Laptop ownership		
No (<i>ref</i>)	1.00	
Yes	2.348(2.348, .1.207)	0.012
Mobile Phone O.S		
Android (<i>ref</i>)	1.00	
Others	1.226 (.506, 2.972)	0.652
Internet Access		
No (<i>ref</i>)	1.00	
Yes	1.104 (.268, 4.551)	0.892
Difficulties in downloading applications		
Easy(<i>ref</i>)	1.00	
Difficult	.735(.378, 1.429)	0.364
Level of Communication in English		
Poor (<i>ref</i>)	1.00	
Good	1.165(.436, 3.117)	0.760
<i>Model fitting information</i>		P-value <0.05
-2 Log-likelihood	330.276	
Nagelkerke R ²	.487	
Model χ^2 (Significance)	5.148(.525)	

OR = Odds Ratio; CI = Confidence Interval; P.C = Personal Computer; O.S =Operating System

From Tables 4.14 and 4.15, both model one and two are significant with Nagelkerke R-squared values of .219 and .487. The first model which measured the relationship between map use and knowledge alone produced a Nagelkerke R-squared value of 21.9%. The Nagelkerke R-Square is an indication that approximately 22% of the variation in map use for navigation among road users in Kumasi metropolis could be explained by knowledge alone. Other independent

variables were introduced in the second model. The second model also produced a Nagelkerke R-squared value of 48.7%. Findings showed that participants with higher knowledge of maps were 0.985 times more likely to use digital maps (for example, Google Maps) for navigation as compared to those who reported lower knowledge levels (OR = 1.985; 95%CI: 1.053-3.744). Knowledge about maps therefore stands out as an independent predictor of map use for navigation.

It could be observed from Table 4.15 (model 2) that apart from knowledge, education, map reading ability and personal computer ownership were statistically significant at $p < 0.05$ and would be interpreted. It is evident from the results that as compared to road users with the highest level of education (college/tertiary), those with middle school education, high school education and primary school education were (0.22, 0.12 and 0.17) times less likely to use maps for road navigation. It is argued that, Education plays a pivotal role in knowledge acquisition and thus, has a direct influence on practice which is defined as the application of rules and knowledge that leads to action (Rodrigues et al., 2012; Badran, 1995).

Again, it is seen from Table 4.15 that, one's ability to read a map also influences map use for road navigation. Compared to road users who could read maps, those who could not read maps were 0.36 times less likely to use a digital map for road navigation. In which ever form they may be, maps need to be read and interpreted in the right way before it could be applied for any purpose, chiefly, road navigation. This undoubtedly explains the higher likelihood of map use for navigation for those who could read a map as compared to those who cannot. Moreover, the odds of having a high map usage for road navigation also increases with personal computer ownership. Those who owned a personal computer or laptop had a higher usage of 1.3 times more than those who did not (OR =2.348; 95%CI: 2.348-.1.207). There is the higher likelihood that respondents who owned laptops and personal computers are modern technology literates who could easily access and use software for navigation. For example, google maps.

Table 4.16 Levels of SAS Knowledge and Attitude by SAS Use Among Road Users in Kumasi Metropolis (Logit Regression).

Indicator	OR 95% CI	P-value
Level of SAS knowledge		
Low knowledge (<i>ref</i>)	1.00	
High Knowledge	5.912 (3.116, 11.216)	<0.001
Attitude		
Negative Attitude (<i>ref</i>)	1.00	
Positive Attitude	10.960 (5.968, 20.126)	<0.001
<i>Model fitting information</i>		P-value <0.05
-2 Log-likelihood	303.634	
Nagelkerke R ²	.550	
Model χ^2 (Significance)	.136 (.934)	

OR = Odds Ratio; CI = Confidence Interval

4.17 Logistic Regression Model of SAS Use and Selected Explanatory Variables

Variable	OR 95% CI	P-value
Level of SAS Knowledge		
Low knowledge (<i>ref</i>)	1.00	
High Knowledge	5.056(2.469, 10.353)	<0.001
Attitude		
Negative Attitude	1.00	
Positive Attitude	9.508 (4.820, 18.756)	<0.001
Education		
No formal education	.000(.000)	1.000
Primary education	.000(.000)	0.999
Middle school/JHS	.098(.014, .701)	0.021
High school education	.147(.053, .410)	0.000
College/Tertiary (<i>ref</i>)	1.00	
Map Reading Ability		
No	1.00	
Yes (<i>ref</i>)	.000(.000)	0.998
PC/ Laptop ownership		
No (<i>ref</i>)	1.00	
Yes	1.136(.438, 2.945)	0.793
Mobile Phone OS		
Android	1.00	
Others	1.1364(.553, 3.275)	0.512
Internet Access		
No (<i>ref</i>)	1.00	
Yes	.682(.093, 4.981)	0.706
Difficulties in downloading applications		
Easy (<i>ref</i>)	1.00	
Difficult	1.407(.643, 3.076)	0.393

Level of Communication in English		
Poor (<i>ref</i>)	1.00	
Good	1.319(.257, 6.782)	0.740
<i>Model fitting information</i>		P-value <0.05
-2 Log-likelihood	256.921	
Nagelkerke R ²	.643	
Model χ^2 (Significance)	6.355(.608)	

OR = Odds Ratio; CI = Confidence Interval; P.C = Personal Computer; O.S =Operating System

Tables 4.17 and 4.18 present the results of the test for relationship first between knowledge, attitude and SAS use and then, SAS use and other independent variables that were identified as possible barriers to use. The Nagelkerke R-squared value for the first model was .550 implying that about 55% of the variation in SAS use for navigation among road users in Kumasi metropolis could be explained by Knowledge and Attitude (Table 4.17).

The second model was also significant with a Nagelkerke R-squared value of .643. Knowledge (OR =5.056; 95%CI: 2.469-10.353) and attitude (OR =9.508; 95%CI: 4.820-18.756) are again identified as having strong relationships with SAS use for road navigation. In model two, it is seen that as one climbs up the higher levels of the formal educational ladder, the higher the odds of using an SAS for road navigation. Surprisingly, in model two (Table 4.18), only education apart from knowledge and attitude, had a relationship with SAS use for road navigation. It could be implied from the results that, the knowledge levels about street addressing systems (SAS) and the attitudes towards their use for road navigation stand as principal factors that affect use and not necessarily the possible challenges identified above. On the basis of this results, the null hypothesis that, there is no relationship between road users' access to services and resources and SAS use for road navigation is accepted. Incorporating local travel route information in addressing system development would be successful when

road users are first educated on the importance of SAS as a means of curbing urban mobility challenges and as such improving urban mobility in Kumasi metropolis and beyond.

4.6 Local Travel Route Data Acquisition and Mapping

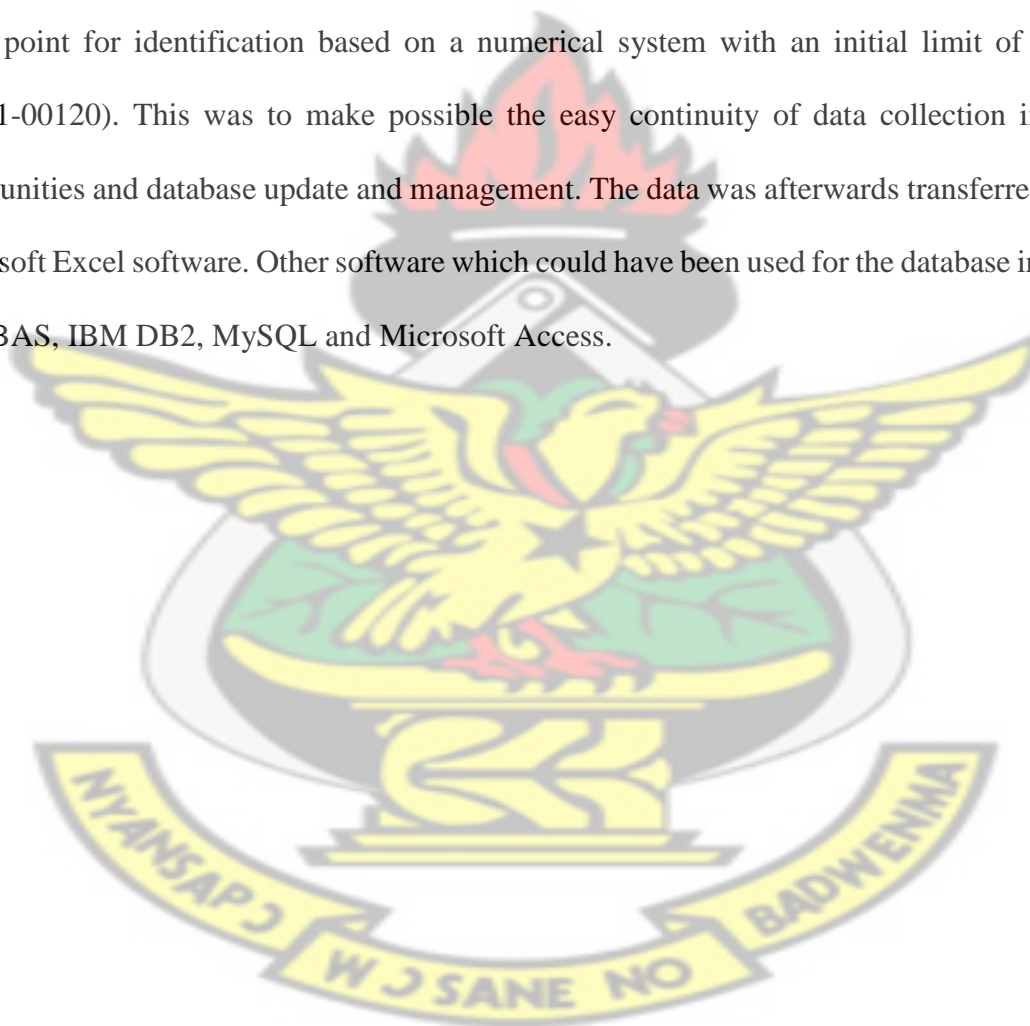
4.6.1 Database Creation for Recording, Storage and Retrieval of LTRI

Data needed to create a database for LRTI was primarily field data on selected routes, communities, roads, locally assigned names of the various alighting points (stops), the geographical coordinates of the alighting points and information on major landmarks. The data collection process was achieved through a route based data collection process where the researcher collected and stored the geographical coordinates of each alighting point using a handheld GPS while recording the stop (point) names, road names, community names, and names of major landmarks at each point. The information on point names and street names were collected from trotto drivers and their conductors. In order to ensure the validity of this information however, community dwellers who reside close to the selected routes were consulted to confirm the names given.

There were no contradictions in the names given by the trotto operators and the community dwellers although in some instances, the community dwellers provided other names in which case a particular point had more than one locally assigned name. In these circumstances, the most commonly used name was adopted as the point name although other names were recorded. Another major challenge that was encountered that has implications on database creation was the duplication of point names. For example, at least three alighting points bore the name “*school junction*” because the streets were linked to major schools in the respective communities. Attaching community names to the point names provided a means of overcoming this challenge. For example, “*School Junction-Ayeduase*” “*School Junction-*

Boadi” “*School Junction-Appiadu*”. The names of the major landmarks, in this case, the specific schools are recorded for easy differentiation and identification.

After the field data collection, the data was screened for any errors and various corrections were made. Existing databases on road network information such as road names and community names were also consulted for validation. The data was first inputted in notepad using a comma delimited format. The major captions included; ‘*point name*’, ‘*road name*’, ‘*community*’, ‘*Latitude*’, ‘*Longitude*’ and ‘*landmark*’. A unique identifier (id) was given to every point for identification based on a numerical system with an initial limit of 10,000 (00001-00120). This was to make possible the easy continuity of data collection in other communities and database update and management. The data was afterwards transferred to the Microsoft Excel software. Other software which could have been used for the database includes ADABAS, IBM DB2, MySQL and Microsoft Access.



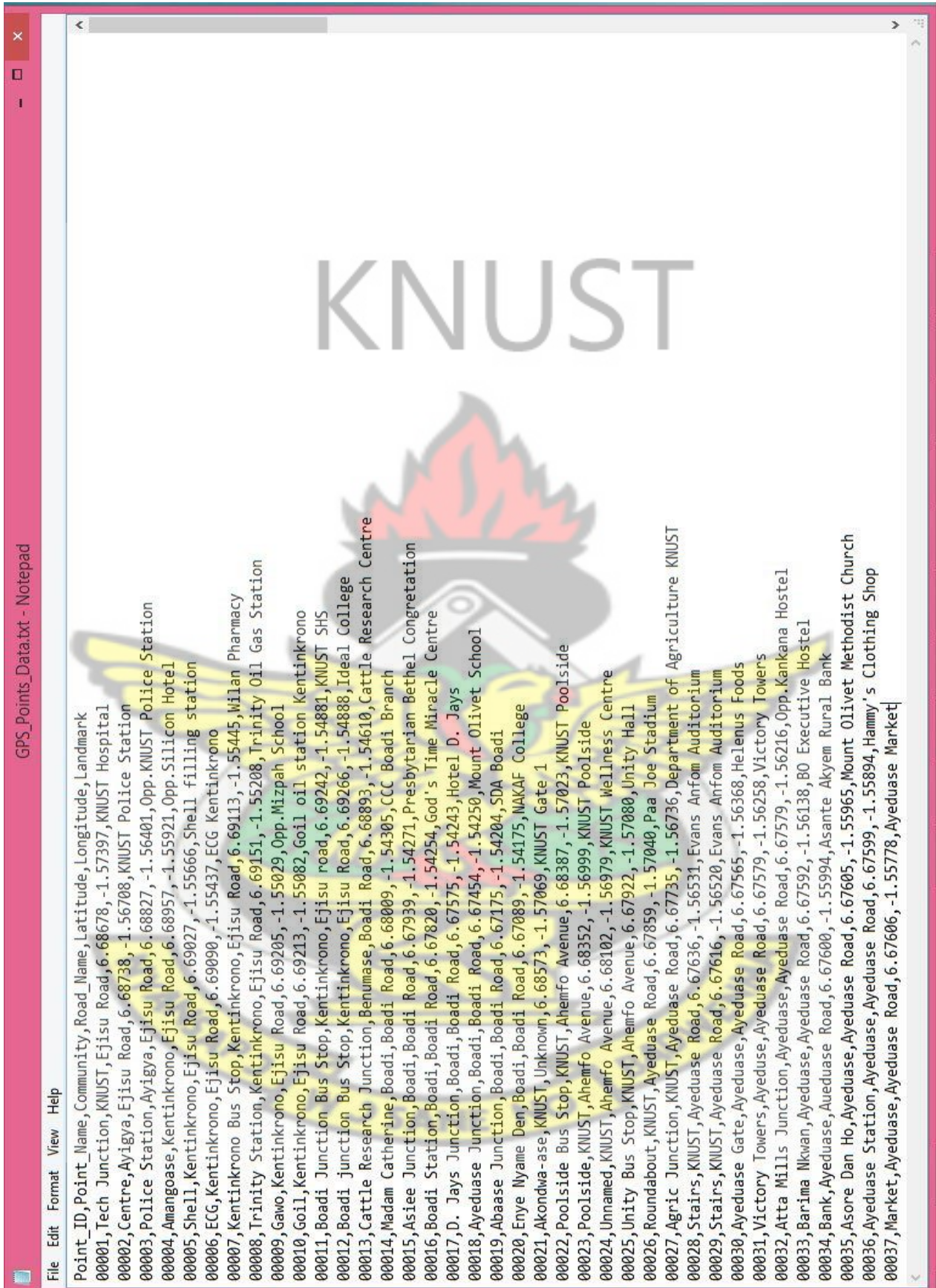


Fig.4. 1 Data input in notepad screen capture

GPS_Points_Db.xlsx - Excel (Product Activation Failed)

Point_ID	Point_Name	Community	Road Name	Latitude	Longitude	Landmark
1	Centre	Ayigya	Ejisu Road	6.68738	-1.56708	KNUST Police Station
2	Police Station	Ayigya	Ejisu Road	6.68827	-1.56401	Opp.KNUST Police Station
3	Amangoase	Kentinkrono	Ejisu Road	6.68957	-1.55921	Opp.Silicon Hotel
4	Shell	Kentinkrono	Ejisu Road	6.69027	-1.55666	Shell filling station
5	ECG	Kentinkrono	Ejisu Road	6.6909	-1.55437	ECG Kentinkrono
6	Kentinkrono Bus Stop	Kentinkrono	Ejisu Road	6.69113	-1.55445	Wilan Pharmacy
7	Trinity Station	Kentinkrono	Ejisu Road	6.69151	-1.55208	Trinity Oil Gas Station
8	Gawo	Kentinkrono	Ejisu Road	6.69205	-1.55029	Opp.Mizpah School
9	Goil	Kentinkrono	Ejisu Road	6.69213	-1.55082	Goil oil station Kentinkrono
10	Boadi Junction Bus Stop	Kentinkrono	Ejisu road	6.69242	-1.54881	KNUST SHS
11	Boadi Junction Bus Stop	Kentinkrono	Ejisu Road	6.69266	-1.54888	Ideal College
12	Cattle Research Junction	Benumase	Boadi Road	6.68893	-1.5461	Cattle Research Centre
13	Madam Catherine	Boadi	Boadi Road	6.68009	-1.54305	CCC Boadi Branch
14	Asfee Junction	Boadi	Boadi Road	6.67939	-1.54271	Presbyterian Bethel Congregation
15	Boadi Station	Boadi	Boadi Road	6.6782	-1.54254	God's Time Miracle Centre
16	D. Jays Junction	Boadi	Boadi Road	6.67575	-1.54243	Hotel D. Jays
17	Ayeduae Junction	Boadi	Boadi Road	6.67454	-1.5425	Mount Olivet School
18	Abaase Junction	Boadi	Boadi Road	6.67175	-1.54204	SDA Boadi
19	Enye Nyame Den	Boadi	Boadi Road	6.67089	-1.54175	NAKAF College
20	Akondwa-ase	KNUST	Unknown	6.68573	-1.57069	KNUST Gate 1
21	Poolside Bus Stop	KNUST	Ahemfo Avenue	6.68387	-1.57023	KNUST Poolside
22	Poolside	KNUST	Ahemfo Avenue	6.68352	-1.56999	KNUST Poolside
23	Unnamed	KNUST	Ahemfo Avenue	6.68102	-1.56979	KNUST Wellness Centre

Fig 4. 2 Database in Excel format screen capture

4.6.2 Mapping of Stops along Selected Trotro Routes

The processes of data entry and database creation was followed by a sequential mapping process in QGIS. Fig. 4.3 shows the output of the mapping process with alighting points represented as green dots in the interface capture. It could be observed that, the alighting points reveal an irregular pattern which is a replica of the road network in the communities. The background map of the study area showing the selected communities and trotro routes was added to the point shapefile as displayed in Fig. 4. 3. The resultant map reveals that, the alighting points are so close to the roads enough for no significant distance to be observed between the road and the points. This is so because only a handful of alighting points were designated as proper bus stops with a demarcated area for vehicles to stop. Most of the trotro stops were close to the roads. Both passengers and pedestrians are put at risk of road accidents due to indiscriminate parking practices.

Alighting points or stops along major trotro routes were chosen for the study because whiles major trotro routes link up major communities, these points mark the beginning of major streets and lanes that link to various houses, schools and other facilities in each community. Again, these points are mostly used as reference when giving oral directions to residences and facilities. In a nutshell, the alighting points along each trotro route represent what would be in other places, the street numbers or street signs without which addressing and identifying places would be extremely difficult if not totally impossible.

Incorporating LTRI in street addressing systems would be highly beneficial to all and sundry as it would help encourage the use of addressing systems for navigation. Government agencies and emergency service providers would also benefit from this outcome as people and places could be easily identified based on the locally acquired travel route information in various communities.

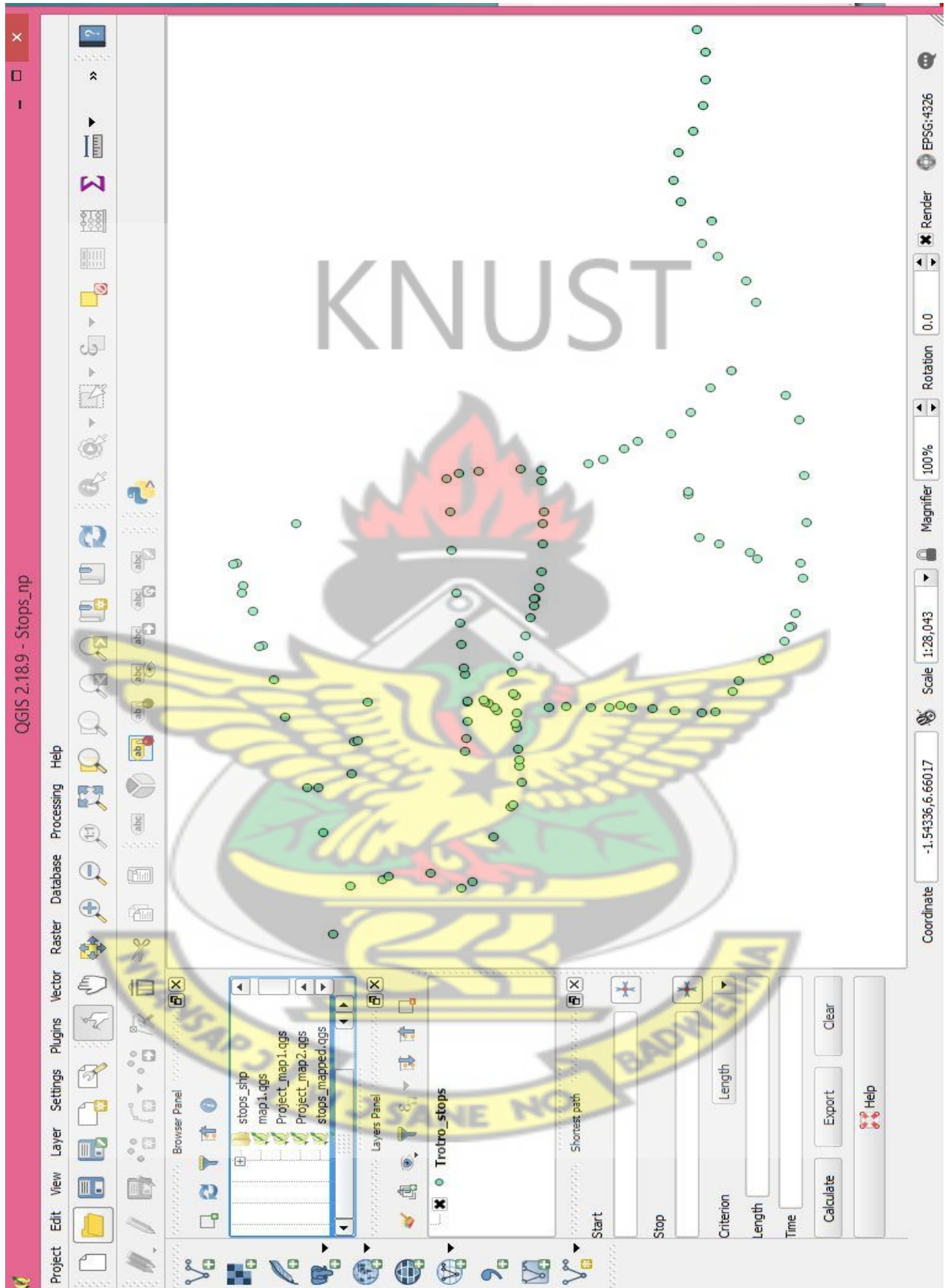


Fig.4.3 Mapped stops in QGIS screen capture

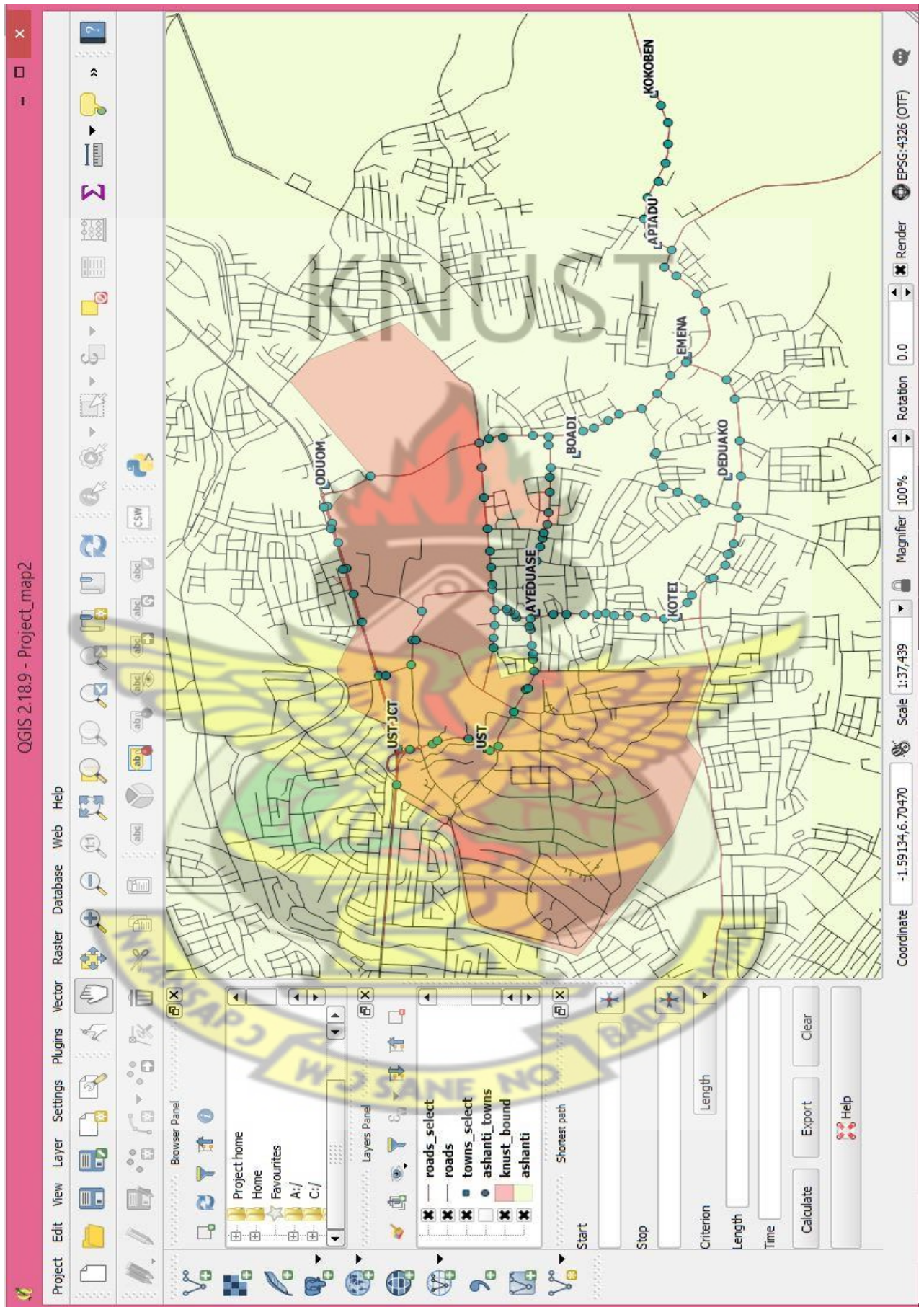


Fig. 4.4 Final output image showing mapped stops along selected routes

Network Analysis

Network analysis is an important aspect of transport geography and specifically relating to mobility. This is so because it involves the description of the disposition of nodes (points) and their relationships with line or linkage of distribution. Network analysis is critical in measuring accessibility and connectivity and also allows comparisons to be made between and within regional networks within a country and between other countries (“Important Measures of Transport Networks”, n.d). Shortest Path algorithm is an important aspect of network analysis that provides an important measure of accessibility.

Using the mapped data, a network analysis was performed using the road graph plug-in in QGIS. Based on the arc-node topology, the shortest paths from a chosen origin (node/vertex) to a destination are calculated using a path (arc). In this study, the mapped alighting points are employed as vertices or nodes with roads representing the path. The shortest paths were calculated using distance as the criterion in order to calculate the minimum distance from an origin to a destination. For the purpose of demonstration, one origin was chosen from which shortest paths were calculated to selected nodes representing each community. Table 4. 19 displays the results of the shortest path calculations from the origin to various destinations. The essence of this calculation and its implication on urban mobility is that it would help road especially emergency service providers such as ambulance and fire service agencies in accessing places with ease in times of emergencies. This would help bring quick relief to those in need and also help save lives. It may also assist courier services to easily identify clients and help visitors to navigate easily without necessarily asking for directions.

Table 4. 19 Results of Network Analysis

No.	ORIGIN	DESTINATION	DISTANCE	Min.secs
1	Tech-Junction	Oduom	2.89436km	3.47
2	Tech-Junction	Ayeduase	2.66176km	3.19
3	Tech-Junction	Kotei	3.84489km	4.61
4	Tech-Junction	Deduako	5.44883km	6.54
5	Tech-Junction	Boadi	4.80782km	5.77
6	Tech-Junction	Emena	5.98212km	7.18
7	Tech-Junction	Appiadu	7.34081km	8.81
8	Tech-Junction	Kokoben	8.93746km	10.72

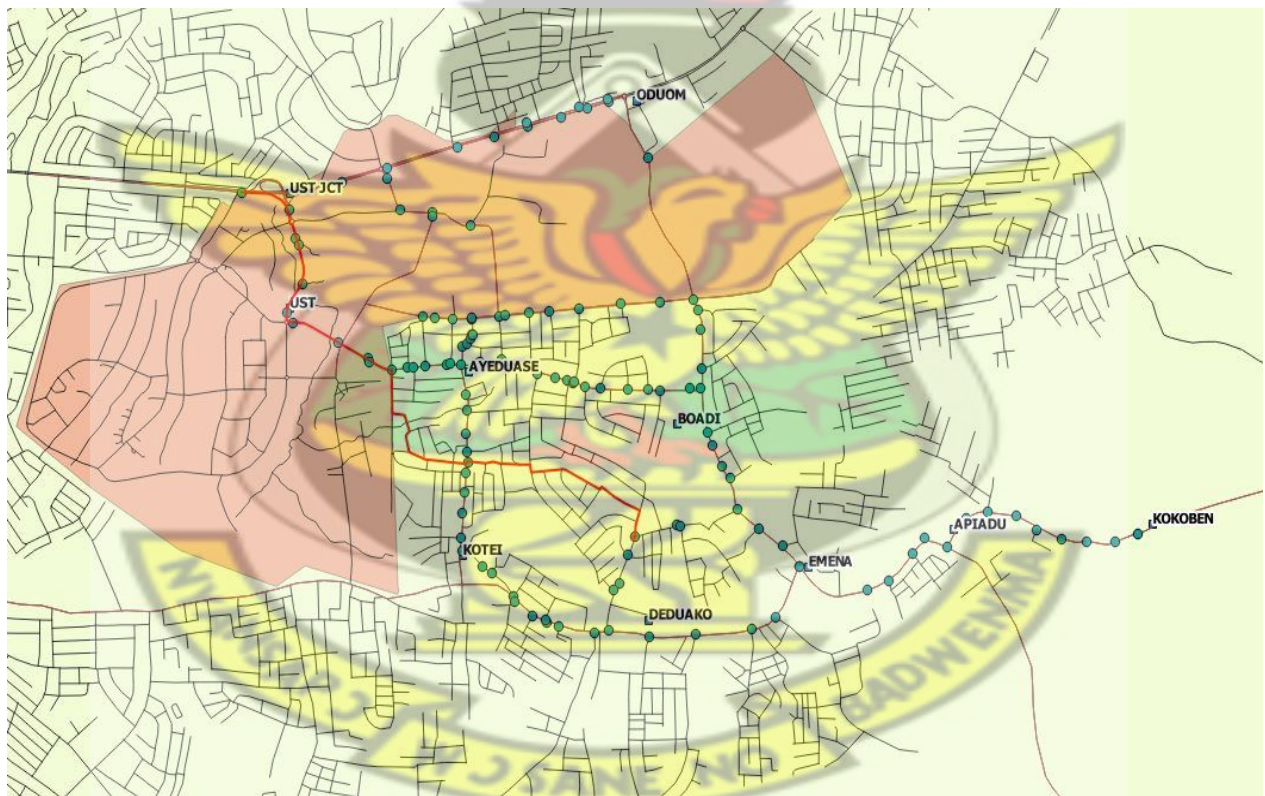


Fig. 4.5 Demonstration of network analysis

CHAPTER FIVE

SUMMARY OF KEY FINDINGS, CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Introduction

The study employed the cross sectional study design to investigate the potential of incorporating local travel route information in addressing systems development to improve urban mobility in Kumasi. This final chapter includes a summary of the main findings of the study. Major conclusions are also drawn from which the final outcome of the study is defined. The chapter also includes recommendations offered to be considered in the designing and implementation of future policies towards the improvement of addressing systems in Ghana. Finally the chapter provides some directions on future research in relation to SAS development and utilisation.

5.2 Summary of findings

In order to achieve the general objective of this study, the researcher first sought to investigate road users' knowledge, attitudes and practices regarding SAS use for road navigation. A critical realisation that prompted these specific objectives was the fact that, achieving effective urban mobility through the incorporation of LTRI in addressing system development could be a total failure without knowledge about road users' level of awareness and familiarity with existing SAS as well as their perceptions and actual use of SAS in achieving urban mobility. Again, meeting these objectives was critical in unearthing road users' challenges in accessing and utilisation SAS in general and specifically for road navigation. Averting these challenges is crucial to ensuring that changes and improvements in SASs are not only done on the basis of road users' familiarity with traditional travel route information but also that road users are

much acquainted with and sufficiently skilled in order to employ SASs in achieving effective urban mobility.

5.2.1 Modal Choice and Travel Behaviour of Respondents

In this study, trotro was the most common means of daily commuting (modal choice) among the study participants. 63% of respondents relied on trotro for daily commuting while 5% relied on taxi cabs. 22% of respondents resorted to walking due to proximity. Lower cost and availability of travel means were significant predictors of modal choice. Comfort was the weakest predictor of modal choice especially among trotro users. A larger proportion of respondents (70%) spent less than 30 minutes traveling to school or work. Apart from commuting for educational or commercial purposes, respondents also engaged in other activities including religious meetings, social gatherings, shopping and recreational activities which increased the dependency on urban transport means especially, trotro and taxi cabs.

5.2.2 Knowledge and Use of Maps and Street Addressing Systems

Generally, road users reported low levels of SAS knowledge. Majority of respondents had heard about addressing systems but had no knowledge about its relevance neither did they report SAS use for any purpose. Knowledge about maps in general was relatively higher as compared to SAS. Majority of respondents (90%) could also read and interpret maps and this was a basic requirement needed for one to use an addressing system, specifically, a digital addressing system for road navigation. However, SAS use for navigation was very low among the study cohort. Road users' levels of map and SAS knowledge were strongly associated with their use of these facilities specifically for road navigation. One's level of formal education was a major factor associated with knowledge of maps and SAS.

5.2.3 The relationship between Road users' level of knowledge, attitude and use of SAS.

Besides low levels of SAS knowledge recorded among study participants, road users' attitudes towards the use of SAS for road navigation were generally poor. As much as 63% of respondents recorded negative attitudes towards SAS use by scoring less than 19 in the attitude test. Among the study participants, only 34% used SAS for road navigation. Attitude also had a strong association with knowledge and SAS use for road navigation. A bivariate analysis using Pearson's Chi-square test of association revealed significant associations between knowledge and attitude, knowledge and use and attitude and use.

5.2.4 Barriers to the Use of Maps and Addressing Systems for Road Navigation

The study also found that, total lack or insufficient knowledge and negative attitudes were major predictors of practice (SAS use). Road users with low levels of SAS knowledge were less likely to use SAS for road navigation as compared to road users with relatively higher levels of knowledge. Apart from knowledge, map reading ability and personal computer ownership had a strong relationship with digital map use for navigation. SAS use on the other hand was not dependent on resources or access to services. Majority of respondents owned mobile phones with operating systems that permit the use of digital navigational facilities. Most road users could communicate effectively in English and also had access to internet services. Road users' knowledge and attitude about SAS use for navigation were as such the major determining factors that were associated with use.

5.2.5 Local Travel Route Data Acquisition and Mapping

The outcome of the study revealed that, there is a higher possibility of successfully incorporating LTRI into addressing system development in order to increase urban accessibility and as such, improve urban mobility in Kumasi Metropolis. This was demonstrated through

the field data collection of LTRI from trotro operators and road users and the subsequent mapping of this information with the help of GIS techniques.

The study however disclosed some challenges that have implications on the successful implementation of LTRI. These challenges included duplication of community names and road names, inconsistencies in the naming of streets, that is, traditional naming of streets as juxtaposed to official Street naming and addressing making it impossible to identify certain places and lack of clear demarcations or boundaries between communities. The importance of LTRI in addressing was demonstrated through study participants' responses as to how they give directions to their homes and places of work. Directions were given on the basis of community names, road names, locally assigned street names and reference to prominent facilities. In giving directions, road users also preferred and used locally assigned street names and not names indicated on street signs. For example, Martison Street at Kotei is up till today referred to as Naasei (Nana-Osei) street. The formal incorporation of LTRI is highly relevant as this would help eradicate the flaws and inconsistencies associated with verbal addressing and also help in service delivery and emergency care provision.

5.3 Conclusions

This study explored the potential of incorporating local travel route information in addressing systems development to improve urban mobility in Kumasi. The study has made significant contributions to knowledge regarding road users' knowledge about maps and Addressing systems. The outcome of the study has significant implications for practice and policy concerns most especially, in Ghana and in many other African countries where street addressing systems are poorly implemented and lowly adopted by the general populace. This study reveals peoples' knowledge, attitude and use of SAS in an urban context. Low levels of knowledge and negative attitudes regarding SAS confirm the need for policy directions into providing the means of

educating and increasing inhabitants' familiarity with SASs and its relevance for meeting urban mobility needs.

Again, this research has provided empirical evidence to establish the claim that roads users' knowledge about SAS is directly linked to their attitude and practices concerning SAS use for road navigation. In all, two out of the four hypothesis were justified. The study found statistically significant associations between road users' level of map and SAS knowledge and use. Also, education was identified as a major influence on SAS use for road navigation. The results of the binary logistic regression model however revealed that there was no relation between available resources and access to services and SAS use for road navigation. Knowledge and attitudes towards SAS rather stood out as a major factor influencing SAS use. Respondents' attitudes were also related to their knowledge.

Moreover, the study brings afore the need for continuous database update to provide the needed information to inform policy decisions and implementations in matters regarding transportation in general and road transport in particular. There is also the critical need for the enabling of a conducive environment for road users and community dwellers participation in street naming and addressing processes. This would go a long to curb inconsistencies in addressing and increase inhabitants' familiarity with existing SASs. Finally, the study concludes that, capitalising on GIS technology, LTRI could be successfully incorporated in SASs to increase accessibility and improve urban mobility.

Despite the significant empirical contributions this study has made, some limitations and few methodological challenges were encountered which are worth outlining. First of all, looking at the objective of the study, it would have been beneficial if a larger transport network and as such, more communities were covered in the study. This was however not possible due to time constraints and limited financial resources. The non-random sampling technique which was

used in selecting the study communities may represent a bias since other potential study areas were not given the chance of being selected. This sampling procedure was however necessitated due to the need to select communities within the chosen road network loop. Some respondents were reluctant in giving responses to some questions, especially, questions relating to their age. In such cases, the respondents were persuaded and confidentiality was reassured but there could be the possibility of false responses given which could affect the validity of the results.

Some of the trotro stops had duplicate names and double names which presented a setback for database creation. To overcome these challenges, community names were attached to stop names in the first instant to allow for differentiation. In the case of double names, at least two community dwellers besides the trotro driver and the conductor were asked to confirm the most commonly used names of the stop. These names were used as the stop ID although other names were recorded. A difficulty also arose in indemnifying the boundaries between communities. Again, community dwellers were fallen on for assistance.

5.4 Policy Recommendations

Based on the outcome of the study, the following recommendations are proposed to ensure the successful implementation of LTRI into Street Addressing processes in Ghana and also to help minimise, if not totally eradicate, the persistent challenges that continually impede the success of SAS implementation.

5.4.1 Awareness Creation on the Importance of SAS

First of all, in order to address the problem of low levels of knowledge about SAS which evidently affect use, there is the critical need to enhance public education in order to increase people's awareness about the existence, utility and relevance of Street addressing systems although some efforts are being made currently. Ghana Broadcasting Corporation (GBC) has

a major role to play in intensifying efforts to increase awareness on the importance of SAS. Private media organizations, for example, Multimedia Ghana, should also be actively involved in efforts to intensify awareness and thereby increase knowledge on SASs.

5.4.2 Education on SAS

Again, as formal education is linked to knowledge acquisition at all levels, Ghana Education Service (GES) could incorporate lessons on SAS in the curriculum structure of especially basic and junior high school pupils to help teach them about the importance of street addressing. This effort could have beneficial and tripling effects as these young people could also help educate their parents, especially, those who are illiterate and therefore encourage and influence them to not only accept but also utilise SASs in meeting basic mobility needs.

5.4.3 Continual Update of Transportation Database

Furthermore, Ministry of transport, MMDAs, and the Department of Urban Transportation should make efforts to intensify data collection processes and continual update of all information relating to transportation. For example, data collection on various travel routes, streets and stops along the major routes are essential for knowing the condition of various transport infrastructure and also assessing safety concerns.

5.4.4 Community Participation in Street Addressing Projects

A critical observation from this study shows that, residents still stick to old street names and not those assigned by Kumasi Metropolitan Assembly (KMA). This shows the crucial need for the active involvement of community dwellers in street naming processes. This would help to ensure the development of an addressee-based addressing system. Local information on street names and road names where applicable must be collected from indigenes and successfully implemented in addressing systems. What would be the benefit of erecting street signs which only stand as street decoration and not utilised for the intended purposes?

5.4.5 Incorporation of LRTI in Existing SAS

Finally, the Government of Ghana and Vokacam, the designers and implementers of the current digital addressing system in Ghana, GhanaPostGPS must prioritise the addition of LTRI into the existing system. This would help in encouraging the use of the application in general and specifically for road navigation. Without this, on the basis of current evidence from this research about the use of the mobile app, it would continually remain as an official address system necessary for documentation and nothing else.

5.5. Suggestions for Future Research

This study has made significant contributions to knowledge about SAS knowledge, attitudes and use. Nonetheless, there are many avenues that could be further explored. The findings from this study provide the basis for future research directions which are suggested below:

Firstly, the study showed that although various alighting points are important in terms of addressing, most of these stops are not designated as bus stops and they also encourage on-street parking which could have serious implications on passenger and pedestrian safety. A study is therefore recommended to study in detail the conditions of these stops that link to major streets and how improvements could be made to ensure road safety practices.

Again, the information provided in the study would be useful for the creation of a local travel aid or routing infrastructure that could help guide local travel. Currently, such a study is being spearheaded by some faculty members of the Department of Geomatic Engineering and Department of Geography in KNUST. The study is aimed at inventing a mobile phone application that could be easily accessed and used for road navigational purposes using LTRI.

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APPENDICES

APPENDIX A

Questionnaire Protocol for Road Users

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF GEOGRAPHY AND RURAL DEVELOPMENT

KNOWLEDGE BASE AND USE OF MAPS AND ADDRESSING SYSTEMS IN KUMASI.

Dear Respondent,

This survey is being conducted to elicit information aimed at investigating road users' knowledge about maps and various addressing systems, and the challenges faced in accessing and utilizing the facilities especially for road navigation. It would be greatly appreciated if you could respond appropriately to the questions below. You are assured that your responses would be treated as completely confidential and anonymous as practicable. However, your honest answers would contribute extensively to achieving the objectives of the study.

Thank you for your cooperation.

Name of Community: Date:

SECTION A. DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS

1. Sex of respondent	a. Male <input type="checkbox"/>			b. Female <input type="checkbox"/>		
2. Age of respondent					
3. Marital Status	a. Never married <input type="checkbox"/>		b. Married <input type="checkbox"/>		c. Divorced/separated <input type="checkbox"/>	
			d. Widowed <input type="checkbox"/>		e. Other (specify)	
4. To which ethnic group do you belong?					
5. What is your highest educational attainment?	a. Never-been-to-school					
	b. Primary education					
	c. Middle School/JSS/JHS					
	d. High school education					
	e. College/Tertiary					
	f. Other (specify)					
6. What is your average monthly income					
7. Language(s) used in communication (use the scale below) 1 - Poor 2 - Fair 3 - Good 4 - Very good 5 - excellent		speaking	writing	Reading		
	English					
	Twi					

SECTION B: KNOWLEDGE AND USE OF MAPS AND STREET ADDRESSING SYSTEMS

8. Do you know about maps?	a. No [] b. Yes []	
9. On a scale of 1-5, how would you rate your level of knowledge about maps?	Poor	[1]
	Fair	[2]
	Good	[3]
	Very good	[4]
	Excellent	[5]
10. Do you know about the use of maps?	a. No [] b. Yes []	
11. Could you read a map?	a. No [] b. Yes []	
12. Have you used a map before?	a. No [] b. Yes []	
13. When was the last time you used a map	a. A day ago [] b. A week ago [] c. Two weeks ago [] d. A month ago [] e. 6 months ago [] f. A year ago [] f. More than a year ago []	
14. What did you use the map for? <i>(please tick all that apply)</i>	a. To give direction to my house b. To give direction to my workplace c. For navigational purposes d. For academic purposes e. To locate a facility f. To give direction to emergency service providers g. Others (specify).....	[] [] [] [] [] []
15. How many times during the past 6months have you used a map?	a. Not at all b. 1time c. 2times d. 3times e. 4times f. More than 5times	[] [] [] [] [] []
16. How often do you use a map for navigational purposes? (google map or any other map)	a. Never b. Not often c. Often d. Very often e. Always	[] [] [] [] []
17. How many times during the past 6months have you used a map for road navigation? (google map or any other map)	a. Not at all b. 1time c. 2times d. 3times e. 4times f. More than 5times	[] [] [] [] [] []
18. Do you know about Google maps?	a. No [] b. Yes []	
19. When was the last time you used google map for road navigation?	a. A day ago [] b. A week ago [] c. Two weeks ago [] d. A month ago [] e. 6 months ago [] f. A year ago [] e. more than a year ago []	
20. Do you know about Google Local Guide?	a. No [] b. Yes []	
21. If yes to Q20 , have you used it before?	a. No [] b. Yes []	

22. Have you heard about Street Addressing Systems (e.g GhanaPostGPS)	a. No [] b. Yes []
23. Do you know about the use of Street Addressing Systems (SASs)?	a. No [] b. Yes []
24. Have you ever used a Street Addressing Systems (SASs)? for any purpose?	a. No [] b. Yes []
25. If yes, to what use was the Street Addressing Systems (SASs) employed? (please tick all that apply)	a. To give direction to my house [] b. To give direction to my workplace [] c. For navigational purposes [] d. For academic purposes [] e. To locate a facility [] f. To give direction to emergency service providers [] Other (specify)..... []
26. Which of the following addressing systems have you heard about?	a. SnooCODE [] b. GhanaPost GPS [] c. Asaase GPS [] d. Others (specify)..... []
27. Which of the following addressing systems have you ever used?	a. SnooCODE [] b. GhanaPost GPS [] c. Asaase GPS [] d. others (specify)..... []
28. To what use was it employed? (please tick all that apply)	a. To give direction to my house [] b. To give direction to my workplace [] c. For navigational purposes [] d. For academic purposes [] e. To locate a facility [] f. To give direction to emergency service providers [] g. others (specify)..... []
30. How often do you use an addressing system for navigational purposes?	a. Never [] b. Not often [] c. Often [] d. Very often [] e. Always []
31. How many times during the past 6 months have you used an addressing system for navigational purposes?	a. Not at all [] b. 1time [] c. 2 times [] d. 3times [] e. 4times [] f. more than 5 times []

Please tick [√] below according to your level of agreement

Attitudinal/perceptual statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
A Street Addressing System (eg. GhanaPostGPS) is relevant for road navigation					
I have difficulties downloading the GhanaPostGPS app					
I am aware of the uses of the GhanaPostGPS app					
I do not find any use for the GhanaPostGPS app					

I would download the GhanaPostGPS app only when I need my digital address for official documentation					
I prefer Google maps to the GhanaPostGPS app					

SECTION C: CHALLENGES FACED IN ACCESSING AND UTILISING MAPS AND STREET ADDRESSING SYSTEMS

32. Do you have a personal computer/laptop?	a. No [] b. Yes []
33. Do you have a mobile phone?	a. No [] b. Yes []
34. If yes to Q33, how many?	a. 1 [] b. 2 [] c. 3 [] d. 4 or more
35. Which operating system do you use?	a. Android [] b. Windows [] c. IOS [] Others (specify).....
36. Rate how difficult is it to download and use various apps using your operating system?	a. Very difficult [] b. Difficult [] c. somewhat difficult [] d. easy [] e. Very easy []
37. Do you have access to the Internet?	a. No [] b. Yes []
38. How often do you use the Internet?	a. Never [] b. Not often [] c. often [] d. very often [] e. Always []
39. What do you use the internet for?	a. Learning [] b. Social media networks (WhatsApp, Facebook, Instagram, etc.) [] c. Accessing navigational maps [] d. Downloading applications []
40. How difficult is it for you to access the Internet	a. Very difficult [] b. Difficult [] c. Somewhat difficult [] d. Easy [] e. Very easy []
41. Could you communicate in English	a. No [] b. Yes []
42. How would you rate your level of accuracy in communicating in English?	a. Poor [] b. Fair [] c. Good [] d. Very good [] e. Excellent []
43. In which community is your school or work place located?
44. What travel means do you often employ to commute to school or work daily?	a. Private automobile [] b. Minibus(Trotro) [] c. Taxi cab [] d. cycling [] e. On foot [] e. Others (specify).....
45. What is the reason for the preferred choice selected in Q44? Please tick as many as apply	a. lower cost [] b. easy access [] c. convenience [] d. comfort [] e. Others (specify).....
46. Apart from school and or work, which other places do you often travel to using your preferred mode of transportation? Please tick as many as apply	a. church [] b. social gatherings(weddings, parties, funerals) [] c. Market [] d. recreational facilities [] e. Others (specify).....
47. How many times in a week do you take trotro?	a. Not at all [] b. Less than 3times [] c. 4times [] d. 5times [] e. 6 times [] f. 7times [] e. More than 7times []

<p>48. On average, how many trips do you make a day to travel to school or work and return to your place of residence (N.B: using your preferred mode of transportation)</p>	<p>a. 2trips [] b. 3trips [] c. 4 trips[] d. 5trips [] d. 6 or more trips []</p> <div style="border: 1px solid black; width: 100px; height: 15px; margin-top: 5px;"></div>
<p>49. What is the distance between your place of residence and your school or place of work? <i>(in km)</i></p>	<p>.....</p>
<p>50. How long, on average, does it take to travel to school or your work place?</p>	<p>a. less than 30 minutes [] b. 30 minutes – 1hour [] c. 1 – 2 hours [] c. 2 – 3 hours [] d. 3 – 4 hours [] more than 5 hours []</p>
<p>51. In case of any emergency, rate the ease or difficulty with which Fire or Police Service could access your residence or place of work</p>	<p>a. Very difficult [] b. Difficult [] c. Somewhat difficult [] d. easy [] e. Very easy []</p>
<p>52. Do you know the address for your house or hostel?</p>	<p>a. No [] b. Yes []</p>
<p>53. If yes, state it</p>	<p>.....</p>
<p>54. How do you locate places and essential facilities when you do not know their specific geographical location?</p>	<p>a. Ask people for directions [] b. Ask trotro operators [] c. Use google map [] c. Use GhanaPostGPS [] d. Use Asaase GPS [] e. Others (specify).....</p>



APPENDIX B
Spatial Data Booking Sheet

POINT_ID	POINT_NAME	COMMUNITY	ROAD_NAME	LATITUDE	LONGITUDE	FEATURE_ID	LANDMARK
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

