THE EFFECT OF CHANGES IN LAND USE CHARATERISTICS ON ACCESSIBILITY IN THE SUBURBS OF KISUMU CITY, KENYA.

BY

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ABSTRACT

Globally, studies on the influence of density, transport costs and modal splits in the suburbs have yielded conflicting results indicating the need for more studies. Studies have also shown that the extent to which residential location relates to modal split in the suburbs has not been fully established. There has also been varying conclusions on transport costs between the residential areas and employment zones in them. Most African city suburbs are charaterised by high population densities with uncontrolled land use mix but little is known on influence of density on accessibility in them. The suburbs in Kisumu city experiences high population densities and continued land use mix creating complex movement patterns. However, little is still known on how these changes influences time to destinations and the relationships between residential location and modal split and cost of transport to work. The objectives of this study were to: assess the influence of density on travel time; determine the relationship between residential location and modal split and; examine the relationship between work place location and transport cost in Kisumu city suburbs. This study adopted tringulation mixed method design and covered three suburbs namely: Otonglo, Mamboleo and Nyamasaria within Kisumu City. The study population comprised 9604 households out of which a sample of 370 was drawn and interviewed. The survey instruments used included questionnaires, focus group discussions guides, interviews schedules, land use maps and photography. Secondary data was collected from published and unpublished reports. Data was analysed using both quantitative and qualitative techniques.The study revealed that increasing density increases travel time to destinations while residential locations do not depend on modal split but house ownership and rents in the suburbs. There is also no positive relationship between workplace location and transport costs. It was concluded that density inhibits accessibility and modal split do not influence accessibility to residential location while transport cost is minimal but in the form of discomfort and fare charges. The study recommends the need for control of density and adoption of balanced mixed use through zoning and promotion of the use of single occupancy means of transport. The existing policies guiding land use and transport relationships should be implemented while minimizing dependency on particular means of transport. Designate employment zones in the most accessible manner. Further studies should be conducted on place accessibility while applying other accessibility measures as network analysis and automated GIS land use modeling systems.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Globally, land uses in the suburbs are generally characterised by lower density of population, housing, and business complexes (TCRP 55, 1999; Schwirian, 2003; Stiff, 2011; Siembab 2012; Dowall,1982). According to the "flight from blight" theory advanced by Mieszkowski and Mills (1993), residents moving to the suburbs are in search of land uses characterized by low density and evenly distributed activity location that can be accessed at the shortest time possible. However, according to Rosenberg (2013) this is normally not the case since low density implies wider separation of activity locations which sometimes increases time taken to destinations. Litman (2012; 2008) revealed that the relationship between density and time is complex such that in some cases it reduces time while in other cases it increases time taken to reach activity locations. These conflicting findings by various studies on the relationships between population density and time show the complexity in determining whether density positively or negatively influences time to destinations. Since it is still not clear on what could be causing these variations in findings, this study aimed at finding out how population density influences time taken to destination in suburbs that have experienced change in their land use characteristics.

Africa is having a faster rate of urbanization and one of the major effects is the emergence of informal settlements charaterised by high population density (Tibaijuka, 2006). It is estimated that in overall the suburbs in African cities accommodate more than 25 per cent of the total

urban population(Cox, 2007; Isabel, 2013; Febrina, 2009) with Kisumu city having over 60 percent of its population in the suburbs (UN-HABITAT, 2005). Despite the high population density recorded in the suburbs, Tiago (2011) pointed out that little is still known about the influence of the density on time taken to work in the suburbs of Africa. There is still a gap in knowledge on where these people go to and what means of transport are accessible to them in terms of time taken to destinations. The density-time relationship in the suburbs of African cities is critical considering the fact that they accommodate the bulk of urban labour force. Any negative influence on time taken to destinations in the suburbs therefore implies inaccessibility and hence, a reduction on the overall urban production.

The suburbs are also charaterised by high densities of land use mix which could minimize time taken to activity locations. However, previous study results have shown that it is only land use mixing with balance that can significantly reduce commuting time (Steil *et al.*, 2007, Steven and Maria, 2004, Minerva *et al.*, 1996 Dowall,1982; Litman 2003). But how does land use mix influence time in locations charaterised by imbalance like in the case of suburbs of Kisumu city? This is because the uncontrolled land use mixes in a locality forces different people to have different accessibility needs, mobility options and abilities to reach particular locations. This shows that there is a need to examine how densities in the suburbs influence travel time and particularly in the suburbs of cities like Kisumu. Currently, the land use and transport studies that have been conducted in Kisumu city have also not focused on density-time relationship and particularly in the suburbs (Otieno,1993; Onyango,1997; UN-HABITAT,2004 ; UN-HABITAT/IHE/ITDG, 2005).

Accessibility studies should not miss to examine the dynamics of the relationships between residential location and modal choices. According to Sanit, *et al.*, (2013) and Zhao *et al.*, (2002) changes in land use characteristics depicted by residential location generally influences modal choice in various ways since it triggers multi-household trips. According to Sultan (2011) people select their residential location according to their modal preferences but the precise causality cannot be established due to the complexity in travel decisions. On the other hand, LaMondia *et al.*, (2009) contends that it is the personal preferences as destination characteristics, travel distances, costs and travel times that determine modal choice and not residential location.

These varying findings still raises questions on the nature of relationships between residential locations on modal split that this study addressed. The suburbs of Kisumu city are characterized by uncontrolled activity locations, disorganized public transport system and low motorized mode ownership. The study therefore aimed at finding answers as to whether suburb residents choose their residential location based on their ability to use alternative means of transport to different destinations or whether there were other factors determining modal split. Cao *et al.*, (2008) revealed that the extent to which residential location influences travel behavior and particularly on modal split is still not well understood. This study in Kisumu city, examined the percentage of households using particular means instead of others contrary to the observed distances between residential locations and other destinations and what really causes the deviations in the modal split.

Changes in land use characteristics also influence the cost of transport to work. The major argument here is that the suburbs in Kisumu city, being former rural settlements did not have any major challenge of journey to work since the places of employment were within their residences but the changes in land use characteristics have led to the separation between the work places and their residence. However, they are emerging in informal nature implying that the transport cost to workplaces may be different from the planned suburbs and hence, their measures may also be unique. This is because informality is associated with forms of spontaneous settlements, poor transport infrastructure and heterogeneous populations that are predominantly engaged in informal economic activities whose locations are also not controlled (Mushumbusi, 2011; Ejigu, 2011). Raymond (2013) contends that there is no clear correlation between the residential location and the cost of transport to work while Yang (2005) revealed that increased distance between residence and workplace influences transport cost in terms of distance covered but this varies with locations. These varying findings also indicate that the nature of influences of distance on transport costs even within well planned urban zones. They further raise the question on the nature of transport cost to work within the unplanned zones that are characterized by incremental activity locations, and poor transport infrastructure. These zones generates enormous amount of movement but at the same time creates barriers through spontaneous developments that may reduce accessibility to locations and increase transport costs (Swärdh, 2009; Ackelman & Andersson, 2008).

Interestingly there is still inadequate empirical evidence on the nature of relationship between transport cost and residential locations in the suburbs characterized by informality (Horswell and Barton, 2010). For example, it has not been very explicit how the increasing and

heterogeneous populations access their places of work within these suburbs and the cost of means and means of transport they use. Similarly, it has been established that street configuration and quality determines transport cost but the transport cost of the unpleasant and unsafe roads and interchange stations characterizing the informal suburbs are yet to be fully understood. This study examined the possible relationships between road configuration and transport cost in the suburbs to find out whether it adds or reduces the cost of travel to work. Since informality is linked to poverty and low mode ownership, there are possibilities of the suburb residents like those in Kisumu to fully depend on cheaper means of transport to work that are accessible to them (Ejigu, 2011; Carrion, 2009; Hill & Lindner, 2010, Murray & Wu, 2003; Febrina, 2009). It was therefore important for this study to find out on whether the residents have alternative means that are considered less costly in terms of waiting time, fare charges or comfort to their work places. The other challenge when determining transport cost in the suburbs is the applicability of tools that have been used in measuring the cost of transport between residential areas and work places in planned suburbs on the ones characterized by informality.

1.2 Statement of the Problem

The suburbs in Kisumu city were former rural settlements dominated by agricultural land use but currently have several land uses with varying characteristics. The varying characterization have led to separation of activities and triggered complex movement patterns. Despite all these challenges, little consideration has been put on how the varying characterization affects accessibility to locations in the suburbs. This exclusion has led to accessibility challenges in the suburbs of Kisumu City that needs further investigation. It is important to understand how the

increased density influences travel time from and to destinations, how residential location relate to modal split and the relationship between work places and transport cost in the suburbs.

It is estimated that currently, Kisumu city suburbs accommodates over 60% of its population. The population density of the suburbs studied was estimated at 981 people per km^2 surpassing that of the overall city which stands at 828 per km^2. Due to poor development control in the suburbs, the land uses are also characterized by high densities of unbalanced mix which seems to have impacts on time taken to various activity locations. Despite the increasing unbalanced mixed density, it is still not clear how these changes affects accessibility in terms of time taken to different locations in the suburbs.

Changes in land use characteristics depicted by residential locations generally relates to modal split in various ways since it triggers multi-trips (Sanit, *et al.*, (2013). Suburbs in Kisumu city currently attract new settlers and different kinds of means of transport. The suburbs are also characterized by disorganized public transport system depicted by mixture of both motorized and non-motorized means and their mode of operation. The location of residential places seems to be uncontrolled and connected with varied road networks. Currently it is still not clear how the residential location relate to modal split in the Kisumu city suburbs.

The separation between the residences and workplace generally defines transport cost in various ways in the suburbs. The nature of transport cost to work in Kisumu city suburbs seems to be unique. This is because the suburbs are characterized by incremental residential and workplace locations that seem to create varying costs to destinations. There are also no clearly

zoned workplaces and residential areas in the suburbs since the developments take the form of unbalanced mix. The suburbs are also characterized by heterogeneous population with varied employment needs. The street configuration and quality that also determines transport cost are also in poor state in the suburbs. However, little is still known on how the current situation in the suburbs influences the relationships between workplace locations and transport cost in Kisumu city suburbs.

Therefore, the purpose of this study was to assess the effect of changes in land use characteristics on accessibility in three suburbs of Kisumu city, namely, Nyamasaria, Otonglo and Mamboleo.

1.3 Objectives of the study

The overall objective of the study was to assess the effect of changes in land use characteristics on accessibility in the suburbs of Kisumu city. The specific objectives were:

1. To assess the influence of population density on travel time to destinations in the suburbs of Kisumu city.
2. To determine the relationship between residential location and modal split in the suburbs of Kisumu city.
3. To examine the relationship between work place location and transport cost in the suburbs of Kisumu city.

1.4. Research Questions

1. How does population density influence travel time to destinations in the suburbs?
2. What is the relationship between residential location and modal split in the

suburbs?

3. What is the relationship between work place location and transport cost in the suburbs?

1.5 Justification of the Study

This study assessed the effect of changes in land use characteristics on accessibility in the suburbs of Kisumu City. The contribution of this study lies in the following areas. First understanding the relationship between the changes in land use characteristics and accessibility can help the Kisumu city authorities come up with strategies of harmonizing the activity location thereby improving the ease of movement within the suburbs. Secondly, one of the major concerns was on how to improve access to areas developing as informal settlements. Information on factors influencing modal split in the suburbs addressed by this study will also be critical to transport planners since it reveals the accessible means frequently used by the suburb residents in cities like Kisumu.

Researchers have been concentrating on the influence of transport on land use but this study shows also that land use characteristics can also influence accessibility is such zones as the suburbs. The study also generated data that could be used for transport or personal accessibility planning in the suburbs, a concept that has not been adopted in Kisumu city. This study also adopted a mixed method approach which is different from previous accessibility studies that have been adopting explanatory designs. This is because the search for knowledge on accessibility currently represents a fertile research venture that needs application of various designs in order to gain information. Finally, the study fills a gap in knowledge concerning the accessibility situation in the suburbs that are developing in an informal manner.

1.6 Scope and limitations of the Study

The study focused on land use charateristics and personal accessibility in three suburbs in Kisumu city including Otonglo, Mamboleo and Nyamasaria. On land use charateristics, the study concentrated on such variables as the commercial locations, residential locations, industrial locations, social halls, gross population density and work places. On the other hand, accessibility variables included time, cost and road conditions. The nature of variables to be analysed led to the adoption of triangulation mixed method design. The analysis was based on primary data from households, Focused Group Discussions, government officials and land use consultants. Secondary data was sourced from the libraries, Kisumu city council offices, Ministry of lands offices and internet.

Some limitations of the study were also noted like little research on the study topic in Kenya, inadequate databases in government offices, reliance on self-reported data and techniques in data collection. Little research on the effect of land use characterization on accessibility in Kisumu led to the adoption of mixed method study design which was exploratory in nature.

Lack of databases specifying detailed suburban form features, such as their official boundaries, land use zones and characterization from both city and county offices, limited the scope of analysis. The scope was therefore limited to households and observations within areas that qualified as suburbs based on the set threshold weights for the purpose of the study. Much reliance on self-reported data created possibilities for biasness in terms of selective memory and exaggeration for example in the estimation of distances and time taken. Limited application of Geographic Information Systems (GIS) in data collection also inhibited the ability to

conduct a thorough analysis of the results in spatial context. The application of GIS will be necessary for future studies, for example, the recommended studies on place accessibility in the suburbs.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter covers an elaborate analysis of the available literature on the subject under study. The literature pans from international to local level reviews in order to fully understand the influence of density on travel time for non-work trips, relationship between residential location and modal split and the relationship between work place location and transport cost in the suburbs. It also gives a summary of related theories/models and the conceptual framework of the study which shows the relationship between the study objectives and the key variables in the study.

2.2 Influence of population density and travel time in the Suburbs

Globally, land uses in the suburbs are generally characterised by lower density of population, housing, business complexes (TCRP 55, 1999; Schwirian, 2003; Stiff, 2011; Siembab 2012; Dowall,1982). According to the "flight from blight" theory advanced by Mieszkowski and Mills (1993), residents moving to the suburbs are mostly in search of low density places with evenly distributed activity locations that can be accessed at the shortest time possible. However, Rosenberg (2013) revealed that land uses characterized by low population density on the other hand, imply wider separation of activity locations which positively or negatively influences time taken to destinations and use of means of transport. In some cases, high population densities have been associated with high levels of accessibility to locations and hence, shorter time taken while in some cases it causes delay due to connectivity challenges (Shen, 1998; Frank, 2007; Geurs and Ritsema van Eck 2002; Kockelman, 1995). Other studies

have also revealed that the relationship between density and time is complex, since in some cases, increased density have resulted into increase in traffic congestion which again increases time to activity location (Litman, 2008; 2012). David and Ajay (1997) on the other hand, contended that density in urban areas is positively associated with distance and not statistically significant against time. These conflicting results show that there is need for further investigations on how density influences time taken to destinations in the suburbs.

Over half of the 6.3 billion of world's total population currently live in the urban areas and Africa is leading with the fastest rate of urbanization with a projection that in the next 25 years, its total urban population will be 400 million (Tibaijuka, 2006). One of the signs of urbanization in the major cities in Africa is the emergence of suburban locations characterized by varying land use characteristics (Mabin *et al.*, 2013). It is estimated that in overall the suburbs in African cities, like other developing nations accommodate more than 25 per cent where in most cities the suburbs cater for over 50% of the total urban population. In Mexico City the suburbs accommodate 50 percent, Sao Paulo 65 percent, Buenos Aires 80 percent and in Kisumu city over 60 percent of the population(Cox, 2007; Febrina, 2009; UN-HABITAT, 2005). Despite the high population density recorded in the suburbs, Tiago (2011) pointed out that little is still known about the influence of the density on time to work in the suburbs of Africa. It is still not clear how density influences travel time and means used to various destinations in the suburbs.

Studies that have been dedicated to the urban land use and transport in Africa also reveal that they rarely touch on the suburbs and particularly on relationship between density and time

taken to destinations (Isabel, 2013; Cooke, 2012). They focus on the general urban land use planning with little examination on the link between land use and accessibility variables like activity locations and time taken reach them (Robert, 2002; Ikpoki and Owei, 2006; Nyakaana *et al.*, 2003; Jarabi, 1982; Kadiri, 2006). There could be a an assumption that since majority walk to work, time taken between destinations may not be of significance. However, the density-time relationship in the suburbs of African cities is critical considering the fact that they are homes to the bulk of urban labour force yet their informal nature of development may have negative influence on time taken to work. Since the effect of density on travel time has been considered to be complex, it would be interesting to know how density influences time in land uses charaterised by uncontrolled location of activities like the suburbs.

Even low density suburban areas have also been criticized for encouraging more private car ownership and use as opposed to walking and use of other means of transport as a way of minimizing time wastage (Desvarro, 2012; TCRP 55, 1999; Schwirian, 2003; Stiff, 2011; Siembab, 2012; Rosenberg, 2013). These challenges have led to proposals for more studies on the possibilities of encouraging higher densities and land use mix in the suburbs as a means of minimizing commuting time in them but still this poses other challenges in different suburbs considering their heterogeneity in nature (Boarnet *et al*, 2011; Rosenberg, 2013). Past study results have shown that land use mixing with balance in the suburbs significantly reduces commuting time (Steil *et al.*, 2007, Steven and Maria, 2004, Minerva *et al.*, 1996 Dowall,1982; Litman 2003; (Ewing and Cervero 2010, TRB 2009; Handy et al., 2003, Meurs and Wee, 2004; Srinivasan, 2000; Schwarze, 2002; Challuri; 2006, Short and Rat, 2004; Litman, 2008). But the

still litte studies have been dedicated to the influence of density on time taken to destinations in the suburbs that are charaterised by imbalanced land use.

On the other hand, even the suburbs having land use balance are not homogeneous in nature hence, density may not influence time in the same manner. Other studies have also shown that increased land use mix reduces travel time but encourages more trips to destinations and the use of alternative means while others shows that travel time increases with land use mix (Modarres 1993; Kuzmyak and Pratt 2003; Spears *et al.*, 2010; Frank and Pivo, 1995). These contradictory study results about the relationship between density and time due to land use mix raises the need to examine suburbs in terms of their variation in the suburbs geographical settings and the research designs that have been applied. It would also be interesting to know whether travel time is positively or negatively related to density in different geographical settings like on the suburbs of Kisumu city.

It is important to note that the nature of density in the suburbs of cities developed countries may not uniformly apply in all cities of the world. These suburbs are characterized by high population density, poverty, weak development control, and poor infrastructure and unplanned mixed land use. They are also faced with the challenge of lack of full implementation of land use policies and regulatory measures that control their densities. All these factors could be having unique influence on travel time between activity locations within the suburbs. The land use charateristics that explain how density influence travel time in the suburbs can be examined at the individual, group, mode and or activity levels (Litman, 2012; Beaton; 2006). This is because the uncontrolled land use characteristics force different people and or groups to have

different accessibility needs, mobility options and abilities to reach particular locations. Similarly, Niemeier *et al* (2011) found out that increased density reduces travel time, particularly in areas with more than 1,500 households per square kilometer and in land uses characterized by controlled development. Even though, studies have proved that increasing urban densities characteristically reduces travel time by 25-30%, the main question is on the reasons behind the reduction considering the variations in the conclusions. This shows that there is a need to examine how densities in the suburbs influence travel time particularly in the suburbs of cities in developing countries.

Kenya, like other African countries, have had several studies on general urban land use and transport with little focus on density-time relationships particularly in the suburbs (UN HABITAT,1997; UN HABITAT,1993; Otieno,1993; Onyango,1997; Oludo,1985; Obudho and Aduwo,1988; Rukunga, 1990; Sclar *et al*, 2007; World Bank, 1996; SUM, 2006). Likewise, the land use and transport studies that have been conducted in Kisumu city have also not focused on density-time relationship in any of the suburbs (Otieno, 1993; Onyango, 1997; Oludo,1985; Olima and Obala, 1991; UN-HABITAT, 2004 ; UN-HABITAT, 2005 ; UN-HABITAT/IHE/ITDG;2005). Eventhough, some of these studies have examined the suburban locations as informal settlements, the relationship of density and time in an informal nature of development has been largely missing.

These conflicting findings by various studies on the relationships between density and time show that there is still no agreement on how density influences time taken to destinations in the suburbs. Some of these studies on the relationship between density and time have been

conducted on the overall urban setting while other has been conducted in suburbs having balanced land uses. On the other hand, even in cases where the studies in the suburbs have considered how density influences time, they have failed to examine how density as a land use characteristic influences time taken to other characteristics within the same land use. The other challenge is that the instruments that have been used to measure the realationship between density and time may not fully apply in the all the suburbs including those in the developing countries that are experiecing unique development patterns. Little studies on the influence of density on time have also been conducted in the suburbs of Kisumu city that is charaterised by the uncontrolled land use characteristics that forces different people and or groups to have different accessibility needs, mobility options and abilities to reach particular locations On the other hand, even though studies have shown that increasing urban densities reduces travel time still questions are raised on the reasons behind this reduction.

2.3 Relationship between residential location and modal split in the Suburbs

Accessibility studies generally examine the dynamics of the relationships between residential location and modal split. Sanit, *et al.*, (2013) revealed that changes in land use characteristics portrayed by residential location, employment location, shopping location, and the location of new dwellings, jobs and shops generally influences modal split various ways. For example, it triggers multi-trip by households making the interaction between household location and commuting decisions become more complex than it was before. Sultan (2011) established that in well planned land uses, people select their residential location according to their modal preferences but still states that the explicit causality of direction cannot be established due to the complexity in travel decisions. Despite this finding, questions still arises on the nature of

the influence of residential location on modal split particularly in unplanned zones like the suburbs of Kisumu city that are also characterized by disorganized public transport system and low motorized mode ownership.

Several models have been extended from the Lowry model in order to explain the influence of change in land use characteristics on modal split. Some of these models include Leeds Integrated Land Use (LILT) which predicts change in zonal population in relation to accessibility, zonal attractiveness and modal split as a function of network travel times and costs (Mackett, 1983; Timmermans, 2003) and cell based models of land use as Cellular Automata (CA) applicable in the assessment of land use change and their impacts (Torrens *et al.*, 2001; Iacono *et al.*, 2008). However, these models have been criticized for their simplicity and not being applicable in all areas particularly those characterized by unplanned land use mixed zones as in the case of the suburbs of Kisumu City.

Balcombe, *et al.*, (2004) and Larwin, (1999) revealed that the growing population, increased levels of inaccessibility and the shrinking role played by the public transport means in suburban areas is posing a great challenge to modal split. Other studies have also shown that there is a general shift in the split whenever there are changes in the demographic characteristics such as, population growth, income, age structure and household size in any locality as the suburbs (Balcombe *et al.*, 2004; Nurdden *et al.*, 2007, Hovell and Jones, 1975; Hagi, I. S. A. K, 2006). However, most of these studies fail to examine the influence of residential location on modal split. Davies, (2012) when examining the links between populations weighted density and the use of transit in Australia, found out that modal split correlates with the degree to which

population is concentrated in a zone. However, the study did not examine the modal split between residential location and activity locations in the zones.

LaMondia *et al.*, (2009) revealed that it is the personal preferences that influence modal split in any locality. According to these scholars, these preferences include destination characteristics, travel distances, costs and travel times. Teshome, (2007) on the other hand, contends that out of all these preferences, it is income that mostly influences the mode split which then affects the general efficiency with which people travel in the suburbs. Other studies have also shown that personal income is the key variable that generally influences travel behavior either through mode choice or modal split (Polzin, 2007; Litman, 2003; Lawson, 1999; Balcombe, *et al.*, 2004). This is because residents mostly act as rational consumers and choose the mode that provides them with the highest utility in terms of travel distance, time and fare charges and not only income (Schwanen and Mokhtarian, 2005). On the other hand, income has been criticized for encouraging dependency to a particular means hence, skewing modal split. The study investigated whether suburb residents choose their residential location based on the nature of modal split or whether there were other factors that determine this.

Gravity model has been useful in examining the accessibility between two land use locations but fails to examine the accessibility between the various activity locations within the land uses which are mixed but also not balanced (Iacono *et al.*, 2008; Cervero, 1989). It also fails to examine the relationship between residential choice location and modal split since people choose to use some locations irrespective of the distance or mode of transport which defies the dictate of transport cost. On the other hand, while the gravity model is very successful in explaining the choice of a large number of individuals, the choice of any given individual

varies greatly from the overall value. This is quite critical when examining individual decision to locate in a zone.

Cao *et al.*, (2008) further states that what is little understood is the extent to which residential location influences travel behavior and modal split. The questions that should be answered are for example why people walk to work in an environment characterized by several alternative means of transport. In some cases, there could be observed relationships in between the location of activities and residential locations either in terms of proximity but people still tend to choose particular means to the destinations instead of walking. While in other some cases, even people in high income neighborhoods choose to walk to work instead of using motorized means. The study examined some of the factors determining in modal split and how this relates to residential choice location in the suburbs of kisumu city.

These study results reveal that even though there exists the relationships between residential location and modal split the nature of causality has not been established. On the other hand, the varying results indicate that questions still exists on the nature of relationship between residential locations on modal split particularly in unplanned zones like the suburbs of Kisumu city. It is still unclear particularly in the suburb of Kisumu city whether residents choose their residential location based on the nature of modal split or there are other factors that determine this. The study findings have also shown the relationships between modal split both in the high and low income residential areas but little is still known about the nature of relationships between modal split and suburbs characterized by mixed income groups.

2.4 Relationship between work place location and transport cost in the Suburbs.

Raymond (2013) in his studies on the efforts of workers to minimize the costs of travel within planned urban land use found out that there is no clear correlation between the residential location and the cost of transport to work. However, the study by Yang (2005), on the impacts of urban growth pattern on commuting distance between residence and workplace revealed that increased distance influences people's cost through distance covered while compact development minimizes cost through commuting time only in some locations and not others. These studies confirm that changes in land use characteristics have influence on the cost of travel between residence and workplace but the nature of costs differs. However, their varying conclusions indicate that the nature of influences also differs despite the fact that they are conducted within well planned urban zones.

The study by Silva, *et al.*, (2006) on effects of employment location on transport cost between the residences and workplace further confirmed that even though people living in denser, central, compact, and mixed zones make more intense use of public transport and walking to work, the influence of employment location on travel cost varies. This implies that further investigation should be carried out on the nature of transport cost within the unplanned zones characterized by incremental constructions, overcrowding and poor transport infrastructure as the suburbs of Kisumu city. It has also been observed that the spontaneous developments in the informal settlements generates enormous amount of movement, creates barriers and reduces accessibility to locations (Swärdh, 2009; Ackelman & Andersson, 2008). This nature of development indicates the possibility of having unique transport costs between residences and workplaces in the suburbs that needs further examination.

Sub-Saharan Africa has had the largest proportion of its former rural settlements within the city boundaries changes into suburbs. These locations attracts huge populations from the central zones estimated as to be over 70 %, compared to the average of developing regions at 43.0 % (Tibaijuka, 2006; HABITAT 2003: Hurskainen, 2004). The suburban locations generally develop in informal manner (Eric, 2010; Ackelman & Andersson, 2008). Due none enforcement of the city regulations, haphazard suburban development generally emerge and hence, the city authorities try to endorse tighter development controls and zoning as methods of trying to bring order to curb the rising informality(Larkham, 1999; Rosenberg, 2013; Steil *et al.*, 2007). Despite all these attempts, it takes some time to bring order in terms of seperating workplace location and residetial locations. Similarly, the nature of development also have some impacts on the transport costs to the suburb residents. The emerging informal nature of development in the suburbs implies that the transport cost to workplace may be different from the planned suburbs and hence, measured in different ways. This could be in terms of distance, time, monetary costs, hidden costs and the existing transport infrastructure depending on the prevailing suburb condition. However, it has been observed that informality is generally associated with forms of spontaneous settlements, heterogeneous populations that are predominantly engaged in informal economic activities and poor transport infrastructure (Mushumbusi, 2011; Ejigu, 2011). In this scenario, the transport cost to work place may in different forms that need further examination.

Currently, there is still inadequate empirical evidence on the relationship between transport cost and employment locations in the suburbs characterized by informality (Horswell and Barton,

2010; Paulley *et al.*, 2006). This implies that even the nature of transport cost in the suburbs is still not clearly understood. For example, it has not been very explicit how the increasing and heterogeneous populations access their places of work within these suburbs and the means and means of transport they use. This also shows that there is still need for more studies on how changes in land use charateristics contributes to transport cost in the suburbs particularly in African cities that are currently experiancing faster rate of growth. According to Alba (2003) and Siembab, (2012), street configuration and quality is basically a transport cost that determines movement between residential areas and work places. For example unpleasant and unsafe roads and interchange stations which characterize informal settlements can either minimize or increase the cost of transport between residences and workplaces. How are the streets in the suburbs characterized by informality configured and does their configuration add some transport cost to the suburb residents.

Since informality is linked to poverty, it shows that there are possibilities of the residents in informal areas to fully depend on cheaper means of transport to work since they are accessible to them (Ejigu, 2011; Carrion, 2009; Crane & Crepeau, 1996; Hill & Lindner, 2010, Murray & Wu, 2003; Febrina, 2009). However, some of the presumed means may be costly to the residents either in terms of waiting time, fare charges or comfort considering the location of their work places and the existing transport infrastructure. According to Mamun (2011), several tools of measuring transport costs have been developed in various studies focusing on different variables using different transit accessibility analysis tools. Some of these include Time-of-Day (TOD), Transit Level-of-Service (TLOS), and Local Index of Transit Availability (LITA) among others (Ryus *et al.* 2000). However, applicability of these tools in measuring the cost of

noted like in the case of Kisumu city suburbs where residential location may be influenced by need to own residence than the cost to workplace.

The varying conclusions on the relationships between the work place location and transport cost indicate that every locality has a unique relationship between the two that needs further examination. The emerging informal nature of land use characteristics in the suburbs of Kisumu city also implies that the transport cost to workplace may be different from the planned suburbs and hence, the need for further investigations.

2.5 Literature gaps

Whereas massive literature exists on the influence of density on time and accessibility, there is still little information on the influence of population density on time taken to destinations. The review revealed that the influence of population density on time to different activity locations varies even in planned suburbs hence, the need for further investigation particularly in the areas characterised by unbalanced mixed land uses like the Kisumu city suburbs. Currently, there is no study that has been conducted in Kisumu examining the relationship between population density and accessibility in the suburbs.

The review also revealed that it is still not clear whether or not people the choice of residental location if fully influened by the opportunities to choose from different means of transport. This is based on the conflicting findings by various studies on non suburban locations some of which affirms while others dispute the fact that residential locations influences modal choice. This is a gap that should be field through further studies similar to this one.

These study results reveal that even though there exists the relationships between residential location and modal split the nature of causality has not fully been established. The varying results on the relationships also indicate that there exists a gap in knowledge that should be filled. Little studies have been conducted in Kisumu city on the relationship between residential location and modal split in the suburbs.

The nature of cost of transport between residential location and workplaces is still unclear due to the unique of changes in land use charateristics in different suburbs. Studies have also proved that changes in land use characteristics have influence on the cost of travel to workplace but the nature of costs differs both within the dispersed and the compact land uses.

The varying conclusions on the relationships between the work place location and transport cost indicate also revealed that there is a gap in knowledge that needs to be filled. The emerging informal nature of land use characteristics in the suburbs of Kisumu city also creates a unique transport cost to workplace that needs further investigations.

2.6 Conceptual framework

Figure 2.1 presents a conceptual framework of the main land use characteristics that affect accessibility in the suburbs of Kisumu City as per the scope of the study. The framework summarizes the major inferences of the literature review on land use characteristic variables considered to affect accessibility.

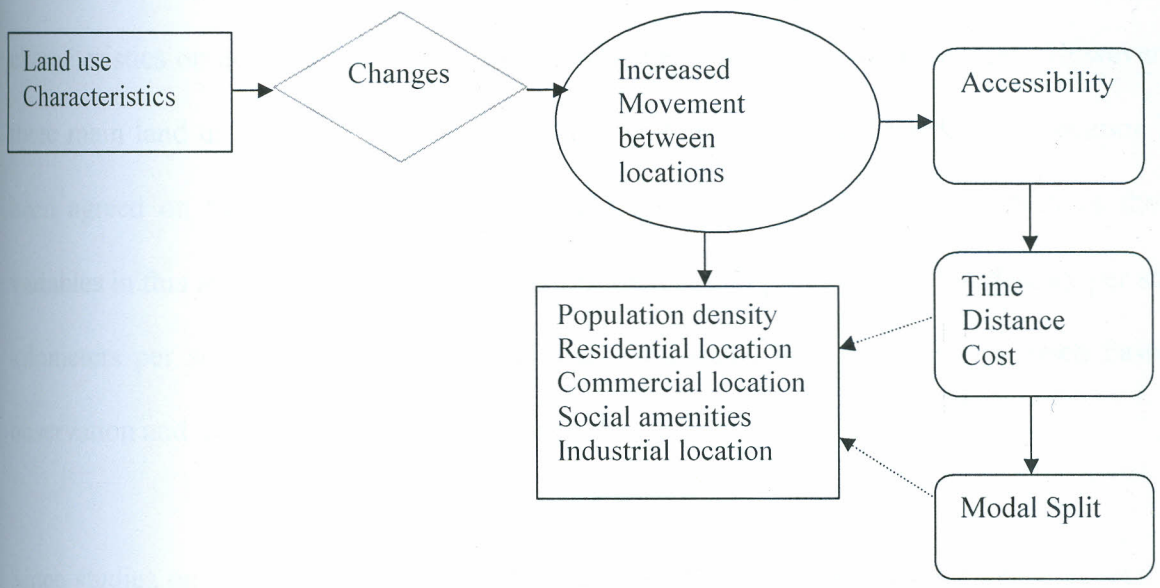

Figure 2. 1: Conceptual framework for the effect of changes in land use characteristics on accessibility. Adapted from Four-Step Travel Demand Model http://www.fhwa.dot.gov/planning/scenario_and_visualization/

Within this study's context, accessibility is believed to result from the need to participate in spatially disperse activities within a land use where some factors either facilitates or deters it. Most authors on relationship between land use and accessibility agrees that it is accessibility that influences land use but in this study, it is the characteristics of latter that is viewed to influence the former when considering the observed suburban development trend in Kisumu city. Land use characteristics considered in the study include; density, residences, commercial areas, social amenities and industrial location. In the case of Kisumu city suburbs, the changes

of these characteristics increases movement between them creating accessibility challenge. On the other hand, the factors considered to influence and determine accessibility between these locations include means of transport used, time taken, distance, and transport cost.

Most authors on relationship between land use and accessibility agrees that the change in the former have influences but, still there is no consensus on the level of influence of their characteristics on accessibility due to the heterogeneity of regions or locations. However, the three main land use characteristics, density, residential location and work place location have been agreed on to influence accessibility hence, the decision to consider them as the key variables in this study. Density was assessed in the context gross population density per square kilometers per suburbs. While residential and work place locations were assessed based on observation and description from the respondents.

Since studies on factors indicating that land use characteristics directly influence accessibility are limited, it was therefore assumed that the main variables were modal split, time taken, distance, and transport cost. Modal split was examined in terms of existing means that suburb residents use between the activity locations. Transport cost was assessed both in monetary terms and risks taken when travelling in the suburbs. While distance was based on the residents' estimation since the straight line measurements could not be used considering the uncontrolled nature of developments in the suburbs. Time taken was also based on the suburb residents' time estimates.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter highlights the study area and methods used in the study including; study design, study population, sampling procedure, data collection methods, analysis and interpretation. The main objective of the study was to examine the effect of changes in land use characteristics on accessibility in the suburbs of Kisumu city, Kenya. The study was carried out in three suburbs namely Nyamasaria, Mamboleo and Otonglo.

3.2. 0 The Study Area

Kisumu is the second largest city in Kenya and the principal town in Western part of Kenya. It is currenly the headquarters of Kisumu County. It stands on the shores of Lake Victoria which is the second largest fresh water lake in the world, at an altitude of 1160m above sea level (Figure 3.1). Kisumu is situated approximately $00^{0}06'$ South of the Equator and $34^{0}45'$ east of Greenwich. It is connected to major towns and cities in Kenya like Narobi and Nakuru to the east, Eldoret to the north east , Busia to the West and Kakamega to the North by rail, road and air. Kisumu City lies at the shore of Lake Victoria with an elevation of approximately 1140m above sea level and the Nyando escarpment to the North, which rises to over 1800m. The town covers an area of approximately 417 Km^2, of which 35.5% is under water. The area within the town boundary rises gradually from the lakeshore to the foot of the Kisian escarpment, a level of approximately 1259m.

Figure 3. 1: Location of Kisumu City in the National Context

Kisumu also experiences a wide mean annual range of temperatures. It has a maximum annual temperature that range from 25°C to 30°C while the mean annual temperature ranges from 18°C

to 20°C (Wera; 1981). The knowledge of the climatic conditions is important to land use and transport use since it affects all developments and movement patterns in the suburban areas. Kisumu City is divided into two topographic regions that is, the Northern highlands and the southern plains. The former covers Konya, Kogony, Korando and Dago sub-locations where Otonglo, and Mamboleo suburbs are located. The Southern plains cover Nyalenda, Chiga and Nyalunya sub-locations and extend to the vast Kano plains to the East and Southeast where Nyamasaria suburb is located (Kenya, 1989). Three suburbs selected for study included Mamboleo, Nyamasaria and Otonglo. Mamboleo suburb is located to the north east along Kisumu-Busia road, Nyamasaria to the east along Kisumu-Nairobi road and while Otonglo to the west along Kisumu-Busia road (Figure 3.2).

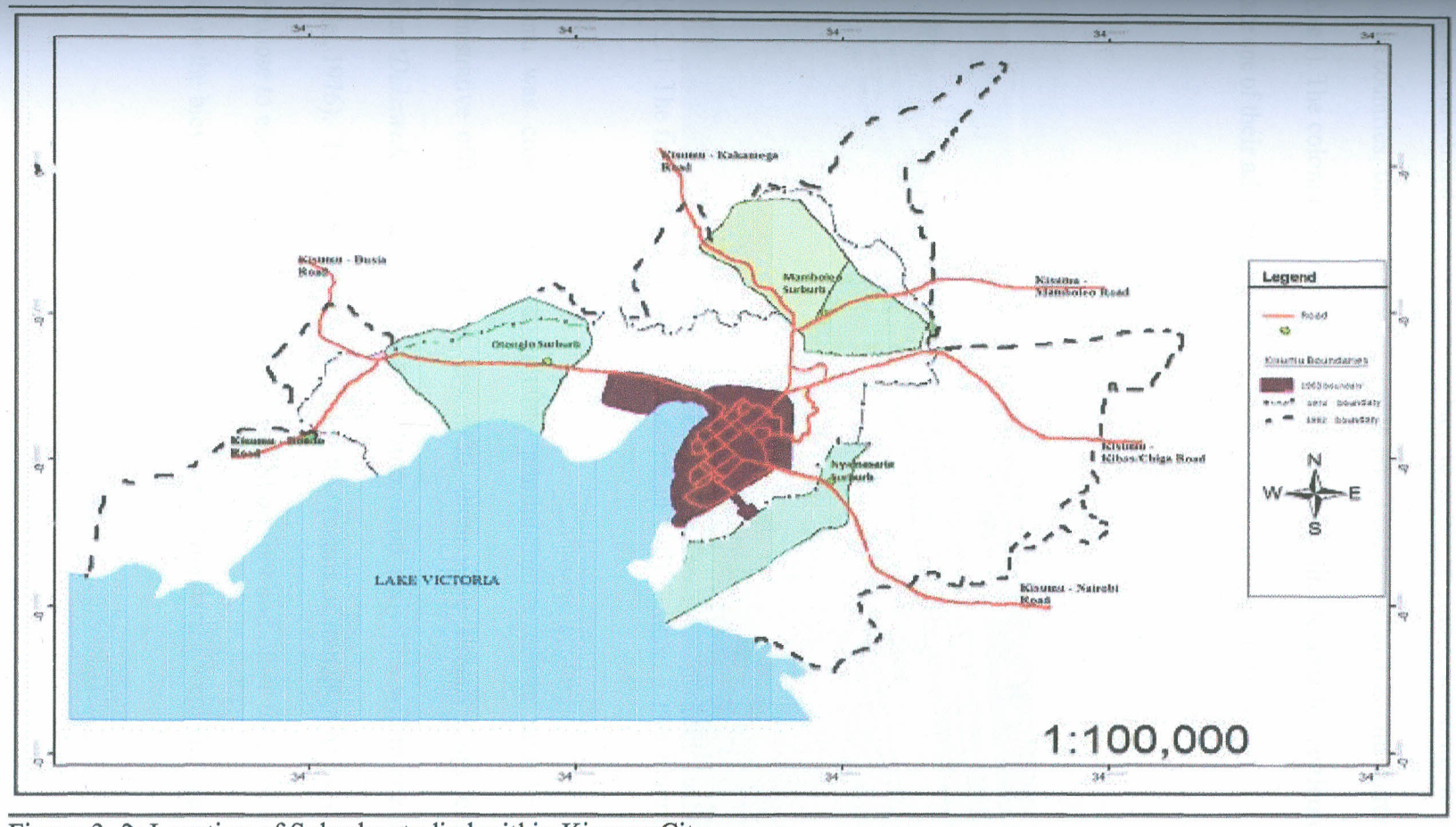

Figure 3. 2: Location of Suburbs studied within Kisumu City

3.2.1 The Historical background

Kisumu City was identified as an alternative railway terminus and port for the Uganda railway in Port Victoria by 1898. It was not until 1901 when the Uganda railway reached the port, which was identified as a strategic place to settle in and a terminus to serve the three East African countries, that is, Kenya, Uganda and Tanzania that Kisumu started to grow as a town (Plate 1). The colonialists recommended it to be a suitable area for settlement and hence it was made one of their administrative centers for controlling the region.

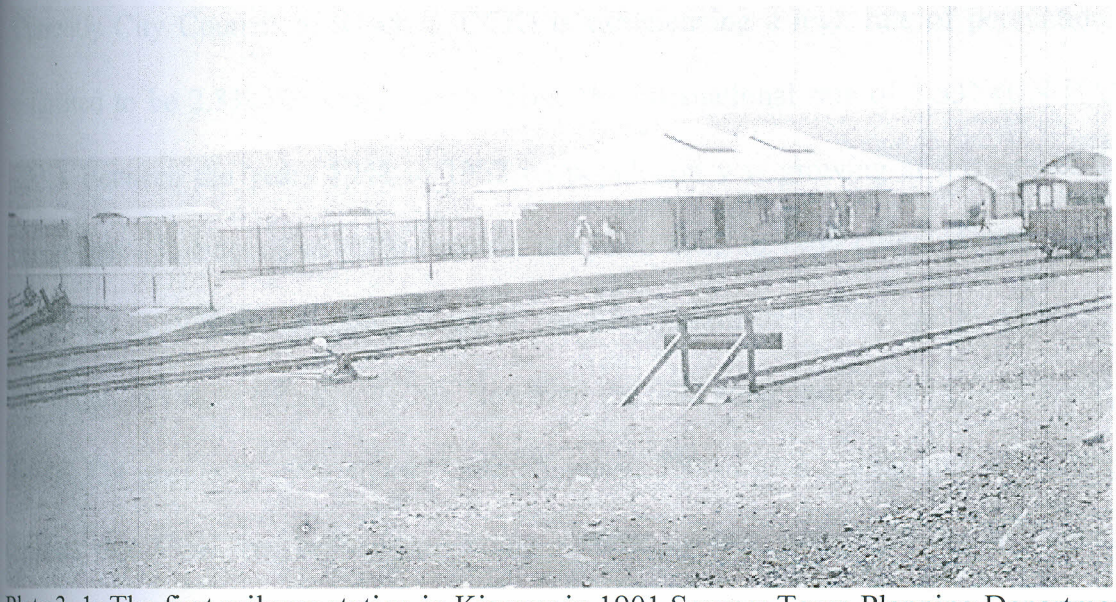

Plate 3. 1: The first railway station in Kisumu in 1901 Source: Town Planning Department-CCK

Kisumu was considered as a suitable administrative centre and by 1902 it had some administrative offices and shops. By 1920, there were already some erected shops and the Indian '*Dukawalas*' had started some commercial activities within the centre (Obudho and Waller, 1976). There were few streets and few means of transport as most of the developments were close to each other and could be reached on foot and other forms of non-motorized means such as the bicycles (Otieno, 1993). The town's boundaries were first gazetted in 1963 with a

total acreage of 12,000acres including the waters and in 1972 its boundary was again extended to 417 square kilometers. Kisumu was elevated to a City Board and City Council in 1940 and 1960 respectively. Its elevation led to the steady rise of its population such that it had a population of approximately 11000, 24000 and 150000 in 1942, 1960 and 1972 respectively. In 2001 Kisumu was declared a City by the Kenyan president and in 2006 it was declared a millennium City by UN Secretary General to show case an urban set up attaining all the MDGs.

3.2.2 Population

Currently City Council of Kisumu (CCK) is experiencing a high rate of population growth estimated to be 2.8% per annum well above the international rate of 1.33%(UN-HABITAT, 2001). Between the years 1948 to 1962 its population was growing at the rate of 5.7% per annum while it dropped to 4.7% between the years 1962 to 1969 (Wera, 1981). Between the years 1969 to 1979 the increase was at the rate of approximately 5.0% and by 1979 CCK had a population of 152,643(Kenya, 1979). However. the total population of the city was estimated to be 322,734 people in 1999 and 409,928 people in 2009 within a total area of 417km2. This implies that CCK has been experiencing a more or less steady population increase since 1948(Table 3.1).

Table 3. 1: Population of Kisumu; 1948 – 2009

Year	1948	1962	1969	1979	1989	1999	2009
Population	10, 899	23, 526	32, 431	152, 643	255 381	322,734	409,928

Source: Kenya population Census 1948, 1962, 1969, 1979, 1989, 1999

The continued population growth has been attributed to rural to urban and urban to urban migration, urban human natural increase and the continued extension of city boundary (Obudho and Aduwo, 1988). The boundary extensions of 1972 and 1983 brought the suburbs

understudy into the city. These includes Otonglo, Mamboleo and Nyamasaria. Figure 3.3 shows the location of the successive boundary extensions and the location of the suburbs within Kisumu city.

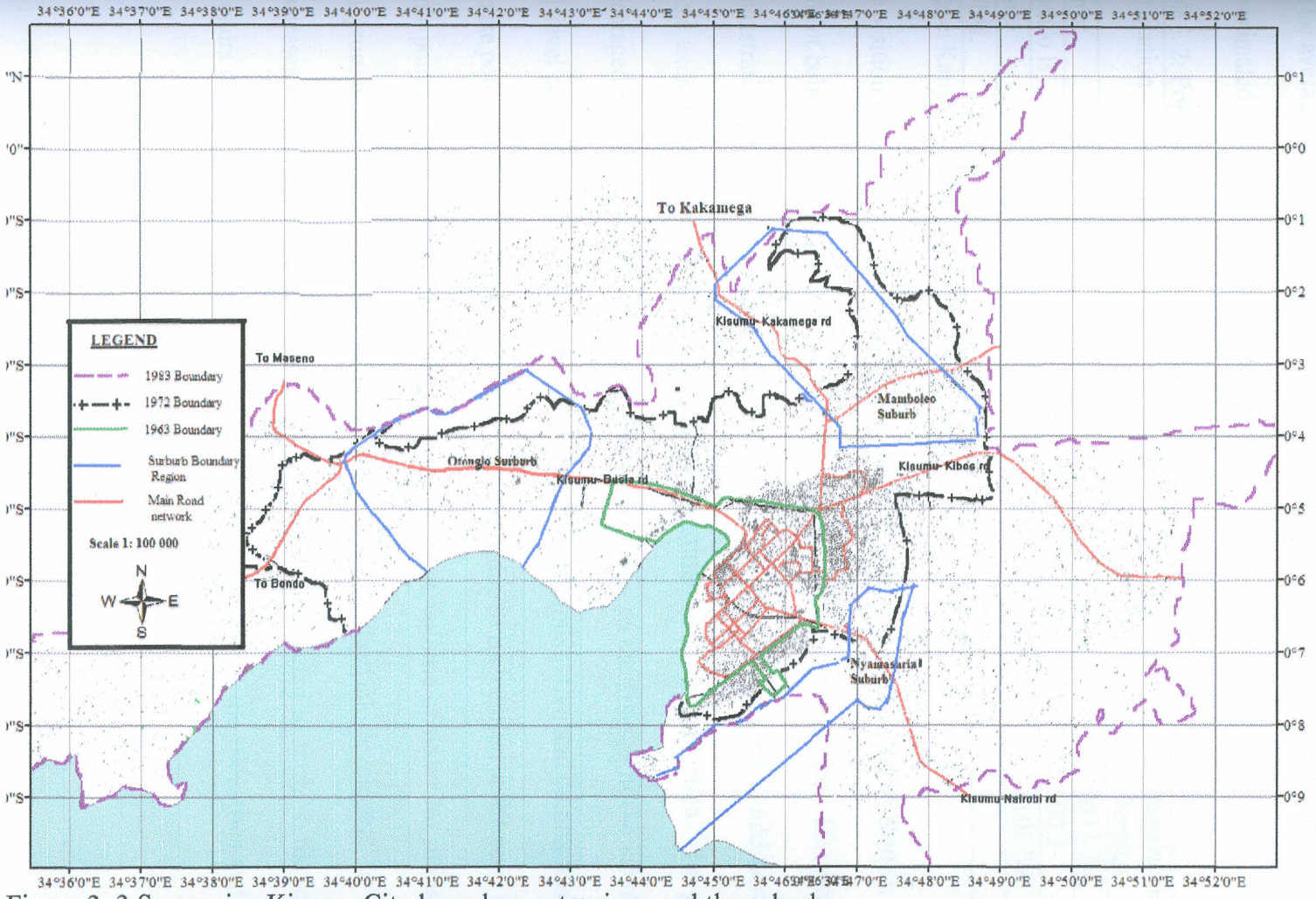

Figure 3. 3 Successive Kisumu City boundary extensions and the suburbs

Figure 3.3 further shows that all the three suburbs are located along the main arterials emanating fron the CBD. These are Kisumu-Nairobi road, Kisumu-Kakamega road and Kisumu-Busia road. These suburbs are characterized by residential land uses coupled with a mixture of commercial, industrial and agricultural land uses. Approximately 60% of Kisumu city's population is being housed in the suburbs(Republic of Kenya, 2005). Table 3.2 shows that the average population density of the suburbs is 981 per square kilometers with a growth rate estimated at 2.8% p.a(Republic of Kenya, 2009).

Table 3. 2: Population in the sub locations in Kisumu City

Sub location	Total Population	Number of Households	Area(km^2)	Population Density
Konya	14,275	3357	13.7	1042.2
Korando B	6,446	1367	8.05	800.3
Kasule	19,252	4880	17.49	1101.03
TOTAL	39,973	9604		

Source: Kenya Population Census, 2009

The position of Kisumu city as the largest urban centre of Western part of Kenya, earns it the credit of being the major administrative and commercial base of the region. Its commercial and administrative position makes it attractive to many people. This has led to addition of pressure on the existing land use spaces and transport facilities in its central zone. The pressure has encouraged migration to the suburbs, hence contributing to the change in the suburbs land use and travel patterns. Kisumu city, apart from being an administrative and commercial centre, has also the potential for industrial development. This is due to its location at the port, rail and road traffic points, the availability of electricity and the large volume of water for industrial cooling and processing. These factors have attracted many industrial developers to locate their businesses in the town and hence, many people are also attracted to settle in the town either as investors or workers in various institutions. Currently, some of the industries and commercial

developments are currently relocating to the suburbs thus increasing the changes in land use and demand for travel.

3.3.0 Study design

The study adopted the triangulation mixed method design. The purpose of adopting this design was to first explore and generate themes about the effects of the changes in land use characteristics on accessibility in the suburbs of Kisumu City using field observation, FGDs, face to face interviews, review of official documents and scrutiny of visual materials as the image data. Based on these themes, a study instrument was developed to survey the households in three suburbs on the effects of changes in land use characteristics on accessibility. The rationale for using both qualitative and quantitative data was that useful survey of households experience could best corroborate the adduced observed and documented evidences. This helped in ensuring that the final evidence obtained assisted in answering the research question as clearly as possible. The challenges of the triangulation mixed method approach are that it requires a researcher to have skills in more than one method and that the finding of one method at times do not coorroborate the other (Denscombe, 2007; Tashakkori & Teddlie, 1998; Creswell and Clark, 2004; Collins *et al.*, 2006). However, these challenges were overcome by the researcher's experience in the field of study and careful choise of the methods.

Since Kisumu city did not have guidelines on how to delineate a suburb, threshold scores was applied to identity the suburban locations to be studied. However, seven zones having suburban characteristics were first identified and this included, Nyamasaria, Kiboswa, Otonglo Kibos, Mamboleo, Kisian and Dunga. In order to analyze the research question and yield better results with minimal bias, three suburbs we.re considered adequate for the study. A particular suburb

was picked based on the set threshold scores per item which were zero (0) and one (1), where 0 indicates no point while 1 indicates one point. Eight items were selected to represent an ideal suburb for study as shown in the legend. The total score for the items for each suburban location was added and the ones with highest scores selected for study (Table 3.3).

Table 3. 3: Items forming suburb selection thresholds

Suburb	ITEM									
	Pop.	A	SPM	MLR	RD	WMB	AR	CN	WAU	TSC
Kiboswa	14668	1	1	1	0	0	0	1	1	5
Kibos	1323	1	1	1	1	0	0	1	1	6
Otonglo	6446	1	1	1	1	1	1	1	1	8
Dunga	13234	1	1	1	1	1	0	0	1	6
Nyamasaria	19252	1	1	1	1	1	1	1	1	8
Kisian	6626	1	0	1	1	0	0	0	1	4
Mamboleo	14275	1	1	1	1	1	1	1	1	8

Where: 0-No point 1- One point

A-	Suburban location within Kisumu City
SPM	Served with intra-city public transport means
MLR	Major land use is residential
RD	Rising population density
WMB	Within the 1983 City boundary
AR	Located along Arterial from CBD and within 3-5 km
CN	Official commercial node/market
WAU	Located within an administrative unit (sub location/ward)
TSC	Total Score

Based on the totals, Otonglo, Nyamasaria and Mamboleo were chosen for the study since they had the highest scores.

3.3.1 The Population and Sampling Procedure

The study population comprised all the households in three suburbs. The population data was drawn from the (2009) national population census based on existing administrative units as Konya, KorandoB and Kasule where Mamboleo, Otonglo and Nyamasaria suburbs fall respectively. The total study population for the three suburbs was estimated at 9604.

In order to get good represenation in all the suburbs and improve on the precision of the results based on the research problem, probability sample was found to be most appropriate. The best probability sampling method adopted for the study was two-stage cluster sampling where in the first stage the suburbs studied were first chosen then in the second stage the samples of households to be interviewed were randonly selected. Simple random sampling in the second stage was considered to be appropriate since it gives each member of a population an equal chance of being selected to become part of the sample (Carrión, 2009; Kenworthy,1986). In order to conduct this sampling method, the researcher defined the sample unit and frame, listed down all the members of the population, and then selected members to make the sample.

The sample frame consisted of all the households within the suburbs according to the Kenya Population Census of 2009 (Republic of Kenya, 2009). Each household formed a unit of analysis within a suburb and the total number of the households in the three suburbs was estimated to be 9604 which formed the sample frame (table 4). According to Fisher, *et al.* (1983) when the study population is greater than 10,000 at 95% confidence level the sample size is 384. Therefore, when the study population is less than 10,000 at 95% confidence level, the sample size is calculated as follows:

$$n_f = \frac{n}{1+n/N}$$

Where n_f = the desired sample size (when the population is less than 10,000)

n = the desired sample size (when the population is more than 10,000)

N = the estimate of the study population.

Therefore,

$$n_f = \frac{384}{1+384/9604}$$

$$= 370$$

A total of 370 household heads which accounted for 3.8% of the sample frame were therefore randomly selected as a representative sample and questionnaires administered to them. The study registered a 64.05% of the response rate accounting for 188 respondents whose questionnaires were complete. This was calculated as follows;

$$\text{Response Rate} = \frac{\text{Completes}}{\left(\text{Completes}\right)+\left(\frac{\text{Completes}}{\text{Completes + Not Qualified}} \text{ X } \left(\text{Not Contacted + Refused}\right)\right)}$$

Where: Completes = 198

Not qualified = 39

Not contacted = 55

Refusal/mid termination =78

$$\frac{198}{198[198/198+39 \text{ x}(55+78)]} \text{ x } 100$$

$$= 64.05\%$$

Given that the three suburbs were assumed to be heterogenous, there was a need to get the sample size for each. In view of the fact that the sample size had been estimated at 370, the percentage of households in each suburb against the total was first calculated and then in the second step the sample size for each suburb was generated (table3.4).

Table 3. 4: Calculated household sample size per suburb

Sub location	Number of Households	Percent of population(%)	Estimated Household Sample Size	Households Sample size for each suburb
Mamboleo	3357	38	370	140
Otonglo	1367	19	370	70
Nyamasaria	4880	43	370	160
TOTAL	9604			370

Source: Kenya population Census, 1999

Table 3.4 shows that within the sample of 370 households, 140 were randomly chosen from Mamboleo while 70 and 160 from Otonglo and Nyamasaria respectively.

3.4. Data Sources

Data was collected from both primary and secondary sources. Secondary sources mainly comprised government records, technical publications, annual reports, and the internet. Data from these sources helped in cross-checking official information and responses from the interviews and households. Data collection from different sources was very important to this study which adopted triangulation mixed method approach.

3.5. Data collection methods

Based on the study design, both primary and secondary data sets were acquired and analyzed in order to get the effects of changes land use characteristics on accessibility in the suburbs of Kisumu city. The household data set provide the most complete picture of land use characteristics and accessibility in the study area. It contained data on demographics, land use characteristics, accessibility, employment location and modal choice. Apart from the household data collected from the field using the questionnaires, secondary data was also collected from central government and local authorities' reports and records, internet and other library

materials such as books and magazines related to the study topic. The data sets from the secondary sources council and other government offices used in this study included zoning standards, structure plans and related policies. The zoning records included some of the characteristics like the land use classifications and plot density standards. Other data on land use characteristics were generated from the aerial photos and images. Participant observation was also used throughout the study to get some information on the land use charateristics and accessibility that could not be got from the households, key respondents and sondary sources. Interviews and FGDs were used to get thematic issues to be further verified by the household data. This type of data triangulation and contextualization helped in the improvement of the quality of the research undertaken.

3.6. Survey Instruments

The survey instruments used in the study included questionnaires; focused group discussions and interview schedules, study area maps, land use maps and a camera. The structured and open ended questionnaires (Appendix 1) were designed and administered to all the selected household heads in the three suburbs to get information on both the land use and accessibility situation in suburbs. The information gathered from these people though the administered questionnaires formed the primary data. The questionnaires were first pretested with a representative sample to find out whether they will assist in measuring the intended objective and how clear and easy they were to the respondents. After the pretesting, the final questionnaires for the households were designed to have the following subsections; demographic data, transport infrastructure, accessibility and land use characteristics(Appendix 1).

Key informant interviews schedules were also used to collect data from the land use and transport professionals in private practice (surveyors, physical planners and property managers) and both from Kisumu City and Ministry of Lands' offices in Kisumu East and West Sub-Countys. The informants included the Town Manager for Kisumu City, City engineers and surveyors, the Director of Town Planning and the Sub-County Physical planning officer (Appendices 2-6). They gave insights on the change in land use, transporat infrastructure and accessibility situation in the City suburbs.

Focus groups discussions were undertaken to assess the thoughts and perceptions of local residents concerning the issues under study. The FGDs helped in collection of rich personalized data, which in turn could be compared with the more objective, carefully coded data obtained from the visual surveys. Each group had between 8-10 participants who must be aged above 18 years(Appendix 7). The number and age was designed so that each individual could have an opportunity to participate. Participants for the focus groups were identified through local Residents Associations and the Chiefs' offices. They were composed of the indigenous residents and the new settlers or tenants. FGD guide for facilitators(Appendix 7) having open ended questions was used to guide the discussions on travel pattern in the suburbs, transport situation, land tenure and the suburb changes land use charateristics.

Observation is an important tool in getting the actual scenario or behavior hence aids in getting true information (Kombo and Tromp, 2006). Participant observation was therefore used throughout the study to get some information on the land use and accessibility sitiation that could not be got from the questionnaires administered to the respondents. The method was used

particularly when collecting data on the effect of the land use charateristics on accessibility in the suburbs including; connectivity and density of land uses, status and safety of roads and other transport facilities, informal transport means' service delivery, distances and spacing of activities.

In land use and accessibility studies like this one, various base maps are necessary in assessinging the land use and accessibility. Any relevant base maps including sateilite images were also used to assist in understanding the changes in land use and accessiblity situation in the study area. The old stucture plan and image for Kisumu City was used(Appendices 9 and 8). A camera was also used to take photographs of the types of transport vehicles, roads, land use densities and other transport facilities.

3.7. Data analysis and presentation

Since the study adopted tringulation mixed method design, data was also analysed using both the quantitative and qualitative techniques. In quantitative analysis, the primary data collected from the field using the questionnaires, was first sieved in order to ascertain it accuracy, possible omissions and errors. The data was then coded to assist in putting them in desired categories for ease of data analysis. The descriptive analysis was then conducted for each question to describe data interms of central tendency and dispersions. This included included the median, means, frequency distribution and percentages. The next step involved cross-tabulation and comparison of information within and between the suburbs. The last sections involved testing the reliability of questions measuring the effects of land use characteristics on accessibility in the suburbs. Lastly, determination was made whether there is or no relationships existed between variables of interests in the study.

Qualitative technique was used in the study order to draw meaningful results from the quantitative data. Qualitative method was used to analyse narrative data collected from the field through observations, desk reviews, interview schedules, and FGD guides. The analysis involved organization of data and then the reflection on its overall meaning. This was followed by detailed analysis entailing coding process that led to the generation of the themes for analysis. These themes were then presented in a qualitative narrative that gives the meaning of the data.

Data has been presented using both the statistical and graphical methods. The statistical methods included percentages, frequencies and crosstabulations while the graphical methods included; the figures, tables, pictures, graphs and charts.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and discussions of the study which is shown according to the set objectives. The overall objective of this study was to asses the effects of change in land use characteristics on accessibility in Kisumu City. The study adopted a mixed method tringulation design where both qualitative and quantitative data were collected and analysed then interpreted. The chapter contains results on the influence of density on travel time for non work trips in the suburbs, the relationship between residential location and modal choice in the suburbs and the relationship between work place location and transport cost in the suburbs.

4.2. Influence of population density on travel time in the suburbs of Kisumu City

This section presents results and discussions on how density influences travel time to destinations from residences in the suburbs of Kisumu City. The density variable used was the gross population density for the suburbs from population census data while travel time variable included time taken to various destiantions within the suburb. The destinations considered were the bus stop, school, industrial site, place of work, shop and social hall. The analyzed data was collected from secondary sources, the households, key informants and FGDs.

Table 4.1 shows combined regression results on density and other explanatory variables as time to social hall, shop, school, bus stop, workplace and industrial site in the three suburbs.

Table 4. 1: Regression results on influence of population density on time taken to destinations

Constant: Gross Population Density					
Dependant Variables	Coefficients	Slope	R-Square	T	Sig. t
Time to social Hall	4.313	.001	.017	16.428	.000
Time to shop	2.773	.001	.009	7.614	.000
Time to school	3.253	-.001	.024	8.470	.000
Time to bus stop	3.016	.001	.020	8.378	.000
Time to Work place	3.037	.001	.003	8.240	.000
Time to industrial site	2.737	.001	.011	7.311	.000

Predictors: (Constant), Time to Work place, Time to bus stop, Time to social Hall, Time to school, Time to industrial site, Time to shop

The results demonstrate that travel time to destinations is positively associated with density in all the suburbs a part from time to school. For example, if the density in a suburb increases by $1km^2$ then time taken to all other five destinations will increase by .001 while that to schools will increase by -0.001. The result also show lower R-squares confirming the findings by other studies that such happens when regressions are performed using observations on individuals behavior on travel than when the regression is against aggregates such as mean travel time (Levtnson and Kumar, 1997). R-square results showed that variation in the dependant variable that was explained by variations in the independent variables ranged between 11%-24% only. However, this does not change the statistical significance of all the tested explanatory variables as also confirmed by the t-test results. The t-test results show that the coefficients are significantly different from zero (0) and since all the values are over 1.96, and then the level of significance is at 5%. These results deviate from that of Levtnson and Kumar (1997) who

revealed that the influence of density on travel time is ambiguous while agrees with Barnes (2001) finding that higher densities tend to increase travel time.

In order to further confirm the influence of density on travel times to different destinations, the travel time means were compared. The results showed that for all the six different destinations within the suburbs, the mean travel time was 10minutes. ANOVA was also calculated to determine if the means are statistically different and the significance value for all the six was found to range between .107 to .484 (Table 4.2).

Table 4. 2: ANOVA results on influence of density on time to different locations

Time Taken		Sum of Squares	Df	Mean Square	F	Sig.
Time to Work place	Between Groups	1.386	2	.693	.729	.484
Time to industrial site	Between Groups	3.456	2	1.728	1.768	.174
Time to social Hall	Between Groups	1.624	2	.812	1.678	.190
Time to shop	Between Groups	1.759	2	.880	.944	.391
Time to school	Between Groups	4.686	2	2.343	2.260	.107
Time to bus stop	Between Groups	3.531	2	1.765	1.940	.147

The ANOVA results in Table 4.2 exhibitss that all the significance levels for time taken to destinations are above 0.05% implying that they are statistically different further confirming that density has influence on travel time in all the three suburbs.

The increase of travel time to the five destinations in the suburbs with increasing population density as revealed by the study shows the nature of relationship between change in land use charateristics and accessibility. The results shows that as population density increases, development also increases but in a manner that it minimizes the ease of movement in the suburbs. The end result is the increase of time taken to destinations from the residential

locations. On the other hand, the study also revealed that increasing population density has also minimized the time taken to schools. This can be interpreted as a sign of more schools being located in the suburbs with increased population. These findings also shows the nature of changes in space use in the suburbs of Kisumu city.

During the key informant interviews, the acting Director of city planning of Kisumu City confirmed that out of the four major land uses in the suburbs, residential is taking approximately 85%, followed by commercial at 10% then industrial 3% and agricultutral at 2%. The changes in percentage of spaces covered by different land uses in the suburbs shows that agricultural land use is diminishing but there is continued mixture of and within the land uses in the suburbs which also determines the accessibility situation in them. The mixture reflects an increasing density of spatial distribution of the activities at each destination due to the changes in demand for these activities from the origin. According to the Director of city planning of Kisumu City, the changes in land use types include changes in their characteristics due to the demand for space for location of activities. It is these changes in the activity locations that shifts their spatial structures from a nodal to a multi-nodal character thereby influencing their accessibility in terms of time taken to destinations. This shift, on the other hand, describes the nature of suburban accessibility between activity locations as defined by time to destinations.

In order to further understand the nature of influence of density on time taken to destinations based on changes in land use charateristics, the correlations between distance and time taken was conducted. Table 4.3 shows the correlation results on the relationships that exists between the distances and time taken to five destinations.

Table 4. 3 Correlation results on relationship between distances and time to destinations

Suburb			Time to each destination
Nyamasaria	Distance to bus stop	Pearson Correlation	.301*
		Sig. (2-tailed)	.010
		N	72
	Distance to school	Pearson Correlation	-.043
		Sig. (2-tailed)	.718
		N	72
	Distance to shop	Pearson Correlation	-.146
		Sig. (2-tailed)	.222
		N	72
	Distance to work place	Pearson Correlation	.181
		Sig. (2-tailed)	.129
		N	72
	Distance to social hall	Pearson Correlation	1.000**
		Sig. (2-tailed)	.000
		N	72
Mamboleo	Distance to bus stop	Pearson Correlation	.262*
		Sig. (2-tailed)	.043
		N	60
	Distance to school	Pearson Correlation	.322*
		Sig. (2-tailed)	.012
		N	60
	Distance to shop	Pearson Correlation	-.022
		Sig. (2-tailed)	.870
		N	60
	Distance to work place	Pearson Correlation	-.116
		Sig. (2-tailed)	.376
		N	60
	Distance to social hall	Pearson Correlation	.964**
		Sig. (2-tailed)	.000
		N	60
Otonglo	Distance to bus stop	Pearson Correlation	.267*
		Sig. (2-tailed)	.047
		N	56
	Distance to school	Pearson Correlation	.089
		Sig. (2-tailed)	.516
		N	56
	Distance to shop	Pearson Correlation	.025
		Sig. (2-tailed)	.852
		N	56
	Distance to work place	Pearson Correlation	-.012
		Sig. (2-tailed)	.932
		N	56
	Distance to social hall	Pearson Correlation	.907**
		Sig. (2-tailed)	.000
		N	56

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

The correlation results in table 4.3 on the relationship between distance to bus stop and time taken in all the three suburbs shows that the value *r* ranges between 0.267* to 0.301* while *p* ranges from 0.047 to 0.100 showing a weak relationship. In terms of relationships between distance to school and time taken, the value *r* ranges between -0.043 to 0.516 while *p* ranges from 0.012 to 0.178 showing very weak relationship in Nyamasaria and Mamboleo and a moderate relationship in Otonglo suburb. This result when related to the regression results in table 4.1 indicates that the way density influences distances to schools in the Nyamasaria and Mamboleo is quite different. Otonglo has the lowest population density 1367 as compared to that of Nyamasaria of 4880 and Mamboleo of 3357 implying that suburbs having higher densities seem to have schools located at closer distances as compared to those of lower densities. The results in table 4.3 further shows that in terms of relationship between distance to shops and time taken, the value for *r* ranges between -.022 to 0.025 while *p* ranges from 0.222 to 0.870 indicating a very weak relationship. Similarly, it showed that as concerns the relationship between distance to workplaces and time taken, the value for *r* ranges between -.012 to 0.181 while *p* ranges from 0.129 to 0.932 also indicating a very weak relationship. However, results showed that regarding the relationship between distance to social halls and time taken, the value for *r* ranges between -.012 to 0.181 while *p* ranges from 0.907** to 1.000** indicating a very strong relationship. In all the three suburbs, the distances to social halls were found to be more than 400m from the places of residence. This was confirmed during the FGD discussions that none of the three suburbs had an official social hall apart from the video halls that were sometimes converted as social halls for some period of time. This finding on the negative relationships further differs with the finding of Levtnson and Kumar (1997) that the higher the density the more destinations that can be reached in the same time.

The nature of relationships between distance and time to destinations showed that there are other factors that determine the relationships between the two which are unbalanced mixture of land use, the nature of transportation network and means of transport used.

The study further examined if the means used to different destinations could be a determining factor in the relationships between population density and time. Results in figure 4.3 shows the combined percentage of households that frequently use particular means of transport to distinations.

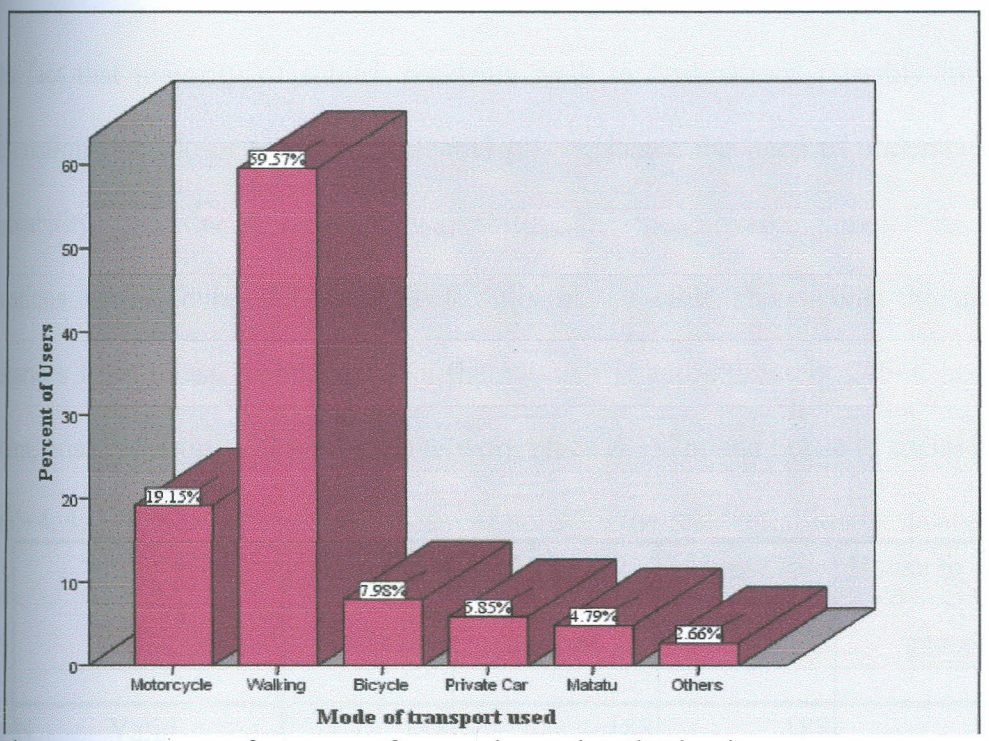

Figure 4. 1: Means of transport frequently used to destinations

Results in figure 4.1 revealed that 59.57% walk to the five destinations in the suburbs while 19.15% and 7.98% use motorcyles and bicycles respectively. Otonglo had the highest percentage of residents walking to destinations at 74.1% followed by Mamboleo and

Nyamasaria at 58.3% and 52.5% respectively. On the other hand, Nyamasaria was leading in the use of motorcycles at 26.4% followed by Otonglo 14.3% at and Mamboleo at 13.3%. Mamboleo had the highest users of bicycles at 15.0% while the other two suburbs had less than 6% users. The high pecentage of suburb residents walking and using bicycles to various destinations also indicates that population density in the suburbs encourages the use of single occupant vehicles. This varies with Taylor (2001) finding that the rise in population density increases travel time but reduces the use of single-occupant vehicles. However, it agrees with the findings of Frank (2007) that population density is positively correlated with walking for most trips to destinations.

The fact that majority of suburb residents walk to destinations possibly implied that these destinations are closer to their residential places, hence the need to understand the nature of walkability. In order to examine walkability, the mean walking distances to five activity locations was calculated(Tabe 4.4). Results in the table shows that the mean geographic distances from house to bus stops in the suburbs is approximately 245m, house to school is 289m, house to shop is 215m, house to work place is 387m and house to social hall is 475m.

Table 4. 4: The mean geographic distances between the residential locations and activities

	House to bus stop	House to school	House to shop	House to work place	House to social hall
N Valid	188	188	188	188	188
Mean	244.6809	288.8298	215.4255	386.7021	475.532
Median	200.00	300.00	200.00	500.00	>500.00
Mode	300.00	300.00	200.00	500.00	>500.0

The mean and mode results in table 4.4 further indicated that the two activities located abit far from the residences were workplaces and social halls with a mode of 500m and a mean of between 387m and 476m. However, all these result indicate that most of these locations are within walking distances. On the other hand, the study reveals negative relationships between time taken and distances covered to destinations that have not bee fully examined by other studies. This finding on negative relationship agrees with the findings of Littman (2012) that increased density encourages walking but may lead to increase in traffic challenges and travel time. The question therefore is why there is no linear relationship between density and time taken to destinations. In order to possibly answer this question, the study examined the charateristics of land use density that possibly influences time taken to destinations based on data gathered from field observations, maps, Focused Group Discussions (FGD) results and key informant interviews. The study further revealed that as the suburbs develop, there is continued agglomeration of different activity locations within the land uses in them that contributes to density characterized by uncontrolled mixture.

The study further revealed that lack of such legal instrument like an approved structure and detailed plans for the suburbs has greatly weakened development control in them hence, the emergence of uncontroled developments that inhibits direct movement between residential locations and different destinations as population density increases. FGD results in the three suburbs revealed that over 70% of the participants feelt that no zoning regulations are respected by them when undertaking different developments including land subdivisions and building of both parmanent and temporary structures. However, there is a variation by suburbs where the

problem seems to be more critical in Nyamasaria (80%) and Otonglo (79%) followed by Mamboleo (62%). The respondents explained that zoning regulations seems not to be obeyed based on the development trends they see in their neighborhoods. Some of these areas are characterized by uncontroled construction of kiosks, flats, apartments, shops, schools, jua kali sheds and other forms of housing(Plate 4.1)

Plate 4. 1: Jua kali Shed in the residential area within Nyamasaria suburb

Based on the field observations, Plate 4.1 charaterizes the trend of activity location in the suburbs. Similar locations are not guided by any land use planning standards which includes the the provision of necessary access to the site. Similar activities attracts others and in the end results into a uncontrolled density that is increasing time to destinations. During one of the FGDs in Nyamasaria, one male participant confirmed this by stating in his own words that:

In this estate we are in a free state where one develops his land the way he wants ..... We only sometimes have problems with the council when they want us to leave big spaces within our plot which we feel is a waste of land (Nyamasaria resident).

The population density was also found to influence time taken to locations through uncontrolled land subdivision because of continued demand for housing but with in a weak development control environment. During the key informant interviews with the County

surveyor of Kisumu East Sub-County, it was revealed that more than 50% of the resultant plots arising out of land subdivision in the suburbs are measuring upto as small as 0.01Ha and most of them are neither planned nor served by the recommended road reserves. It is some of these plots that are developed as residences, jua kali sheds, shops and even private shools. A part from inadequate access due to poor land subdivisions some of these roads have been blocked by unapproved developments that are located on the roads reserves thereby cutting the direct link between various activity locations. A further analysis on the accessibility situation in relation to the effect of uncontrolled density on time revealed that the blockage of direct link to destinations caused by these developments influences time taken from residences to activity location.

The increase of travel time to destinations in the suburbs with increasing density as revealed by the study was found to be due to the nature of activity locational factors in the suburbs. The study revealed that the continued mix of different activity locations within the land uses in the suburbs contributes to density that is characterized by uncontrolled mixture which increases travel time. This finding deviates from other study finding which have shown that increased land use mix reduces travel time (Kuzmyak and Pratt 2003; Frank and Pivo, 1995). The variation seems to be due to the nature of mix in each locality. This implies that even other studies like that by Boarnet *et al*, 2011, which have recommended the possibilities encouraging higher densities and land use mix as a means of minimizing travel time should also re-examine the nature of mix since it may lead to negative results. In the suburbs of Kisumu city for example, the nature of mix was found to increase travel time mainly within the land uses because the densification of land uses are not guided by any land use planning standards. This

has led to some located activities attract the location of others but in uncontrolled manner leading to increase of travel time taken to destinations.

The findings therefore reveals that density influences time to activity location. It fills the knowledge gap that has been existing particularly in Kisumu city where studies have not focussed on the relationship between density and time taken to work particularly in the suburbs. The findings also confirms and disagrees with studies on the relationship between density and time particularly in the suburbs, hence helping to solve some of the conflicting results on density. The mixture of land use can also minimize travel time to destination in a locality if the activity locations are guided be the legal indtruments as land use plans.

4.3. The relationship between residential location and modal split in the suburbs

This section presents results on determination of relationships that exists between residential location and modal split to activity locations within the suburbs of Kisumu city. The residential locational variables used were residential choice and house ownership while modal split variables were mode ownership and use, other means used for various trips and modal choice factors. The analyzed data was collected from secondary sources, the households, key informants and FGDs.

Table 4.5 exhibits factors that determine the residential choice in each suburb within Kisumu City. In overall, the results showed that house ownership and cheaper house rent are the key determinants of residential choice in all the three suburbs.

Table 4. 5: Cross tabulation results on residential choice factors in each suburb

Suburb	Reasons for Choice	Frequency	Percent(%)
Mamboleo	Cheaper Rental House	26	35.6
	Own House	26	35.6
	Place of Work	11	15.1
	Means of transport	-	0.0
	Other factors	10	13.7
	Total	**73**	**100.0**
Nyamasaria	Cheaper Rental House	17	28.3
	Own House	26	43.3
	Place of Work	7	11.7
	Means of transport	2	3.3
	Other factors	8	13.3
	Total	**60**	**100.0**
Otonglo	Cheaper Rental House	14	25.5
	Own House	30	54.5
	Place of Work	2	3.6
	Means of transport	2	3.6
	Other factors	7	12.7
	Total	**55**	**100.0**

Results in table 4.5 shows that Mamboleo is leading with 35.6% of its households choosing residential location due to cheaper rent followed by Nyamasaria and Otonglo at 28.3% and 25.5%. However, Otonglo leads with 54.5% of its households choosing residential location for the need to own a home followed by Nyamasaria at 43.3% and lastly by Mamboleo at 35.6%. Othe other hand, Mamboleo leads with 15.1% of the households who chose their residental location when considering distance to workplace and it is followed by Nyamasaria and Otonglo at 11.7% and 3.6% respectively. The results showed that means of transport is the least determinant of residential choice location in the three suburbs where in Mamboleo no respondent indicated that means of transport determined their location while Otonglo had 3.6% and Nyamasaria 3.3% respectively. The variations in other factors that contributes to

determination of residential location was quite unique in all the three suburbs with household percentages ranging between 12.7% and 13.7% quite higher than the cost of transport.

The results in table 4.5 further showed that despite the fact that means of transport is the least determinant of residential choice in all the three suburbs, Otonglo is leading with 3.6% of the households followed by Nyamasaria at 3.3% and Mamboleo nil. This could be confirmed by the high percentages of house owenership in all the three suburbs where Otonglo is leading with 54.5% followed by Nyamasaria at 43.3% and Mamboleo last with 35.6%. The first two suburbs still have higher percentages of those settling on ancestral land and hence, transport cost confines their location. During the FGD discussions in the three suburbs, transport cost was revealed as a determinant of residential location to some residents like in the case of Otonglo and Nyamasaria. They were found to consider it cheaper since they do not pay any house rents and stay closer to activity locations, hence they do not pay for transport charges. The study further tried to examine the means of transport that are generally chosen to different activity locations by both the house owners and non owners in the suburbs. This is because house ownership, which mostly determines modal choice in the suburbs, was found to be a key determinant of residential location in the suburbs of Kisumu city.

Since house ownership and cheaper rents were found to be the key determinants of residential choice location, the study further examined the relationship between ownership and modal split particularly for work trips. Table 4.6 presents cross tabulation results on the means of transport used by house owners to work in the suburbs of Kisumu city.

Table 4. 6: Cross tabulation results on transport means to work by House Owners

Suburb	House Ownership	Transport Means					Total
		Motorcycle	Bicycle	Private Car	Walking	Others	
Mamboleo	Rented	40.4%	6.4%	8.5%	38.3%	6.4%	100.0%
	Owned	19.2%	15.4%	19.2%	42.3%	3.8%	100.0%
Nyamasaria	Rented	41.2%	20.6%	2.9%	32.4%	2.9%	100.0%
	Owned	26.9%	7.7%	7.7%	53.8%	3.8%	100.0%
Otonglo	Rented	48.0%	8.0%	16.0%	28.0%	0.0%	100.0%
	Owned	26.7%	10.0%	10.0%	53.3%	0.0%	100.0%

The results in table 4.6 shows that in Nyamasaria and Otonglo are leading in house owners walking to work at 53.8% and 53.3% respectively as compared to Mamboleo at 42.3%. Similarly Nyamasaria and Otonglo are leading in house owners using motorcycles at 26.9% and 26.7% while Mamboleo last by 19.2%. However, Mamboleo is leading in bicycle users with 15.4% followed by Otonglo and Nyamasaria at 10.0% and 7.7% respectively. The use of cars by house owners was found to be high in Mamboleo at 19.2% followed by Otonglo and Nyamasaria at 16.0% and 7.7% respectively. The results reveals that most of those living in rental houses use motorcycles where Otonglo is leading with 48% followed by Nyamarais at 41.2% and lastly Mamboleo at 40.4%. The next means mostly used by non-house owners is walking where Mamboleo leads with 38.3% followed by Nyamasaria at 32.4%. The use of bicycles to work by those living in rental houses was only high in Nyamasaria at 20.6%. The findings shows that in the suburbs of Kisumu city, walking and motorcycles takes a larger share in the modal split for hommeowners. According to Cao *et al.*, (2008), the relationship between modal split and home ownership is an area that has not been fully studied and hence, has little information. These results deviates from the general view that public transport means and cars

takes a larger share of homeowners trips particularly to work. However, the study results agrees with the findings of Long *et al.* (2010) that individual mode choice behavior varies considerably across different home owners due to their heterogeneity in the preference to transportation means.

These results prompted the need to further examine if there is relationship between house ownership and means ownership since this could also influence the nature of modal split to work in the suburbs.

Table 4.7 shows crosstablutation results between house ownership and means ownership in the theree suburbs of Kisumu city.

Table 4. 7: Crosstabulation of house ownership and means ownership in the suburbs

Suburb	House Ownership	Means Ownership		Total
		Yes	No	
Nyamasaria	Rented	23.4%	76.6%	100.0%
	Owned	60.0%	40.0%	100.0%
Mamboleo	Rented	47.1%	52.9%	100.0%
	Owned	61.5%	38.5%	100.0%
Otonglo	Rented	48.0%	52.0%	100.0%
	Owned	48.4%	51.6%	100.0%

Results in table 4.7 shows that Mamboleo is leading in house owners that have private means at 61.5% followed by Nyamasaria and Otonglo at 60.0% and 48.4% respectively. On the other hand, Otonglo is leading with the hihest percentage of house owners not having private means at 51.6% followed by Nyamasaria at 40%. Nyamasaria is leading with the highest percentage of those living in rental house while at the same time not owning any means of transport at 76.6% followed by Mamboleo at 52.9%. The study reveals that most of the house owners own means

of transport as opposed to non-house owners. However, this still seeems not to be a key factor determining residential choice. The findings of this study contributes to the body of knowledge based on the fact that previous studies have shown that little is still understood on the extent to which residential location relates modal split (Cao *et al.*, 2008). The results showed that there is no positive relationship between residential location and modal split. This differs with the findings of Sultan (2011) that people choose their residential location based their modal preferences but agrees with his finding that the positive relationship cannot be established. The variations in finding possibly is due to the differences in spatial contexts since his study was conducted in well planned neighborhood but this was in a suburb characterized by informality with weak development control. The factors found to relate with residential locations were cheap house rents and home ownership while closeness to place of work and transport ranked lowest. This finding further deviates from Sanit *et al.* (2013) findings that people tend to locate their residences close to workplaces in order to save travel time and travel cost. Despite the fact that transport means was ranked lowest as a determinant of residential location, some were found to consider it as important in a different perspective in the suburbs studied. These were indigenous residents living on ancestral lands whose major cost to various destinations is that of transport but not rent. In most cases, they walk to different destinations or use other non-motorized means of transport. They were found to consider it cheaper since they do not pay any house rents and stay closer to activity locations, hence they do not fully feel the weight of transport fare charges. The study results also vary with that of Vega & Reynolds-Feighan (2007) on the relationship between choice of residential location and travel-to-work where they found out that it is transport policies aimed at minimizing travel costs that influence modal split in the suburbs. However, based on the study findings, the suburbs in Kisumu city still suffer

from weak development control and implementation of policies guiding land use and transport and their finding may not apply fully. The study results further confirmed that irrespective of residential location, it is accessibility to means, their speed, fare charges and safety that determines modal split.

The study further examined the type of means owned to find out if this possibly contributes to the relationships between modal split and residential choice. The results in table 4.8 further shows that most of the households own bicycles where Nyamasaria is leading with 81.2% followed by Otonglo and Mamboleo at 71.4% and 53.8% respectively.

Table 4. 8: Cross tabulation on types of means owned by the suburb residents

Suburb	Type of Means					Total
	Bicycle	Handcart	Motorcycle	Car	Pickup	
Mamboleo	53.8%	.0%	.0%	42.3%	3.8%	100.0%
Nyamasaria	81.2%	.0%	3.1%	15.6%	.0%	100.0%
Otonglo	74.1%	3.7%	.0%	14.8%	7.4%	100.0%

The results in table 4.8 further shows that car ownership is the second highest where Mamboleo is leading with 42.3% followed by Nyamasaria and Otonglo at 15.6% and 14.8% respectively. The ownership of motorcycles was found to be only 3.1% in Nyamasaria with 7.4% owning pick-ups in Otonglo. The main means of transport owned by the households in the suburbs seems not to greatly influence modal split particularly to work. This is proved by the fact that despite the low ownership of motorcycles, it still has a larger share compared to other means of transport used to work as results in table 4.6 shows. The results in the table show that majority

still walk to work or use motorcycles as compared to bicycles or cars. This further shows that means ownership has no relationship with the modal split particularly in trips to work. It varies with the findings of Bhat *et al.* (2007) that households select their residential location based on demographic characteristics such as motor vehicle and bicycle ownership since even some of the means owners in the suburbs still either walk to work or use motorcycles but agrees with their findings that

The possibility of means ownership influencing modal split was also examined. Figure 4.2 presents results on trips taken by means owned in the three suburbs of Kisumu city. The result showed that only 21.3% of households use them for work trips while 14.4% use them for personal errands while others use them for shopping and visiting friends.

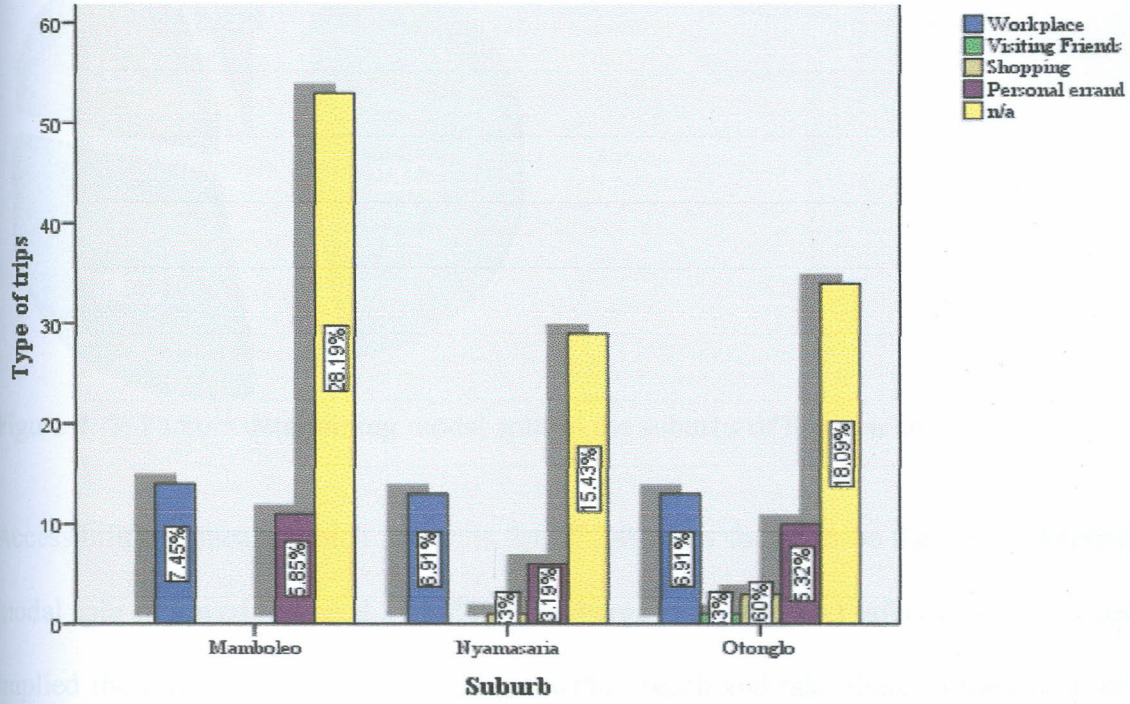

Figure 4. 2: Type of trips taken by means owned by the suburb residents

In Mamboleo, 7.45% of owners use the means for work trips while 5.85% use them for personal errands. In Nyamasaria 6.91% use those for work trips while 3.19% and 0.53% use them for personal errands and shopping. In Otonglo, 6.91% use the for work trips while 6.32% use them for personal errands but 0.60% and 0.53% use them for shopping and visiting friends respectively. These results further proved why walking and motorcycles have the largest percentages in terms of modal split in work trips.

The study further examined the reasons that determine modal split in the three suburbs. Figure 4.3 shows results on factors that determines modal split in the suburbs of Kisumu city.

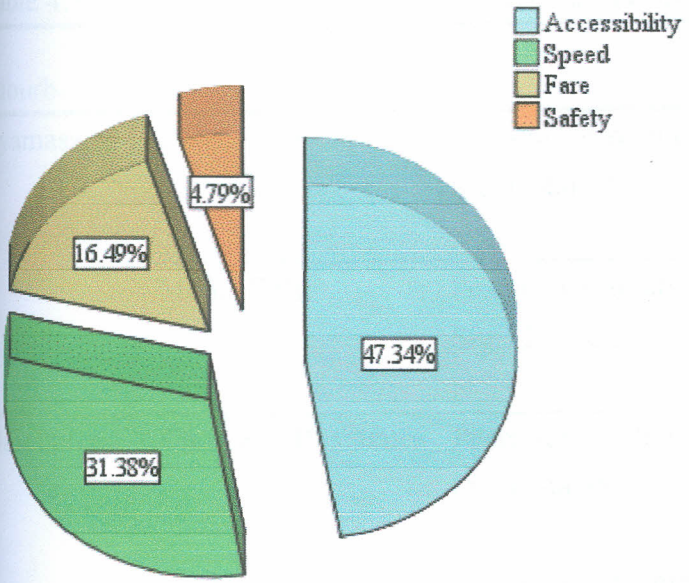

Figure 4. 3: Factors determining modal split in the suburbs of Kisumu city

Accessibility to means which accounts for 47.34% was found to be the major determinant of modal split followed by speed 31.38% , fare charge at 16.49% and safety at 4.9%. Accessibility implied the means the residents could get within reach and take them to their destinations as fast as possible. It is intersting also to note from the result that fare charge which mostly determines modal split is the third the most important in the suburbs of Kisumu city. Safety

was the least with only 4.9% unlike in most cases when other suburb residents value safety particularly when speed and road condition is critical. These results explains why the majority of both house owners and non house owners use motorcycles to work and indicates the nature of relationships that exists between residential choice and modal split.

It was therefore important to examine the nature of relationship between the modal split and residential location in the three suburbs. In order to analyse the relationship between residential location and modal split, a correlation analysis was done. Results in table 4.9 shows correlations between choice of residence and means used to destination in the three suburbs.

Table 4. 9: Correlations between choice of residence and modes used to destinations

Suburb			Choice of Residence	Modal Split
Nyamasaria	Choice of Residence	Pearson Correlation	1	-.061
		Sig. (2-tailed)		.609
		N	72	72
	Modal Split	Pearson Correlation	-.061	1
		Sig. (2-tailed)	.609	
		N	72	72
Mamboleo	Choice of Residence	Pearson Correlation	1	.141
		Sig. (2-tailed)		.281
		N	60	60
	Modal split	Pearson Correlation	.141	1
		Sig. (2-tailed)	.281	
		N	60	60
Otonglo	Choice of Residence	Pearson Correlation	1	-.065
		Sig. (2-tailed)		.632
		N	56	56
	Modal Split	Pearson Correlation	-.065	1
		Sig. (2-tailed)	.632	
		N	56	56

Correlation is significant at the 0.01 level(two tailed)

The correlation results in table 4.8 shows that in Nyamasaria, the value for r = -0.061 and p = 0.69 implying that there is no linear relationship between choice of residence and modal split in the suburb. On the other hand, in Mamboleo, the value for r = 0.141 and p = 0.281 indicating that there is a weak relationship between two while in Otonglo the value for r = -0.065 and p = 0.632 also showing that there is no linear relationship between the two variables. This finding shows that residential location does not relate positively to modal split to various destinations in the suburbs of Kisumu city. The results further confirms that irrespective of residential location, it is accessibility, speed, fare charges and safety that determines modal split in the three suburbs. This finding agrees with Bhat *et al.* (2007) and Muhs (2013) revelations that residential choice in the suburbs is dictated by such attributes as accessibility to means and density but they do not reveal other characteristics that determine modal split as revealed by the study. In general, the study findings show that there are no relationships between modal split and residential location in the suburbs of Kisumu city.

4.4. Relationship between workplace and transport cost in the suburbs.

This section presents results on the examination of relationships that exists between work place location and transport cost in the suburbs of Kisumu city. The work place location variables was the place of work and while transport cost variables included , time taken, fare charges, distance and route conditions. The analyzed data was collected from the households, secondary sources, key informants and FGDs.

Table 4.10 shows the results of the percentage of household's workplace locations from residential places for each suburb studied in Kisumu city.

Table 4. 10 Cross tabulation results on workplace locations in the suburbs

Suburb	Work Place			Total
	City Center	Within suburb	Other Places	
Nyamasaria	10.4%	61.8%	27.8%	100.0%
Mamboleo	12.0%	65.7%	22.3%	100.0%
Otonglo	9.6%	62.1%	28.3%	100.0%

The result in table 4.10 revealed that in on average 63.2% of households work within the suburbs while 26.1% and 10.7% work in other areas and the city centre respectively. Other places as revealed by the study meant other estates, schools, markets and or offices located outside the suburbs but either within the city boundary or outside the city boundary. Mamboleo suburb is leading with the highest percentage of the households working within the suburbs at 65.7% followed by Otonglo and Nyamasaria at 62.1% and 61.8% respectively. Similarly, Mamboleo still leads in those working in the city centre and other places at 12.0% followed by Nyamasaria at 10.4% while Otonlgo leads with higher percentage of those working outside the suburb at 28.3% followed by Nyamasaria at 27.8%. The result on the workplace locations indicates that most of the household work related trips are within the suburbs and this gives a reflection on the nature cost of transport to work places. Yang (2005) revealed that increased distance influences transport cost through distance covered while dense development minimizes transport cost through commuting time but not in all location. On the other hand, Raymond (2013) asserted that there is no clear correlation between the residential location and transport cost to workplace. This shows that even though majority work within the suburbs, there are variations in the nature of relationships between residential location and transport cost to workplaces.

Based on the previous findings that dense development can minimize transport cost through commuting time, the study examined the time taken to workplaces as one of the transport costs to workplaces in the suburbs. Results in figure 4.4 shows the percentages of households and time they take to workplace in each suburb.

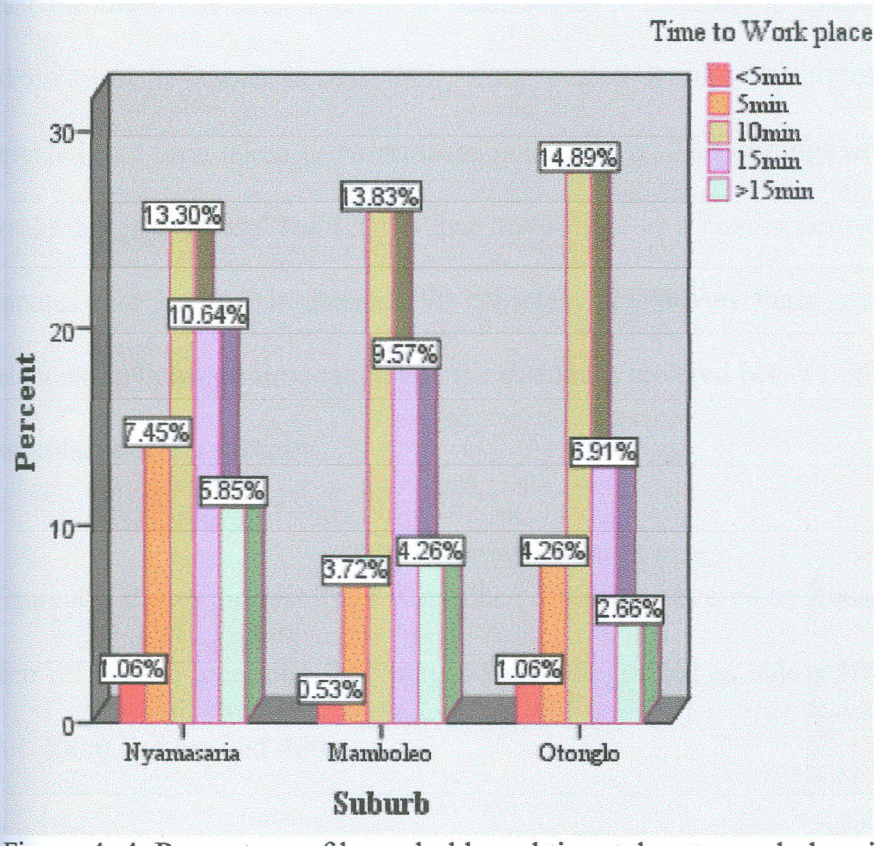

Figure 4. 4: Percentage of households and time taken to workplace in each suburb

The findings in the figure 4.4 indicate that in overall 42.09% of the households takes 10minutes to their work places while a total of 18.1% takes five minutes and below. On the other hand, a total of 39.9% of the households were found take 15minutes and above from their residential places to workplaces. Otonglo suburb which had the least percentage of those working within the city centre has the highest percentage of those taking 10minutes to work places at 14.89% compared to Mamboleo that had the highest percentage of those working within the suburbs at

13.83%. Nyamasaria suburb is still leading with the highest percentage of those taking 15minutes and above at 16.49% followed by Mamboleo at 13.83% and Otonglo 9.57%. Similarly, Nyamasaria still lieads with 8.51 % for those taking five minutes and below to work followed by Otonglo at 5.32% and Mamboleo at 4.25%. Considering the fact that 63.2% also work within the suburbs, then it implies that the transport cost to workplaces in terms of time is quite minimal. The cost, in terms of time, seems to be lower in Mamboleo and Otonglo suburbs whose most residents access their work places within 10minutes and below. The study revealed that time taken to workplaces is not costly. The findings of this study agrees with the results of Carolyn and Ian (2012) that travel time as a cost is considered low if it takes 20-40 minutes and high if it exceeds 90 minutes. However, there was a need to examine the relationship between time taken and the distances covered between the residential locations and workplaces in the suburbs.

Figure 4.5 shows the results of workplace distances covered by households in the suburbs from their residentail locations. The ranges were categorised as below 100m, 101-200m, 201-300m, 301-400m and beyond 400m.

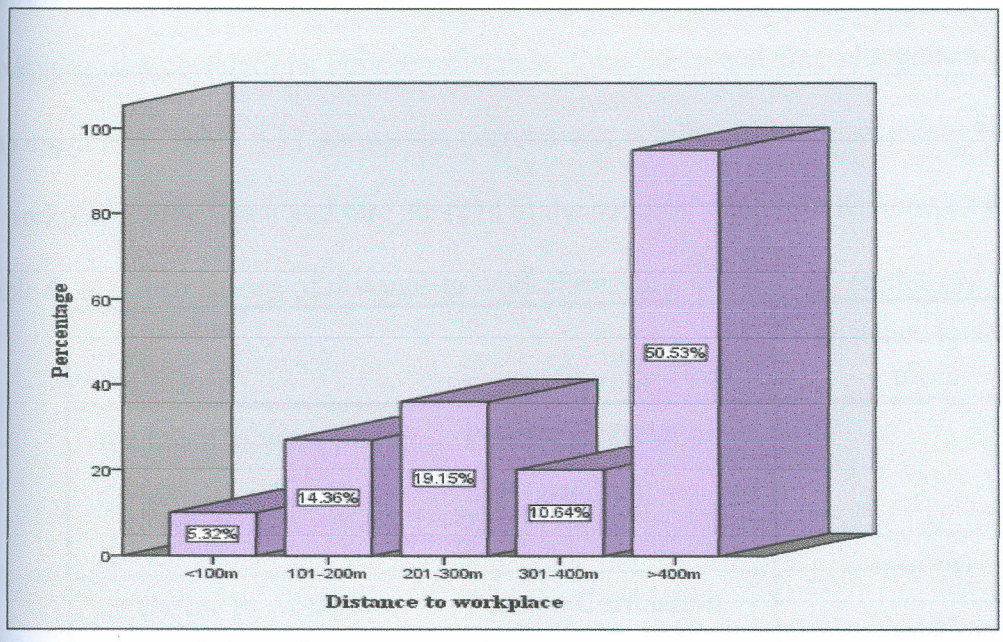

Figure 4. 5: Workplace distance ranges covered by households in the suburbs

The results in figure 4.5 on ranges of workplace distance covered by households in the suburbs showed that 50.53% of the work places are located beyond 400m from the residential locations and 19.15% within 200-300m while 5.32% are located less than 100m. The short distances confirms the explanations of the town manager of CCK during the key informant interviews that the commercial land land uses and industrial activities are emering within the suburbs such as office spaces, agencies, bookshops, distributors, wholesale shops, jua kali sheds and designated market centers. Taking into account that 63.2% of the suburb residents are working within the suburbs, then it implies that most of the work places are located within walking distances. The results in table 4.6 showed that majority still walk to work followed by the use of mororcycles. This possibly explains the variations of time taken where majority 42.09% takes 10minutes while 39.9% of the households take 15minutes and above and 18.1% takes five minutes and below to their workplaces.

However, to further understand the nature of relationship between the time as transport cost and workplace, the correlations between distance, time taken and fare charged to workplaces was also examined. Table 4.11 shows the correlations results on the relationship between distance to workplace, time taken and fare charged in the suburbs studied in Kisumu city.

Table 4. 11: Correlations of distance to workplace, time taken and fare charged to work place

		Distance to work place
Time taken to work place	Pearson Correlation	.038**
	Sig. (2-tailed)	.605
	N	188
Fare charge to workplace	Pearson Correlation	-.006**
	Sig. (2-tailed)	.930
	N	188

**Correlation is significant at the 0.01 level(two tailed)

The correlation results in table 4.11 showed that the values for r = 0.038 and p = 0.65 implying that there is a weak relationship between distance to work place and time taken to workplace in all the three suburbs. Similarly the values for r = 0.-006 and p = 0.930 indicating that there is a very weak relationship between distance to work place and fare charged to workplace in all the three suburbs. The results show a weak relationship between distance to work place and time taken to workplace in all the three suburbs and weak relationship between distance to work place and fare charged in all the three suburbs. This finding agrees with the findings of Raymond (2013) results that there is no clear correlation between the workplace location and the cost of transport to work. However, he only examined cost in terms of fare charged and not the time taken and distance covered that this study examined.

These results shows clearly that there are other underlying factors that explains the relationships between workplace location and transport cost in terms of fare charged, distance and time taken. Cross tabulations was conducted between the distance and transport challenges in order to find out if there could be factors contributing to transport Cost. Table 4.12 shows the Cross tabulation results of the relationship between distance and transport challenges.

Table 4. 12:Transport challenges experienced between varying distances to work in the suburbs

Suburb	Distance to work place	Transport Challenges					Total
		Accidents	High fares	Discomfort	Lack of parking stages	Insecurity	
Nyamasaria	<100m	.0%	.0%	50.0%	.0%	50.0%	100.0%
	101-200m	20.0%	10.0%	30.0%	20.0%	20.0%	100.0%
	201-300m	17.6%	23.5%	29.4%	23.5%	5.9%	100.0%
	301-400m	.0%	25.0%	50.0%	25.0%	.0%	100.0%
	>400m	11.4%	37.1%	14.3%	14.3%	22.9%	100.0%
Mamboleo	<100m	33.3%	.0%	33.3%	33.3%	.0%	100.0%
	101-200m	.0%	66.7%	11.1%	22.2%	.0%	100.0%
	201-300m	.0%	36.4%	27.3%	18.2%	18.2%	100.0%
	301-400m	20.0%	40.0%	20.0%	.0%	20.0%	100.0%
	>400m	21.9%	28.1%	12.5%	28.1%	9.4%	100.0%
Otonglo	<100m	.0%	.0%	60.0%	.0%	40.0%	100.0%
	101-200m	.0%	25.0%	37.5%	12.5%	25.0%	100.0%
	201-300m	.0%	37.5%	12.5%	37.5%	12.5%	100.0%
	301-400m	14.3%	28.6%	.0%	42.9%	14.3%	100.0%
	>400m	7.1%	28.6%	28.6%	10.7%	25.0%	100.0%

Results in table 4.12 showed the transport challenges experienced by the households between their residential places and work places. In Nyamasaria suburb the main transport problem the residents travelling within in all distances experience is discomfort which has a percentage of between 14% to 50% followed by high fares and lack of parking stages. However, in

Mamboleo suburb the critical problem was high fares having percentages of between 28.1% and 66.7% while in Otonglo the most serious challenge is discomfort with percentages of between 12.5% and 60%. In all the three suburbs, a higher percentage ranging between 33.3%-60% cited discomfort as the most critical challenge within a distance of less than 100m. On the other hand, within the distances of between 100m-201m, the challenges having the highest percentages were discomfort for Nyamasaria and Otonglo at 30.0% and 37.5% respectively and high fares for mamboleo at 66.7%. Between the distances of 201m-300m, the major challenge in Nyamasaria was found to be discomfort at 29.4% while in Mamboleo and Otonglo the main challenge was found to be high fares at 36.4% and discomfort at 37.5% respectively. It was interesting to note that for the distances beyond 400m, the main transport challenge was high fare charges in all the three suburbs with percentages ranging between 28.6% and 37.1%. The results shows that the major transport challenges making distance become a transport cost between residential places and workplaces are discomfort and high fare charges. Since, majority walk to work, discomfort was mainly experienced during walking. These findings reveals some of the hidden costs and nature of transport conditions created by incremental developments which increases distances to locations in the suburbs that were not clearly pointed out by Ackelman & Andersson (2008). This finding also varies with the assumption in the Lowry model that Oryiani (1987) tried to affirm in his studies that there are a perfect relationship between residential zones and workplaces in terms of distance as a transport cost element.

In order to understand this further, the analysis was also done to find out the possible relationships between fare charges and distance to workplaces. The analysis results revealed

that on average, the majority accounting for 28.7% do not pay are transport fare to work implying that they either walk to work or use their private means. This is followed closely by those who pay between Ksh 41-60 to workplaces which accounted for 26.1%. Table 4.13 shows the cross tabulation results between distance to work and fare charged.

Table 4. 13: Cross tabulation on distance to work and fare charged

Distance to work place	Fare charge to work(Ksh)					Total
	None	41-60	61-80	81-100	>100	
<100m	60.0%	.0%	30.0%	.0%	10.0%	100.0%
101-200m	11.1%	55.6%	14.8%	.0%	18.5%	100.0%
201-300m	27.8%	13.9%	47.2%	.0%	11.1%	100.0%
301-400m	20.0%	10.0%	5.0%	50.0%	15.0%	100.0%
>400m	32.6%	28.4%	15.8%	14.7%	8.4%	100.0%

The results in table 4.13 indicates that 60% of those working within a distance of 100m do not pay any fare, 55.6% working within a distance of between 101m-200m pay between Ksh. 41-60. On the other hand, 47.2% of those working within 2001-300m pay ksh 60-80 while 50% those working within a distance of between 201-400m pay between Ksh. 81-100 and interestingly 32.6% of those working beyond 400m do not pay fare to work, implying that they walk to work. These results further shows nature of cost of transport in relation to means used to work. An interview with some of the motorcycle operators revealed that their minimal fare charge irrespective of the distance is Ksh. 30 and this also depends on the weather condition where during poor weather the fare increases up to a minimum of Ksh 60 in all the distances. Most of those whose workplaces were beyond 400m were found to either use private means or other means like matatus a part from walking. Since motorcycles are operating like public transport means within the suburbs, they are dominating in service delivery and hence dictates

the fare charge levels. This shows why the fare charges in these suburbs are higher in short distances as compared to that charged by such public transport means like the matatus that charge a maximum of Ksh. 60 for two way trip. On the other hand, the findings also contributes to knowledge in that according to Jorgensen and Pedersen (2001), there is still inadequate empirical evidences on how fares charges and relate to distances to work place.

Considering the fact that work trips in the suburbs are dominated by mainly two means, which are walking and motorcycles, the study further examine how these modes influence transport cost to workplace. The walk time to work was examined to find out the possible variations and factors contributing to this. Table 4.14 shows combined cross tabulation results on the relationships between times taken to workplace by different transport means used by the suburb residents.

Table 4. 14: Time taken to workplace by different transport means in the suburbs

Suburb	Transport Means	Time to Work place					Total
		<5min	5min	10min	15min	>15min	
Nyamasaria	Motorcycle	20.8%	25.0%	29.2%	20.8%	4.2%	100.0%
	Bicycle	.0%	14.3%	28.6%	42.9%	14.3%	100.0%
	Private Car	.0%	66.7%	22.2%	.0%	11.1%	100.0%
	Walking	3.6%	7.1%	42.9%	32.1%	14.3%	100.0%
Mamboleo	Motorcycle	.0%	33.3%	38.1%	19.0%	9.5%	100.0%
	Bicycle	.0%	.0%	44.4%	44.4%	11.1%	100.0%
	Private Car	.0%	.0%	100.0%	.0%	.0%	100.0%
	Walking	4.0%	16.0%	40.0%	28.0%	12.0%	100.0%
Otonglo	Motorcycle	20.0%	20.0%	50.0%	5.0%	5.0%	100.0%
	Bicycle	20.0%	.0%	20.0%	40.0%	20.0%	100.0%
	Private Car	.0%	28.6%	57.1%	14.3%	.0%	100.0%
	Walking	.0%	12.5%	54.2%	20.8%	12.5%	100.0%

The results in table 4.14 shows that on in all the three suburbs, the majority who accounts for 42% of takes 10minutes to reach their place of work a part from Otonglo suburb where the majority of private car users accounting for 66.7% takes 5 minutes. However, variations in percentages were noted in all the three suburbs for those taking 10minutes in relation to means used. In Nyamasaria 42% of those who take 10minutes walk to work while in Mamboleo 100% use cars and in Otonglo 57.1% use cars for the same duration. Since the study revealed that majority of the residents walk to work, the results on the relationship between time taken and means used revealed a varying scenerio. In Otonglo is leading with those walking to work and taking 10minutes at 54.2% followed by Nyamasaria and Mamboleo at 42.9% and 40.0% respectively. Interms of motorcycles, Otonglo is still leading with 50% followed by Mamboleo at 38.1% and Nyamasaria at 29.2%. Condidering those taking 15minutes to work places, bicycles and walking were found to take more time compared to other means. Mamboleo had the highest percentage of bicycle users taking 15minutes at 44.4% followed by Nyamasaria and Otonglo at 42.9% and 40.0% respectively. On the other hand, Nyamasaria was leading with the highest percentage of those taking 15minutes to work while walking at 32.1% followed by Mamboleo and Otonglo at 28.0% and 20.8% respectively. These results indicate that transport cost is higher on walking and bicycles considering the time they take over long distances. This further confirms the results in table 4.12 that the main transport costs to work experienced in the suburbs is comfort. This finding deviates from that of Litman (2013) that under favorable conditions people prefer walking or cycling to work even if it takes more time due its enjoyment and health benefits. These residents walk or cycle to work out of necessity and not either health or pleasure and that is why they do not consider the two means comfortable.

These variations and particularly the increaed time taken to workplaces and comfort shows the nature of transport costs that could be exaplained by changes in land use characteristics and transport fare charges. During the key informant interviews, the County planner explained they rising costs in reaching such destinations as work places are as a result of poor development control that affects direct accessibility to destinations and the nature of roads serving in a locality. On the other hand, the County surveyor for Kisumu County survey office revealed that the problem could be caused by private surveyors who only provide roads to serve resultant plots without considering other functional aspects that can promote accessibility and connectivity to various destinations. This is because some of the surveyors working in private firms do not have engineering, land use or transport planning skills that helps them come up with well designed roads during the land subdivisions.

The study findings also differed with Silva *et al.*, 2006 on their findings that people living in denser, central, compact, and mixed zones have reduced transport cost to work and use of public transport but agree with the result that the influence of land use characteristics on travel cost varies. The uncontrolled mixture of development in the suburbs creates several turns and narrowness of ther roads making it difficult even for some means of transport like matatus to serve between residential location and work places. This possibly has made these means operating as public transport means to give minimal service along the main transport corridors. They therefore leave most of the service to motorcycles, hence creating creating room for rise in transport cost by one dominating mode. This type of dominance generally leads to dictation of fare charges by the motorcycle operators since the do not experience stiff competion from

other means. This contributes further to the increase in transport cost between residential places and work places.

The land subdivision process was found to have had greate impacts on the road networks in the suburbs because it leads to creation of poorly linked road network that increases transport costs in terms of time taken to destinations. Thorough scrutiny of the PIDs revealed that the emerging road network and connectivity in the suburbs cannot adequately promote accessibility by reducing transport cost. The trend has created two types of un-matching road networks, that is the grid and hierarchical having different connectivity levels(Figures 4.6 and 4.7).

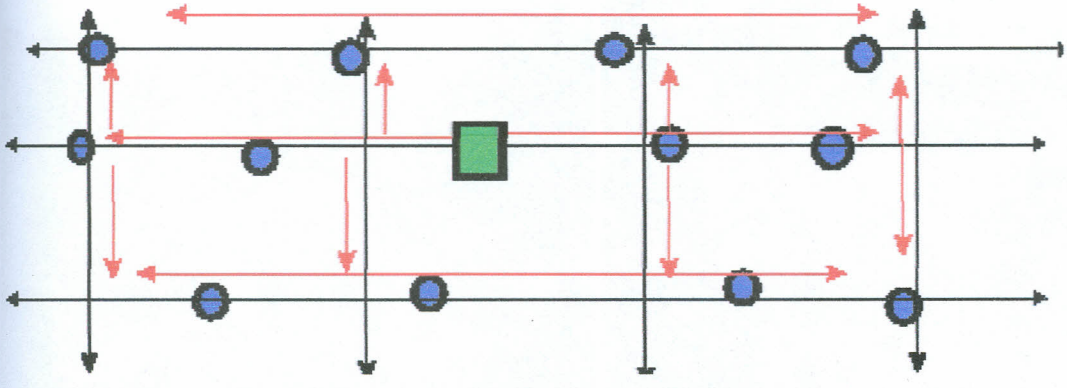

Figure 4. 6: Grid road network

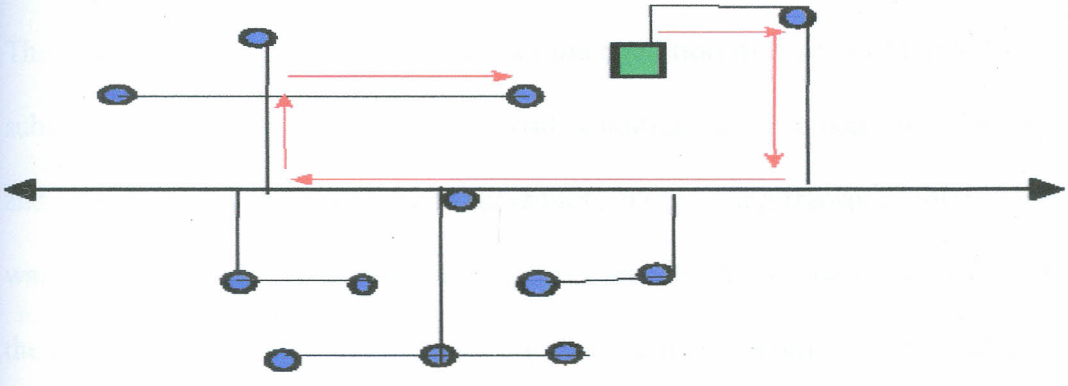

Figure 4. 7: Hierarchical road networks
Source: Litman (2008)

Some parts of the suburbs like south eastern part of Mamboleo is characterized by grid type of road network(Figure 4.6) while the northern side is charaterised by hierrarchical road networks(Figure 4.7). Results in Appendix 10 also showed that most parts of the suburbs are characterized by a resemplance of hierarchical road network which generally reduce overall accessibility hence, increasing transport cost. Field observation and analysis of the PIDs also revealed that apart from the poor road network connectivity, their sizes do not meet standard reserves and their conditions also do not encourage faster movement(Plate 4.2a and 4.2b).

Plate 4. 2 (a) Roads Mamboleo Suburb

Plate 4.2(b) Roads Nyamasaria Suburb

The results in plates 4.2a and 4.2b shows the condition of roads in Mamboleo and Nyamasaria suburbs. The results proves that the road conditions are not matching the required standards and hence, they do not encourage accessibility by reducing transport costs in the suburbs. This was confirmed by the Kisumu City Engineer and the Acting Director of City Planning during the interviews both of whom pointed out that the road conditions in the suburbs are very poor and do not encourage accessibility to work places thereby increasing costs.

The lack of proper design of roads and poor road conditions in the in the suburbs contributes greatly to transport costs to work places. There is also the problem of blocked roads by new developments within the suburbs that was revealed to contribute to transport cost during the key informant interviews. Apracticing surveyor in the suburbs of Kisumu City stated in his words during the interviews that:

There is a serious problem of blocked roads particularly in Nyamasaria and Mamboleo that sometimes give us a hard time during our routine survey work. When carrying out land subdivisions we must provide the roads accessing the new parcels but it is not surprising to find that some buildings have been constructed on it later and it has an approved building plan. You wonder whether the council staff verifies the ground before and after the approval of the plans.(Practicing Land Surveyor).

The Kisumu City Surveyor also confirmed this during the key informant interviews that the problem is more serious in the the suburbs since there is no transport master plan covering them. Blocking of the roads is one way of minimizing accessibility and hence, increasing travel distances and fare charges since it decreases the access to the preferred transport means. It was also noted that poor road designs has contributed greatly to creation of turns between residential places and work places hence, increasing time taken even to closer destinations.

Figure 4.8 shows the overall results on percentage of households making turns from residence to work by suburb. It revealed that 54.2% of the residents makes 3 to 4 turns, 39.9% makes 1to 2 turns while only 5.9% makes no turns.

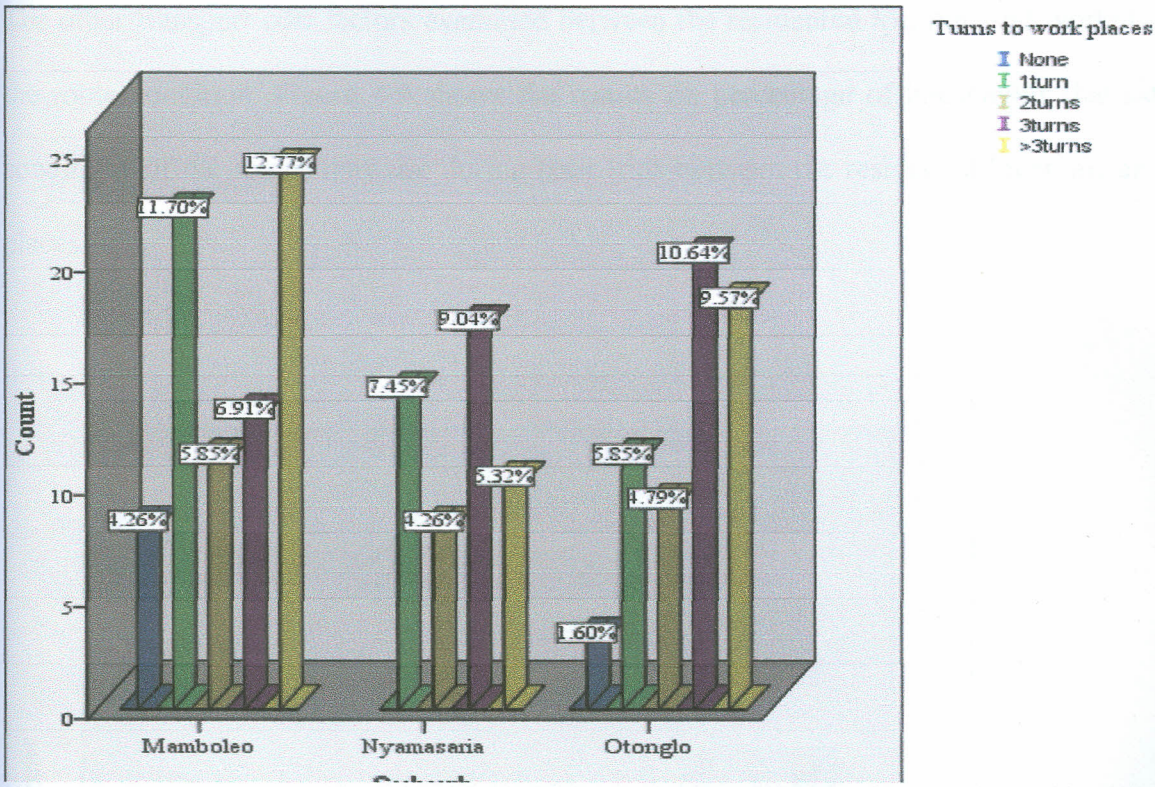

Figure 4. 8: Percentage of households making turns to work places from residntial location

Results in Figure 4.8 shows that Mamboleo suburb is leading with the number of residents making more than 3 turns to place of work at 12.77% followed by Otonglo and Nyamasaria at 9.57% and 5.32% respectively while Otonglo is leading in those making 3 turns at 10.64% followed by Nyamasaria at 9.04%. The high percentage of those making 3 turns and above before they reach their workplaces explains the variations in time taken even in distances that seems closer. These turns and narrowness of ther roads make it difficult even for some means of transport like matatus to serve between residential location and work places very difficult, hence creating form of dependency on motor cycles. This type of dominance generally leads to dictation of fare charges by the motorcycle operators since the do not experience stiff competion from other means.

The other transport cost factors examined between the residential location and workplace was the route condition. Figure 4.9 shows the results on percentage of households that rated the conditions of the routes they use during their trips between the residential locations and work places.

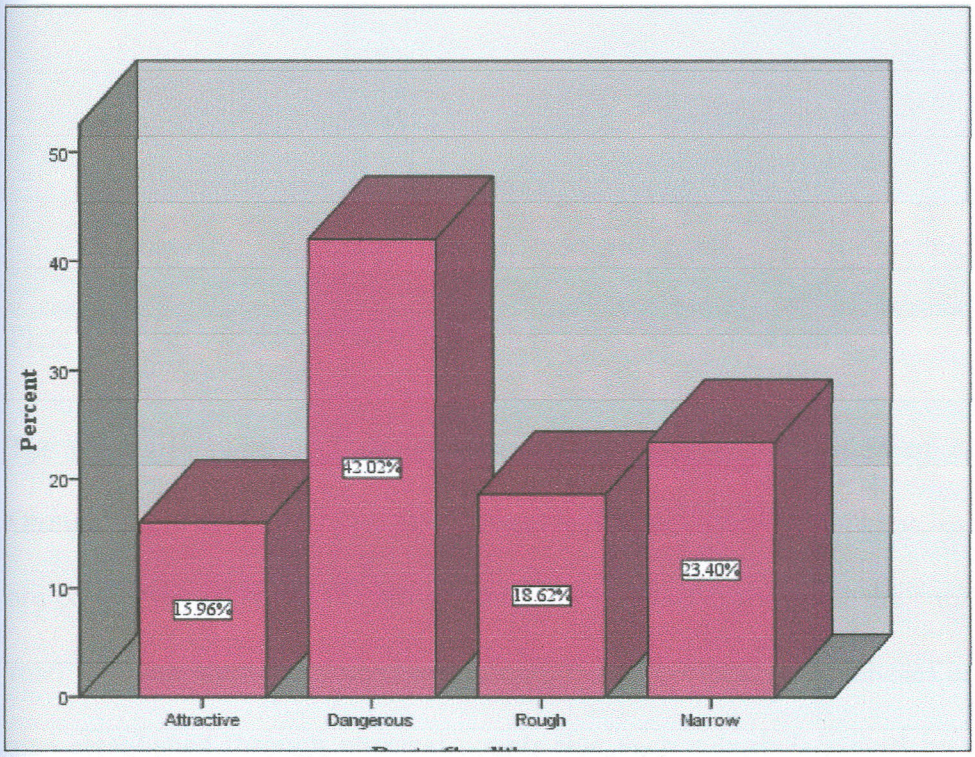

Figure 4. 9: Route conditions as rated by households

The result in figure 4.9 shows that 42.02% rate the routes as dangerous followed by 23.40% that rate them as narrow while 18.62% and 15.96% rates them as rough and attractive respectively. During the Focused Group Discussions, the routes were also rated as dangerous because of the sharp bends, blind corners, uncontrolled misture or means of transport and lack of lighting particularly at night. The narrowness was observed to be as a result of encroachment by developments, erosions due to poor drainage and use by several means at times. The roughness of the routes were due to poor maintenace as was observed in the field (Plate 4.3).

Plate 4. 3 Narrow, dangerous and rough road in Otonglo suburb

The results in plate 4 .3 shows a narrow and dangerous section of Kisumu-Busia road in Otonglo suburb. Different types of means including motorcycles, bicycles, cars and the *matatus* are competing of space for movement. The result also shows at the background that even the road shoulder sometimes used by pedestians and cyclists, is sometimes used as garages. It was also established through physical counts that each suburb is served by only two official bus stops along the main transport corridors like Kisumu-Busia road, Kisumu-Nairobi road and Kisumu-Mamboleo-Miwani road (Figure 4.10).

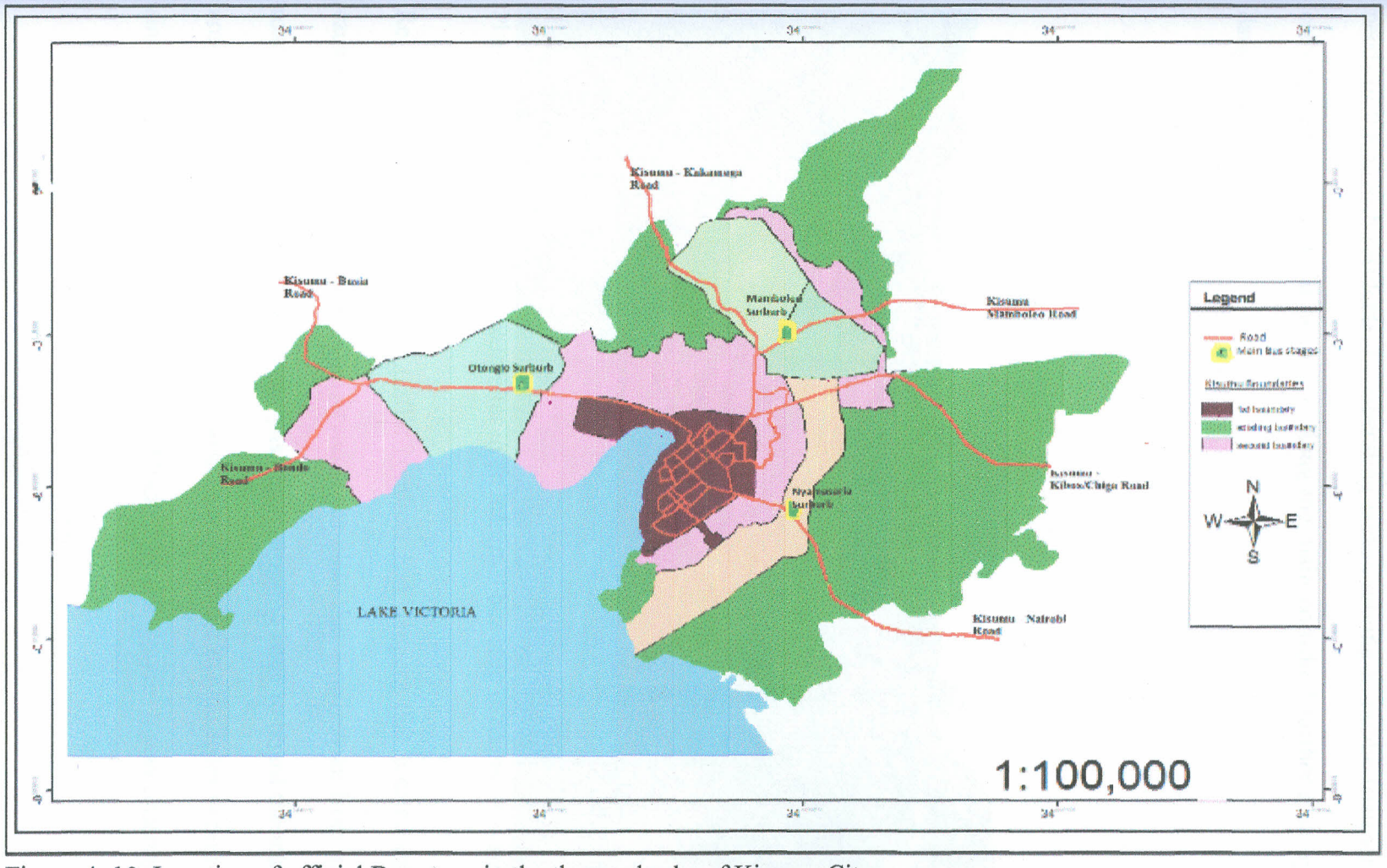

Figure 4. 10: Location of official Bus stops in the three suburbs of Kisumu City

Results in figure 4.10 shows that all the official bus stops that are located within the suburbs along along the major arterials like Kisumu-Busia road, Kisumu-Nairobi road and Kisumu-Mamboleo-Miwani road. Since they are few in number and most were not designed to meet the needs of the suburb residents, the operating means serving as public transport like the matatus ends up creating informal bus stops along the main corridord further making the routes more dangerous (Plate 4.4).

Plate 4. 4: *Matatu picking a passenger in an informal bus stop in Mamboleo suburb*

Results in plate 4.4 shows the traffic conflicts and dangers that created informal bus stops causes in the suburbs. It can be observed in the plate that a pedestrian from another side of the road crossing through a non-marked passenger crossing zone to board the matatu parking on a non-designated bus stop. A cyclist is also overtaking the matatu from within the carriage way since the possible space they can use is blocked by the matatu. It was observed that there is no

additional provision of official bus stops within the suburbs beyond these main transport corridors. The results also showed that the road conditions are not matching the required standards and hence, they do not encourage accessibility by reducing transport costs in the suburbs. They are also narrow, dangerous and rough also influencing the time and distance to work places thereby increasing transport costs. The revelation by the study that the transport cost in the suburbs in terms of increased distances between residential location and workplaces is due to poor development control differs with that of Yang (2005), that increased distance influences people's cost through distance covered in well planned zones. The increased distance also was measured by the number of turns suburb residents make from their places of residents to activity location like work place and shops. Ejigu (2011) and Carrion (2009) also revealed that informal areas generally depend on cheaper means of transport to work since they are accessible to them. But the findings of this study slightly differ with this since motorcycles which are accessible to them, but are becoming expensive in terms of high fare charges even in short distances.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the main findings for each objective set by the study. It gives the conclusions and their applicability in broad context. The chapter also presents recommendations based on the purpose of the study which was to asses the effects of change in land use characteristics on accessibility in the suburbs. Hence, prospective areas for further research are also suggested.

5.2 Summary

The first objective was to assess the influence of density on travel time when accessing destinations within the suburbs of Kisumu city. The study results demonstrated that travel time to destinations is positively associated with density where an increase in density increases travel time. Regression results showed that if the density in a suburb increases by $1km^2$ then time taken to each of the other five destinations will increase by .001. The ANOVA results comparing travel time means showed that the significance value for all the six destinations ranged between .107 and .484 implying that they are statistically different since they are above 0.05%. This further confirmed that density has influence on travel time in alls the three suburbs. These results deviate from that of Levtnson and Kumar (1997) who revealed that the influence of density on travel time is ambiguous while agrees with Barnes (2001) finding that higher densities tend to increase travel time.

The correlation results also showed that despite the increasing density, there is no linear correlation between distance and time taken to destinations in all the three suburbs a part from strong correlation between time taken and distance to social halls. This finding on the negative relationships further differs with the finding of Levtnson and Kumar (1997) that the higher the density the more destinations that can be reached in the same time. The results showed that walking is the dominant mode to different activity destinations but there are factors that increases or decreases walk time with increased density that contributes to non linear correlation between distance and time. The high pecentage of suburb residents walking and using bicycles to various destinations also indicates that population density in the suburbs encourages the use of single occupant vehicles. This varies with Taylor (2001) finding that the rise in population density increases travel time but reduces the use of single-occupant vehicles. However, it agrees with the findings of Frank (2007) that population density is positively correlated with walking for most trips to destinations. The findings also agree with that of Littman (2012) that increased density encourages walking but may lead to increase in traffic challenges and travel time. These challenges were found to emanate from the continued agglomeration of different activity locations as population density increases thereby creating uncontrolled mixture within the land uses. This on the other hand, inhibits direct movement between most of the activity locations within the suburbs. Poor land subdivisions also minimizes access to locations while unapproved developments located on the roads reserves also cut the direct link between some activity locations thereby increasing time taken to destinations even in short distances. The major reason causing uncontrolled density that increases travel time is poor development control within the suburbs. This finding deviates from other study finding which have shown that increased land use mix reduces travel time.

The variation seems to be due to the nature of mix where in cases of balanced mix, the travel time reduces but for unbalanced mix it increases (Kuzmyak and Pratt 2003; Frank and Pivo, 1995). The study also contributes information on the relationship between population density and time in Kisumu city an area where most studies have not focussed on.

The other objective was to determine the relationship between residential location and modal split in the suburbs of Kisumu city. The study establised that 43.62% of the suburb residents choose their residential locations because of the need to own a house and 30.32% are influenced by cheaper rent while only 10.64% choose their locations due to cheap transport cost. The results also showed that even homeownership does not influence modal split in the suburbs. It agrees with the findings of Long *et al.* (2010) that individual mode choice behavior varies considerably across different homeowners due to their heterogeneity in the preference to transportation means. The study further revealed that despite the fact that most of homeowners own different means of transport still this does not contribute to any relationship between residential choice and modal split. These results differ with the findings of Sultan (2011) that people choose their residential location based their modal preferences but agrees with his finding that the positive relationship cannot be established. The study results also vary with that of Vega & Reynolds-Feighan (2007) who found out that transport policies aimed at minimizing travel costs can influence residential location on modal split in the suburbs. This is because the suburbs in Kisumu city still suffer from weak development control and implementation of policies that guide land use and transport. The correlation results showed that residential location does not relate positively to modal split to various destinations in the suburbs of

Kisumu city. This confirmed the fact that irrespective of residential location, the factors determines modal split are accessibility to means, their speed, fare charges and safety.

The last objective was to examine the relationship between work place location and transport cost in the suburb residents in Kisumu city. The result revealed that 63.2% work within the suburbs while 26.1% and 10.7% work in other places and in the city centre respectively. The results indicate that most of the household work related trips are within the suburbs as opposed to city centre or other places outside the suburbs. However, there are variations in the nature of relationships between residential location and transport cost to workplaces. In overall 42.09% of the households takes 10minutes to their work places while a total of 18.1% takes five minutes and below. The study revealed that time taken to workplaces is not costly. The findings of this study agrees with the results of Carolyn and Ian (2012) that travel time as a cost is considered low if it takes 20-40 minutes and high if it exceeds 90 minutes. However, the correlation results showed a weak relationship between distance to work place and time taken to workplace in all the three suburbs and weak relationship between distance to work place and fare charged in all the three suburbs. This finding agrees with the findings of Raymond (2013) results that there is no clear correlation between the workplace location and the cost of transport to work. These results showed that there are other underlying factors that explain the relationships between workplace location and transport cost in terms of fare charged, distance and time taken. The results shows that the major transport challenges making distance become a transport cost between residential places and workplaces are discomfort and high fare charges. Discomfort is as a result of the nature of transport conditions created by incremental developments in the suburbs. This finding also varies with the assumption in the Lowry model

that that there are a perfect relationship between residential zones and workplaces in terms of distance as a transport cost element. In terms of fare charges, motorcycles were found to have high fare charges since they are the dominant means. The results on high transport cost as a result of walking or cycling to work deviates from that of Litman (2013) that people prefer walking or cycling to work even if it takes more time due its enjoyment and health benefits. These suburb residents walk or cycle to work out of necessity and not either health or pleasure and that is why they do not consider the two means comfortable. The discomfort was found to arise from poorly designed and maintained roads used by the residents. The study findings was found to differ that of Silva *et al.*, 2006 that people living in denser, central, compact, and mixed zones have reduced transport cost to work and use of public transport but agree with their result on the influence of land use characteristics on travel cost varies.

5.3 Conclusion

The study established that population density influence travel time between the residences and various activity locations within land uses in all the three suburbs. The continued increase of population and new land uses with changes in their characteristics as construction of residential houses, small scale industrial premises, offices and commercial stores influences accessibility as evidenced by the positive association between density and time taken to destinations. However, density was found to be increasing in uncontrolled manner inhibiting direct and ease of reaching most of the activity locations in the shortest time possible. Increasing population density in the suburbs was also found to encourages the use of single occupant vehicles as bicycles and motorcycles as a way of minimizing time taken to destination. The increase of

time taken to destinations in effect discourages personal accessibility within the suburbs but creates dependency on single occupancy vehicles.

There is also no linear relationship between residential location and modal split. The main factors determining residential location within the suburbs are the need to own a house and cheaper rents as compared to cheaper transport cost and not modal split. Kisumu city still suffer from weak development control and implementation of policies that promote the accessibility relationships between residential locations and transport means. However, the determinant factors of modal split in the suburbs are accessibility to means of transport and their speed. However, the need for a particular means of transport to work and other destination arises after settling and this explains why accessible and faster means to destinations are a priority in the suburbs.

The study also revealed that work place location is not determined by transport cost and vice versa. The fact that most of the suburb residents work within them and the non linear correlation between distance to workplace, time taken and fare charged explains the finding. The main transport costs to work include high fare charges by motorcycles and discomfort experienced when walking or using bicycles due to poor route conditions. However, these transport cost elements do not control the residents workplace locations in relation to the residential locations. This implies that the changes in land use characteristics in the suburbs increases transport cost to work through creation of dependancy on single occupancy means of transport that are also not comfortable when using.

5.4 Recommendations

The following recommendations were made based on the study findings on the effects of the changes land use characteristics on accessibility in the suburbs of Kisumu city.

In order to minimize the negative influence of density on time taken to destinations in the suburbs, the following should be undertaken;

1. Control populations density using the set land use planning standards in the suburbs in order to improve on accessibility to locations.
2. Harness the emerging mixed land use density through zoning since it favors the accessibility planning that minimizes time taken to destinations.
3. Promote the use of single occupancy means of transport by making them comfortable through the improvement of the facilities they use as road network and conditions.

The following should also be considered when improving the relationships between residential location and modal split in the suburbs;

1. Improve on development control and implement existing policies that promote the relationship between land use and operation of transport means.
2. Encourage and streamline the operation of the most accessible means of transport to workplaces

In terms of the relationship between workplace location and transport cost, the following are recommended;

1. Minimize dependency on motorcycles through the promotion of the use of other means of transport and improve on the route conditions used by pedestrians and cyclists.

2. Designate employment zones that are accessible to the suburb residents when using the most accessible means to these zones.

Areas for further research

Considering the changes in land use characteristics in the suburbs, further studies can also be conducted on place accessibility in order to determine the number of activities locations at certain distances from residential houses in a land use zone within a suburb.

This can also be refined further by incorporating other accessibility measures as network analysis and automated GIS land use modeling system.

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