ANALYSIS OF FACTORS INFLUENCING THE CHANGES IN THE USE OF TRANSPORT MODES IN KISUMU, KENYA

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March 2019

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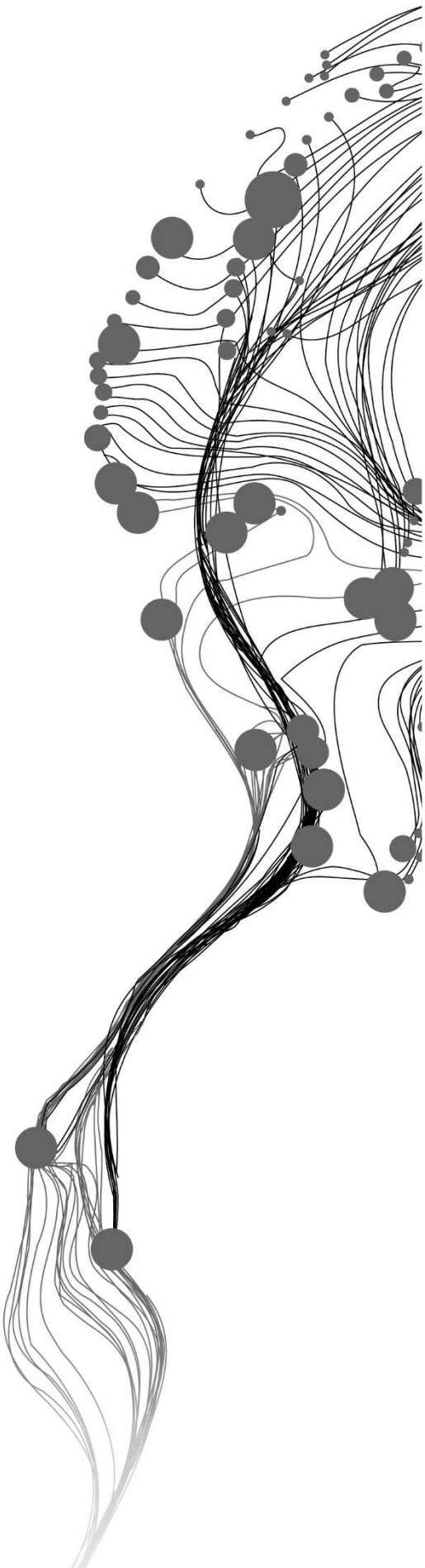

ANALYSIS OF FACTORS INFLUENCING THE CHANGES IN THE USE OF TRANSPORT MODES IN KISUMU, KENYA

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ABSTRACT

A study was carried out in the city of Kisumu which looked at the policies that were put in place by the government causing the changes in transport mode choice. However, the research did not look at the socio-demographic, built environment, trip-related, attitudinal and perception factors influencing the changes in the use of transport modes. The aim of this study, therefore, was to investigate the determinants of the changes in the use of transport modes in the city of Kisumu and underlying factors influencing these changes.

To help put the research into context, a review of the literature was carried out to conceptualise factors influencing the use of transport modes. It then facilitated the development of a household travel survey questionnaire to aid in collecting data through cluster and systematic sampling. Data were analysed using descriptive statistical analysis and Chi-Square test of association to produce the results. A geographical information system analysis was also used to map the spatial distribution of transport mode used by the households.

The analysis revealed that most changes in the use of transport modes in the city of Kisumu occurred in the last five years. It is coupled by an increase in the use and ownership of motorcycles especially in the far-flung city neighbourhoods like Kogony. On the other hand, the reasons advanced by the respondents why they changed the mode revolved around socio-economic, built environment, trip-related, attitudinal and political reasons based on the neighbourhood (sub-locations) one resides. Also, socio-demographic factors are the most likely to be influencing mode choice in the city of Kisumu followed by built environment factors, attitudinal and perception factors in that order.

The findings call for the County Government of Kisumu to work with stakeholders in promoting the benefits of non-motorised transport modes. The local government also need to facilitate policymakers to work with the local community to formulate sustainable transportation policies to include non-motorised transport modes. This study hopes to bring a better understanding to city planners in Kisumu and other similar jurisdictions on factors influencing mode choice to help them develop effective and targeted people and place-based policies. It is also expected that this study will contribute to the academic body of knowledge on the factors influencing mode choice in Global South cities like Kisumu.

Nevertheless, categorical data analysis has methodological limitations inherent in this line of research. It calls for careful interpretation of the results as there may be a limited insight into causality. To this end, it would be of interest for future studies to look at multi-variable analysis in the same context using a household travel survey over large sample size.

Keywords**:** non-motorised transport modes, motorised transport modes, mode choice, travel behaviour, socio-demographic, built environment, sustainability

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"*Philippians 4: 8-9*

8 *Finally, brothers, whatever is true, whatever is honourable, whatever is just, whatever is pure, whatever is lovely, whatever is commendable, if there is any excellence, if there is anything worthy of praise, think about these things*. 9 *What you have learned and received and heard and seen in me—practice these things, and the God of peace will be with you*."

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1. INTRODUCTION

1.1. General Introduction

Transport is a very important aspect of people's lives because their activities cannot be complete without moving from one place to another. The movement of people from one place to another is often facilitated by non-motorized modes such as walking and cycling and motorised modes such as a car, bus, and train. Transport mode choice is closely linked with the traveller's socio-demographic characteristics such as age, gender, marital status, educational level, occupation, etc. Transport is also associated with different activity purposes such as employment, recreational, educational, shopping, etc. (Stead & Marshall, 2001).

At the global level, the average person in non-OECD (Organization for Economic Cooperation and Development) countries travelled by motorised transport modes (MTM) less than 1000 kilometres, unlike in OECD, the average person travelled by MTM over 7000 kilometres in 2010 (Figueroa, Fulton, & Tiwari, 2013). While the use of MTM is scaling up in the developed world, the developing world is not left behind fuelled by an increase in income and economic growth. It means that the use of non-motorized transport modes (NMT) and motorised transport modes (MTM) vary depending on whether the context is developing world or developed world (Cervero, 2013).

At the regional level, the use of motorized transport mode (MTM) is high and stable in North America, Western Europe and Japan, but the trend throughout the rest of Asia, East Europe, parts of Latin America and Africa is a fast transition from NMT to MTM (Figueroa et al., 2013). The transition from NMT to MTM depends on some physical, social, economic, cultural and political factors (Parkin, 2012).

In East Africa, the situation is not any different as the trend in most cities in this region is a car-oriented development. The trend has yielded to a scenario where ideas to solve the mobility needs of the poor is concentrated around public transport. In most cases, a supply-driven approach rather than a demand-driven one is pursued (Sustainable Mobility for All, 2017). In Kenya, second-hand cars imported from Europe and Japan, in particular, are in high demand by the middle-income group. Motorcycles are also in high demand by the group who are venturing into the business of taxis mostly in urban centres (Kenya National Bureau of Statistics, 2017). These trends are also being replicated in cities like Kisumu leading to a gradual change in the use of transportation modes from NMT (walking and cycling) to MTM (private cars, public transport also known as matatus, auto-rickshaws, motorcycle).

1.2. Background and Justification

NMT has got several advantages over MTM such as less congestion; zero emissions; less health, accident and social cost; and reduced infrastructure costs among others (Khisty, 2003). However, in Kenya, these merits of NMT have not yet gained a place in transportation policymakers' agenda.

Anybody familiar with the major cities in Kenya (i.e. Nairobi, Mombasa and Kisumu) will notice the problem of the increasing number of MTM over NMT leading to traffic congestion, air pollution, noise and road rage. Kenya like any other developing country is facing serious challenges to reverse this trend through transportation and planning policies with no solution in sight (Jennings, 2016). This means that there are socio-demographic and related factors (i.e. attitudinal, perception and built environment factors) influencing the changes in the use of transport modes (i.e. mode choice) in the mentioned cities of Kenya, particularly Kisumu which needed to be unearthed. There is also a shortage of available data on NMT and MTM use in the main cities of Kenya, particularly Kisumu (Mitullah, Vanderschuren, & Khayesi, 2017).

Alando, Scheiner and Zuidgeest (2014) reported that Kisumu is still predominantly a walking and cycling city. It shows that when analysing the trend from three points in time (2004, 2009 and 2014), the share of

the bicycle (self) is increasing, cycling (operator or taxi) is decreasing, motorcycles and private cars are increasing (table 1-1). However, overall, the share of NMT dropped from 84% in 2004 to 71% in 2009 and 67% in 2014 (table 1-1). In the study, Alando et al. (2014) found out that some policies from 2004 introduced taxes on bicycles and zero-rated import taxes on motorcycles and second-hand cars thus creating an environment conducive for motorisation (table 1-2).

In this case, Alando et al. (2014) addressed the question of when the change from NMT to MTM started, the magnitude of the change and what caused the change by examining the policies that were put in place by the state. Their study covered the period from 1999 to 2014. In this line of thought, it was, therefore, essential to find out the magnitude of the change and how it was at two points in time (i.e. before the change and after the change) by looking at mainly the residents' perception about transport modes, built environment and socio-demographic factors that are influencing the change.

Table 1-1:Percentage share of each mode in Kisumu between 2004-2014. Source: Adapted from Alando et al. (2014).

	Walking	Bicycle (self)	Bicycle (operator)	Motorcycle Taxis	Private cars
Total share in 2004%	36.7	10.1	36.8	1.7	14.7
Total share in 2009%	23.5	31.1	16.4	8.6	20.4
Total share in 2014%	17.4	38.1	11.7	11.8	21.0

Table 1-2: Summary of the changing transport situation in Kisumu over time. Source: Adapted from Alando et al. (2014).

1999-2003	2004-2008	2009-2014
▪ The emergence of commercialised bicycle taxis ▪ Removal of taxes on bicycles ▪ Transport sector reforms ▪ Sustainable urban mobility project	▪ The emergence of minibuses (matatus) ▪ The emergence of motorcycle taxis ▪ Reintroduction of taxes on bicycles ▪ End of sustainable urban mobility project ▪ Removal of taxes on motorcycles	▪ Growing motorisation (matatus, motorcycles taxis and rickshaws) ▪ Development of Kisumu as University city ▪ Upgrading of roads to support motorisation

1.3. Research Problem

In Kenya, there have been some state actions which are not within citizens control (i.e. policies) like re-introduction of taxes on bicycles and removal of taxes on motorcycles in the period 2004-2008 leading to gradual change in the use of transport modes (i.e. mode choice) mainly in the major urban centres of Nairobi, Mombasa and Kisumu (Kenya National Bureau of Statistics, 2017; Alando et al. 2014). It paints the picture of a problem that needs to be understood from both people oriented (i.e. socio-demographic, attitudes and perceptions about mode choice, etc.) and government instigated (i.e. policies) factors that may be influencing the change, particularly in Kisumu.

Alando et al. (2014) looked at the conditions created by the state (i.e. policies) which influence mode choice by conducting a retrospective survey to obtain data on travel choices. Their study covered three significant dates in the history of transport development in Kisumu, namely; commercialisation of the bicycle for passenger transport, the emergence of a motorcycle taxi and the development of Kisumu as University city. They then predicted the influence of the drivers of change using a multinomial logistic regression model and found out that MTM was on the increase. They also found out that all forms of NMT continued on a

declining trend after 2009 apart from private cycling (i.e. the share of walking is decreasing, bicycle (operator or taxi) is decreasing, and bicycle (self) is increasing). Alando and Scheiner (2016) did a qualitative content analysis of Kenya vision 2030 and Integrated National Transport Policy documents to find out the opportunities presented by the two key policy documents for cycling inclusion. Both studies only examined the conditions created by the state which influence mode choice, however, they did not consider people-oriented and built environment perspectives such as socio-demographic factors, built environment factors, residents' attitudes and perceptions about mode choice which may be influencing the changes in the city of Kisumu.

Also, the current Kisumu city Integrated Strategic Urban Plan 2013-2030 (KISUP 2013-2030) has not considered NMT as an essential and integral travel mode option. It recommends roads expansion to accommodate the increasing number of MTM (Nodalis Conseil, 2013). In other words, the plan appears to be promoting an unsustainable transportation policy described by Schiller and Kenworthy (2017, p. 2) as a "business as usual" approach. Since the Kisumu city, integrated strategic urban plan 2013-2030 is not in sync with the current sustainable transportation policy practices; it was essential to map the spatial distribution of transport mode used by the households in the city of Kisumu.

It was, therefore, significant and necessary to investigate the determinants of the changes in the use of transport modes (i.e. mode choice) and the underlying factors influencing the changes in the city of Kisumu. It was to fill the knowledge gap highlighted in Alando et al. (2014); Alando and Scheiner (2016) and also to give a perspective how the highlighted problem posed by KISUP 2013-2030 can be addressed.

1.3.1. Objectives of the Study

1.3.1.1. General objective

The primary objective of this study is to investigate the determinants of the changes in the use of transport modes in Kisumu and the underlying factors influencing these changes.

1.3.1.2. Specific Objectives

Therefore, to achieve the primary objective, the following specific objectives were set for the study:

1. To Identify factors influencing changes in the use of transport modes.
2. To determine the factors influencing the changes in the use of transport modes in Kisumu.

1.3.2. Research Questions

The following outlined research questions should be answered to achieve the specific objectives of this research:

1. To identify factors influencing changes in the use of transport modes.
    a. What is known about the factors that influence changes in the use of transport modes?
    b. What research methods and research strategies have been employed in studying factors influencing changes in the use of transport modes?
    c. Which factors can be selected and on which basis for studying the use of transport modes in the context of Kisumu?
2. To determine the factors influencing the changes in the use of transport modes in Kisumu.
    a. Which transport modes are the residents using now (after the change-2018) and which ones were they using before the change?
    b. Which transport modes do the residents own now (after the change-2018) and which ones did they own before the change?
    c. What are the reasons for the change of transport mode?
    d. Which factors are influencing the use of transport modes in Kisumu?
    e. How is the spatial distribution in the use of different transport modes in the city of Kisumu?

1.4. Thesis Structure

This thesis is made up of five chapters as summarised in figure 1-1. Chapter one introduced the study by highlighting a general introduction of transport and transportation modes, the background, justification and the research problem and objectives of the study are stated. Chapter two covers the literature review on the development of transport modes, sustainability issues and review of the literature and identification of factors that influence mode choice. The literature on the methods that have been used to understand factors influencing mode choice in previous studies is also reviewed in this chapter. It leads to a conceptual framework of this research on factors influencing mode choice. A comparison, contrast of various methods and why the selected methods are also presented in chapter two. Chapter three describes in detail the study area and the reasoning behind its selection. Narratives and further discussion about transport issues in Kisumu are dealt with in this chapter. Chapter three also explains the methodological approach and tools employed to achieve specific objectives two and three of the study. Further to this, the process of data collection methods is discussed in the same chapter. Chapter four presents the results and discussion of the analysis. It accounts for the results of the analysis based on the specific objectives two and three on factors influencing mode choice in Kisumu. Chapter five summarises, concludes and gives the study recommendations related to transport planning. It also suggests transport policy and future research related to factors influencing the changes in the use of transport modes (i.e. mode choice) in Kisumu.

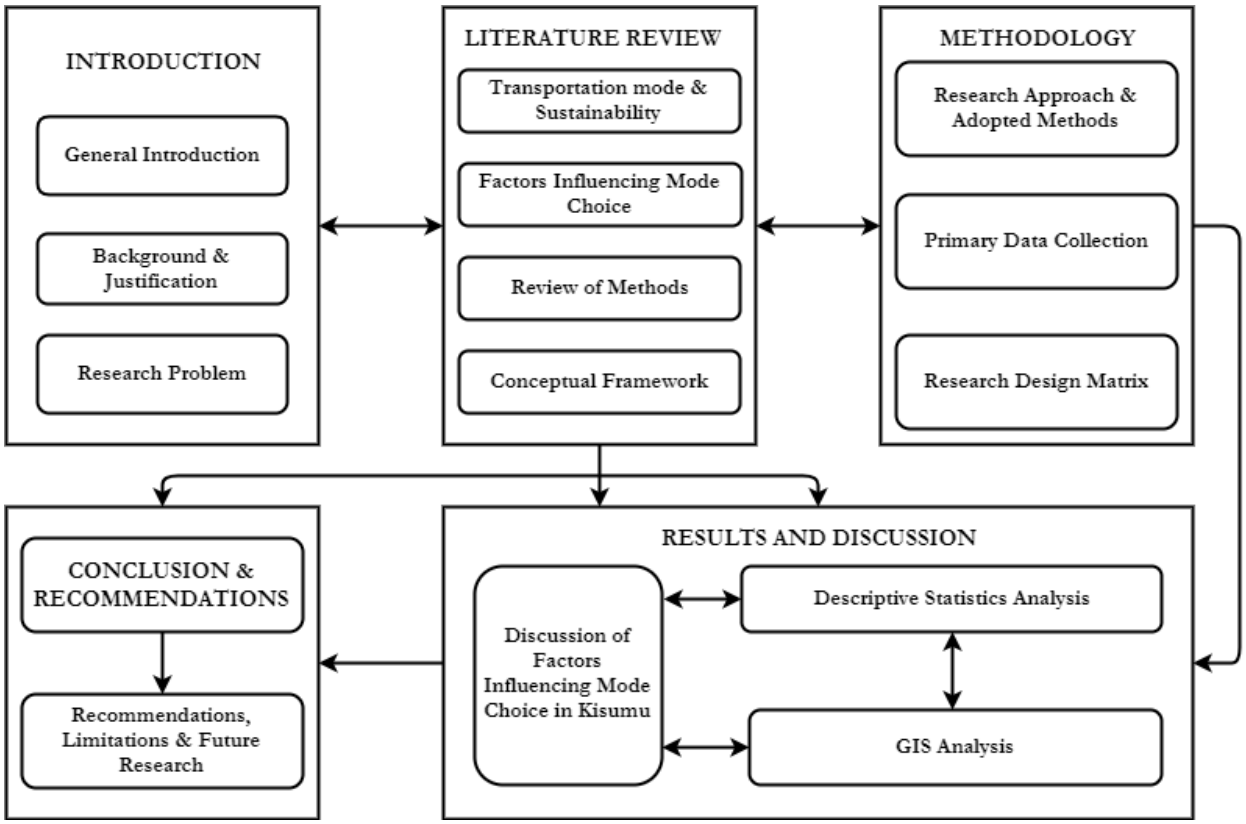


Figure 1-1: Thesis structure.

2. LITERATURE REVIEW

To help investigate the determinants of the changes in the use of transport modes and the underlying factors influencing the changes in Kisumu, a review of the literature to identify factors influencing changes in the use of transport modes is necessary. To guide the review of literature, questions on what is known about the factors that influence changes in the use of transport modes, what research methods and research strategies have been employed in studying factors influencing changes in the use of transport modes, which factors can be selected and on which basis for studying the use of transport modes in the context of Kisumu are answered. Therefore, the chapter discusses the underlined concepts, thoughts and ideas of the research problem. It also relates the concepts to the methods that have addressed a similar research problem and the techniques and tools that are used in this study. It looked at the development of transport modes, sustainability, studies in other jurisdictions on how they contextualised and methods used to investigate the determinants of the changes in the use of transport modes (i.e. mode choice) and the underlying factors influencing the changes that apply to the Kisumu case. A summary review of other past studies done by various researchers is given in table 2-1.

2.1. Development of Transport Modes and Sustainability

History has it that the development of transport modes started with the invention of a component of NMT (i.e. the wheel) at the beginning of the Bronze Age about 3,500-year BCE. The invention initiated further improvement and mechanical development of the NMT by key personalities from various regions of the world which allowed NMT (e.g. the bicycle, cart, etc.) to become common means of transport. However, the advancements of the NMT (the wheel) also brought about MTM especially the works of Scotsman Kirkpatrick Macmillan's 1839 introduction of the treadle attached to the rear wheel as a form of propulsion (Valiulis, 2014).

To this end, humankind's effects on the environment especially regarding carbon emission because of the rise in MTM started to raise concern. It culminated in the sustainability report of 1987 setting out parameters of sustainable development as a development which meets the needs of the present without trading-off the ability of the future generations to meet their own needs (WCED, 1987). It, therefore, meant that human activities particularly the use of MTM should be under scrutiny concerning greenhouse gas emissions, air pollution and noise. Thus, cases like the city of Kisumu is in line with Agenda 21 which implored policymakers to "think global but act locally" regarding sustainable development policy formulation ('United Nations Conference on Environment and Development (1992: Rio de Janeiro, Brazil).', 1993). In light of this, the government of Kenya through relevant institutions have a role in facilitating a local government like Kisumu county government to work with the local community to formulate sustainable transportation policies to include NMT.

2.2. Review of Literature on Factors Influencing Mode Choice

Various researchers have looked at factors that are influencing the use of transport modes (i.e. mode choice). Particular for NMT are some of the following studies: The study by Rahula and Vermab (2013) brought out the effect of various social, economic, environmental and transportation system characteristics (i.e. age, gender, travel time, household income, land use, density and private motor vehicle ownership) on NMT mode use (i.e. walking and cycling). They employed a logistic regression model to determine the effect of various social, economic, environmental and transportation system variables using household survey data of Bangalore city for the year 2009. They found out the following: people prefer NMT (walk and bicycle) for short trips; Individuals who belong to high-income bracket had a less probability of using NMT; MTM

owners had a less affinity towards NMT; People who made trips to school had a positive likelihood compared with the people that made trips to work; As individual age increases, less preference to walk and cycle was observed; Mixed land use and increased density was found to have a positive effect on NMT use. Also, Dunlap (2015) while looking how the weather, land use, and infrastructure influence NMT use, incorporated socio-demographic factors (i.e. age, sex, educational level, employment status, household income, household size), household location, number of household vehicles, trip destination location, trip origin location, trip purpose, mode of transportation, length of trip (distance and time) and time of day for each trip as important characteristics from household travel surveys used in studying travel behaviours. The study found out that built environment factors such as Euclidean distance between trip O/D (origin/destination) and nearest shared pedestrian/bicycle path, number of blocks within one contained in one-kilometre radius buffer of trip O/D correlates with mode choice. Thus, the magnitude, direction and significance of the relationship depend on the purpose of the trip.

However, Bedadala and Mallikarjuna (2016) in their review categorised factors influencing the use of transport modes as socio-demographic factors, attitudinal and perception factors, environmental factors, trip-related factors, infrastructural factors and built environment factors. They concluded that it is necessary to focus on socio-demographic characteristics, individual attitudes and perceptions towards various modes because lifestyle, geographical characteristics etc. differ between developed and developing countries. In the end, they identified, classified the factors and showed considering these factors the differences between developed and developing countries which are likely to have a significant influence on non-motorized mode share.

In looking at Seoul metropolitan area, Choi, Lee, Park, Kim, Choi and Joh (2014) analysed changes in travel behaviour in time and space using household travel surveys and contextualised the factors to socioeconomic/regional characteristics and travel characteristics. The study found out that socio-demographic characteristics such as age, income etc. are firmly related to the use of transport modes in time and space.

Given the above-highlighted studies and to enable a clear understanding of the Kisumu case, several factors influencing the use of transport modes come into play. Based on a critical understanding of the literature and conscious reasoning, the factors can be broadly classified as socio-demographic factors (i.e. characteristics of the population), built environment (i.e. urban form characteristics), trip-related factors (i.e. trip distance and purpose) attitudinal and perception factors. The main categories are explained in (figure 1):

2.2.1. Socio-demographic Factors Influencing Mode Choice

Socio-demographic factors are a combination of social and demographic characteristics of the population such as age, gender, education level, income level, family type, NMT /MTM ownership etc. Barberan, de Abreu e Silva, and Monzon (2017) researched on factors influencing NMT use: a binary choice model with panel data for the case of Vitoria-Gasteiz, Spain, confirmed the importance of socio-demographic characteristics for understanding the use of transport modes. They found out that young people are positively associated with higher bicycle use and the sampled population who do not live in the city centre but work or study there are likely to use a bicycle. Thus, age and distance are critical determinants of the use of transport modes. On the other hand, gender was pointed out, but it was not significant in the binary logit model method they used. The study gives a perspective on which specific socio-demographic factors influence the use of transport modes based on specific study area problems and how a specific methodology was applied to understand the influence of the factors about the context.

Heinen, van Wee, and Maat (2010) in their overview of the literature on commuting by bicycle (NMT) concluded that there is a relationship between socioeconomic factors (i.e. age, gender, income, employment status, being physically active) and NMT. They, intimate that the relationship between cycling (NMT), age and income is mixed which needed to be verified for the Kisumu case. Their review surveyed published

literature on developed country-specific cases at the national level but not city specific to bring out the lower administrative context in the Global North where most of these studies were carried out.

In another context of the Netherlands, Snellen (1999) found out that some socio-demographic characteristics are significant factors influencing the use of transport modes. The crucial characteristics singled out by Snellen (1999) are: higher income is associated with more car use because there is more to spend on transportation; age influences the use of transport modes by elderly people showing positive association to MTM than young people who show positive use of NMT; higher education was found to be positively correlated with NMT for sports and related activities. Again, gender showed no significant effect in this study area in the Netherlands.

In the case of developing cities, Madhuwanthi, Marasinghe, Rajapakse, Dharmawansa, and Nomura (2016) in looking at the factors influencing travel behaviour on transport mode use for the case of Colombo Metropolitan area in Western Province of Sri Lanka concluded that income, safety, comfort and vehicle ownership rate are the main socio-demographic factors influencing the use of transport modes. It tends to qualify the case of local area specifics determinants may vary according to the context and region. However, their research was a quantitative study and did not distinguish transport modes but generalized the modes as private transport modes and public transport modes. Their findings, therefore, points to the socio-demographic factors influencing the use of transport modes in the context of a developing country which informed the case of Kisumu.

This study sought to fill the research gap by looking at these factors from the grass root level in a sub-Sahara African city context to ascertain the findings by Heinen, van Wee, and Maat (2010); Snellen (1999); Barberan, de Abreu e Silva, and Monzon (2017); Madhuwanthi, Marasinghe, Rajapakse, Dharmawansa, and Nomura (2016). Furthermore, this was an opportunity to add to the body of knowledge and few studies that have been done in the East African cities on NMT. The difference in natural, built environment and culture contexts also are issues that could not be overlooked when analysing the factors. Therefore, it is clear the relationship that exists between socio-demographic factors and mode use is context-specific in the developed and developing cities.

Socio-demographic characteristics are dynamic, and some such as family type, household type, education level, income level etc. are classified based on the context of the study area. They may also vary depending on the context of whether the study is in the Global North city or the Global South city. Therefore, any socio-demographic factor specific conclusions are based on the context of the study area and methodology applied to understand the factors. It made it essential to consider unearthing how socio-demographic factors influence the use of transport modes in Kisumu.

2.2.2. Built Environment Factors Influencing Mode Choice

Built environment factors include urban form variables like city size, city shape, etc. Other built environment characteristics are accessibility to activities, density, roadway design, land use mix etc. Crane (2000) reviewed the influence of urban form on travel but could only conclude that understanding of the complex group of relationships remains tentative. It means that although some relationship between land use and travel especially density and trip length are evident, it becomes complex upon closer examination. The review further reveals that little evidence exists specifying how the built environment factors can solidly influence the use of transport modes and more need to be known. On another front, Boarnet and Crane (2001) statistical regression analysis study advance some proof that street patterns and economic agglomerations are associated with fewer non-work automobile trips but only when residential location and geographical scale are included in the statistical analysis. It suggests further research opportunities by those analysing these variables spatially.

Snellen (1999) looked at the relationship between urban form and activity patterns in nine Dutch cities and found out that despite density being a spatial factor and supporting the notion of higher densities favour non-motorised modes and public transport, it did not influence the use of transport modes for this case. In

this Dutch case, medium density favoured NMT, and housing density did not prove to be significant. However, the location of the household regarding services which is also a crucial spatial variable significantly influenced transport mode use (i.e. mode choice) especially with the increase in distance. Another important spatial variable which the Dutch study found to be of significant influence on mode choice is the roadway design especially the neighbourhood and local street level. The Dutch case differed in context with the Kisumu case regarding the culture, natural environment, built environment and all related policies. For example, their road network system is highly developed compared to the Kisumu case. Other issues that differed were the scale of analysis, the strength of the evidence and the causality of relationships mentioned in the study. It means that the literature was only used as a guide in choosing variables for the case of Kisumu particularly characteristics of the built environment which influence mode choice, but some contrary findings were anticipated.

Winters, Brauer, Setton, and Teschke (2010) employed a novel methodology (i.e. multilevel logistic regression model) tailored to NMT (i.e. likelihood that a trip was made by bicycle) to show how built environment influences on healthy transportation choices and evidenced that the built environment influenced decisions to use NTM instead of MTM. The study considered trip distance and personal demographics of the survey data from the Metro Vancouver region. Since they found out that there is increased cycling with less hilliness, less major roads and highways; higher intersection density; presence of cycling specific infrastructure such as traffic calming, signage, road marking etc; more neighbourhood commercial, educational and industrial land uses; and higher population density were important within each of the spatial zones, it was interesting to see what is the case of Kisumu because of the different spatial configuration and context. Therefore, it was necessary to conceptualise built environment factors such as availability of NMT infrastructure, roadway design, quality of roads in the neighbourhood etc. that could be influencing mode choice (i.e. transport mode use) in the city of Kisumu as advanced in the literature.

2.2.3. Attitudinal and Perceptions Factors Influencing Mode Choice

Attitudes and perceptions factors are mental or psychological representation characteristics influencing mode choice by individuals such as safety of the trip, cost of transport, comfort etc. when intending to use a transport mode. People's attitudes and perceptions towards NMT and MTM also have major effects on modal shares (Bedadala & Mallikarjuna, 2016).

In their overview of the literature on commuting by NMT, specifically bicycle, Heinen et al. (2010) found out that cost, travel time, the effort needed and safety of the trip are of great value for bicycle users. These determinants are important for people's decisions about mode choice especially taking individuals in identical situations and in the same socioeconomic groups choosing to travel using different transport modes (NMT and MTM). While looking at attitudinal and perception factors were of paramount importance to this case of Kisumu, the context was different with the cases reviewed by Heinen et al. (2010), and different findings anticipated out of the Kisumu case was of particular interest. It was because of the government actions that had been brought out by Alando, Scheiner and Zuidgeest (2014) and Alando and Scheiner (2016) highlighted in section 1.2.

Ponnuswamy and Anantharajan (1993) in their study of the attitude of users about various transport modes in an Indian City found out that when an individual is faced with several alternative modes, they do not necessarily choose the mode which would give them the higher level of satisfaction, maybe because of their socioeconomic status. In their case, time and comfort factors were found to influence the mode choice to the extent that an individual was willing to pay more if these two respects were met. This information can be used to forecast future trends in modal choice and transportation policies can be aligned to the changing trends. It was to suffice the Kisumu case if the prevailing conditions are known and a modelling fit for the situation is performed.

2.2.4. Trip-related Factors Influencing Mode Choice

According to Bedadala and Mallikarjuna (2016), the essential trip related factors influencing mode choice are trip distance or travel time and the purpose of the trip. The study claims that in Asia and Africa, NMT is mainly primary transport modes, but in America, NMT like a bicycle is mainly used as a recreational mode. The study further claims that in countries like the Netherlands and Denmark, there are mixed uses of NMT. Rahul and Verma (2013) in their study of the impact of various influencing factors on mode choice found out that households in high-income bracket and vehicle owners had a less affinity to walk and cycle in the city of Bangalore. Also, school trips had a positive likelihood compared with commuting in choosing walk mode. While the weight of these factors may vary, these findings gave insight and credence on the variables selected for the case of Kisumu, but a contrary finding was not ruled out because of the difference in the context concerning prevailing cultural, social, economic and political conditions.

2.3. Review of Methods

The interactions between people, land and urban systems can be understood using various methods. In this sphere of thought, determining the changes in the use of transport modes and the underlying factors influencing the changes like the Kisumu case calls for some methods or techniques and tools to be employed. The methods or techniques and tools are used to help quantify the change and identify the factors influencing the changes in mode choice. The methods or techniques can be qualitative methods (QUAL) or quantitative methods (QUAN), or both also known as a mixed method (QUAL+QUAN). Therefore, in reviewing the literature of the methods or techniques and tools that could help bring a clear understanding in the case of Kisumu, issues to do with travel data collection methods, mixed statistical methods and geographical information system (GIS) analysis methods were reviewed as explained below:

2.3.1. Travel Data Collection Methods

Traditional travel data collections such as face-to-face interviews, paper surveys, telephone surveys provide advantages as well as disadvantages. Some of the merits as pointed out by Shafique and Hato (2015) are good response rates, easy to explain questions to the respondents, etc. Computer-assisted methods are replacing the traditional methods because the former is costlier and more time-consuming. Due to the pressing needs for a more in-depth understanding of travel behaviour and mode choice, many researchers are employing computer-assisted methods. It is the case of Kagerbauer, Hilgert, Schroeder and Vortisch (2015) who developed a web-based questionnaire to survey intermodal trips which resulted in intermodal trip information and could also form the basis of intermodal mode choice model.

Also, Stopher and Greaves (2007) emphasise the need to shift from traditional diary surveys commonly used for household travel surveys. It is because it relied on telephone contact for the recruitment and retrieval of data. Its other disadvantages included increasing nonresponse rates, increasing survey costs, new issues about the quality and appropriateness of the data obtained from the surveys. They suggested a paradigm shift from diary surveys to more extensive use of GPS devices which are more accurate. These insights underscored the need to employ a hybrid method (i.e. partly paper-based, and computer-based; like paper-based and Kobo Collect questionnaire) to bridge the gap in the shortcomings of both methods.

2.3.2. Qualitative and Quantitative Statistical Methods

To understand how factors of travel behaviour influence transport mode choice, Madhuwanthi et al. (2016) employed a quantitative technique of descriptive factor analysis. They carried out a survey using questionnaires to collect data on the characteristics of the trip maker, characteristics of the journey and characteristics of the transportation facility. In their study design, they used the 11 (eleven) administrative units of the study area as their sampling frame. To arrive at the sample size, they used Slovin's formula

(Madhuwanthi et al., 2016). In primary data collection, the questionnaire was preformatted into parts of social demographics characteristic of the subjects, travel behaviour of the subjects and factors affecting to choose the mode for travelling. Such quantitative techniques among others gave insight into the case study under consideration. It called for customisation to suit the appropriate data collection instruments and tools employed. Such data require statistical (i.e. Chi-Square analysis) analysis to help understand how the specific variables are related to mode choice. Other advantages that come into play are: because the method able to collect data from reasonable sample size, it is easy to generalise the findings; statistical methods makes the analysis reliable, standardised and appropriate for systematic comparisons. Therefore, further analysis using other methods and applications is possible. On the flip side, the advantages of the mixed method were taken into consideration. It is as employed in the case of understanding the factors influencing public transport mode choice in Taiwan by Liu (2017).

2.3.3. GIS Analysis Methods

The non-existence of transport infrastructure and services in the city like Kisumu can be analysed and understood better by employing the right Geographical Information System (GIS) tools. It was to reveal the disparity in the lower administrative units experiencing under-investment in transport infrastructure being over-stretched by high demographic growth and urban sprawl (Andreasen & Møller-Jensen, 2017).
GIS analysis tools can help in bringing out the spatial distribution in the mode use characteristics of the households. The information from GIS analysis can be useful to see a variation of NTM and MTM use at the neighbourhoods level. The analysis maps make it easy for all to know and understand what is happening in geographic space to plan a course of action as explained by Winters, Brauer, Setton, and Teschke (2013); Krenn, Oja, and Titze (2015). The analysis enables the presentation of detailed information about one or more lower administrative levels like the Kisumu case hence enhancing proper interpretation of facts. Such information can also be used to motivate decision makers to mobilise and allocate resources for investment in NTM-specific infrastructure and facilities as well as an evaluation tool for the development of NTM-friendly transport environment (Servaas, 2000).

Table 2-1: Summary of review of other studies done by various researchers.

Researcher(s)	Year	Factors Studied	Methodology Used	Key Findings
Kuppam et al.	1999	SDF, A & PF	Multinomial Logit Models	The omission of attitudinal and perception variables may lead to serious problems
Sanches & Arruda	2002	SDF & TF	Binary Choice Logit Model	Increase in trip length decreases the probability of choosing to walk
Plaut	2005	SDF & TF	Logit Analysis	The reduced likelihood of using NMT is associated with a higher salary, car ownership, etc.
Kerr et al.	2007	SDF & BEF	Logistic Regression Analyses	Association between urban form variables and walking is more significant in households with more cars and high income
Yang et al.	2010	A & PF, TF	Odd ratio statistics & Binomial Logit (BL) Models	Convenience is the most significant among bicycle-related perceived benefits and trip distance is negatively correlated with cycling

*Socio-demographic factors (SDF), *Attitudinal and Perception Factors (A & PF), *Trip-related Factors (TF), *Built Environment Factors (BEF)

2.4. Conceptual Framework

From the reviewed literature, it is noticeable that there is a substantial amount of literature on studies done on this subject in other jurisdictions (Bangalore-India, Sri Lanka, Netherlands etc.). It is also evident that there are several categories of factors that influence mode choice. The conceptual framework identified the major categories of factors influencing mode choice as socio-demographic factors, built environment factors, Trip-related factors, attitudinal and perception factors. In this case, it identified the main types of factors in each category as conceptualised in figure 2-1. The influence of these factors on mode choice (i.e. the use of transport modes) as conceptualised in figure 2-1 are discussed in the reviewed literature and summarised in table 2-1.

The four identified categories of factors influencing mode choice often interact with each other, and it is difficult to separate the influence or effect of one from another. For example, an educated professional of a particular age group who lives in some high-end apartment in a densely populated neighbourhood of a city and owns a car prefer to commute to work; forming an interaction between and within categories, with a change in mode choice in the middle (figure 2-1). While it is essential to recognise the interaction between and within categories, however, the critical issue is how do the socio-demographic, built environment, attitudinal and perception factors influence mode choice, particularly in Kisumu. It is important because some studies summarised in this review especially the few reviewed studies from the developing cities do not explicitly say how some socio-demographic factors like gender, household type etc. influence mode choice. It was, therefore, an opportunity to fill the missing knowledge gap.

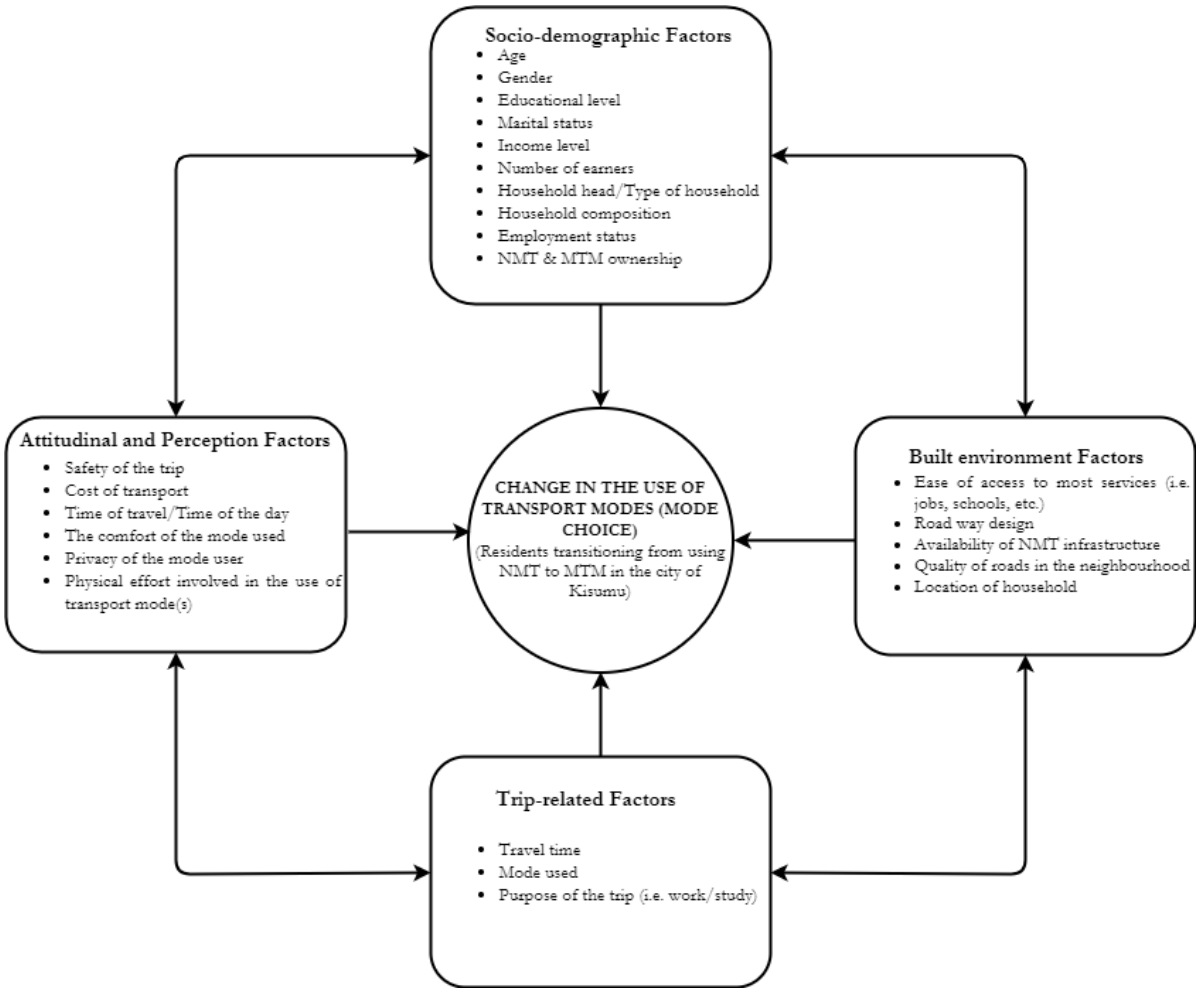


Figure 2-1: Conceptual framework.

Thus, while Alando et al. (2014) used a retrospective survey to obtain data for their study, this study developed a travel survey questionnaire to collect data on socio-demographic characteristics, built-environment characteristics, trip-related characteristics, attitudinal and perception characteristics. It was to help investigate the determinants of the changes in the use of transport modes in Kisumu and the underlying factors influencing these changes as explained in the methodology chapter 3.

3. METHODOLOGY

To investigate the determinants of the changes in the use of transport modes and the underlying factors influencing the changes in Kisumu, a household travel survey questionnaire was developed to aid in collecting data. In this case, the chapter presents a step by step explanation of the research methodology. Section 3.1 narrates research approach and adopted methods. A description of the study area and the rationale behind its selection, sampling strategy and how the sample size was arrived at is also explained in section 3.1. Section 3.2 explains the primary and secondary data collection process and instruments. The post-fieldwork data processing and statistical methods used in arriving at the results are explained in section 3.2. The chapter concludes by giving an overview of the research design matrix in section 3.3 with the specific objectives, research questions, required data and sources, required software for analysis, data analysis methods and anticipated results as the mains points tabulated.

3.1. Research Approach and Adopted Methods

The primary data collection method employed was a hybrid method (i.e. partly paper-based, and computer-based using Kobo Collect) to bridge the gap in the shortcomings of both methods. A travel survey questionnaire was designed to ensure socio-demographic, built environment, trip-related, attitudinal and perception characteristics data were collected from individual household members who travel to an activity (i.e. work/study) at least three days a week and are residents of the study area sub-locations of Kogony, Migosi and Nyalenda "A" in the city of Kisumu.

The questionnaire incorporated mainly quantitative and one qualitative question (i.e. QUAN+QUAL questions). The quantitative questions were mainly to collect socio-demographic, built environment, trip-related, attitudinal and perception characteristics information of the study area population. On the other hand, the qualitative follow-up question was to explore the reasons behind the respondent change of mode of transport. The questionnaire (see appendix 1) was also designed to ensure that the data collected were the characteristics describing the four main components (i.e. socio-demographic, built environment, trip-related, attitudinal and perception factors) explained in the conceptual framework (figure 2-1) and to address the overall research objective.

3.1.1. Study Area

The study area was the three sub-locations of Kogony, Migosi and Nyalenda "A" in the city of Kisumu located in the western part of Kenya as shown in figure 3-1. The three sub-locations were purposively selected and taken as the first clustering level based on the Kenya National Bureau Of Statistics (2017) household economic survey report classifying such neighbourhoods into low, middle and high-income level residential neighbourhoods. It allowed the researcher to investigate and discuss the study findings within the perspective of existing specific administrative boundaries. This was also to bring out specific socio-economic, transport and travel behaviour conditions of the households in the three sub-locations.

Kisumu is one of the 47 Counties in Kenya and stands on the shores of Lake Victoria, at an altitude of 1160m above sea level. It is situated within latitudes 0° 20'South of the equator and 34° 45' East of Greenwich. Kisumu county covers a total land area of 2,009.5 km² and another 567 km² covered by water. The city where the study area lies covers an area of approximately 417 Km², of which 297 Km² is dry land and approximately 120 Km² under water.

Kisumu is the third largest city in Kenya as well as the capital of Kisumu County. It has developed progressively from a railway terminus and internal port in 1901, to become the leading commercial or trading, industrial, communication and administrative centre in the Lake Victoria basin covering the three major East African Community countries of Kenya, Uganda and Tanzania. Kisumu was selected as a study

area because geographically it connects these three major East Africa Community countries. It makes it the hub of the East Africa Community regarding transport (Kisumu County Government, 2013).

The county is well serviced by road network with a total length of tarmac road being 286km. The other are link roads being gravel surface (725.6km) and earth surface (956.6km). The city is traversed by the main trunk road linking Nairobi to Kampala in Uganda through Busia. There is also an important road that links Kisumu to Tanzania through Kisii. An alternative route to Tanzania from Kisumu is through Homa Bay and by water using ferry or boat. Besides these major highways, several tarmac roads are linking the city to Western Kenya towns like Kakamega, Nandi Hill, Kapsabet, Eldoret, Bungoma, Siaya and Kitale among others (Kisumu County Government, 2013). The road network well services the three-study area sub-locations. Nyalenda "A" is considered a low-income neighbourhood with a majority of residents classified as low-income earners while those living in Kogony and Migosi neighbourhoods are classified as middle and high-income earners respectively (Kenya National Bureau of Statistics, 2017).

According to the 2009 Population and Housing Census, the population of Kisumu county was estimated at 968,909 persons with 474,687 males and 494,222 females. Kisumu county has seven constituencies namely: Kisumu East, Kisumu West, Kisumu Central, Seme, Nyando, Muhoroni and Nyakach and 35 wards. The city is divided into seven administrative locations and 12 sub-locations. As of the 2009 Population and Housing Census, the 12 sub-locations had a population of 197,033 persons, and the study area had 51,899 persons as shown in table 3-1 (Kenya National Bureau of Statistics, 2010).

Table 3-1: Study area population.

Name of Sub-location	Male	Female	Total	Households
Kogony	7,099	6,827	13,926	3,815
Migosi	6,755	7,516	14,271	3,287
Nyalenda "A"	12,443	11,249	23,692	7,020
Total	**15,057**	**15,276**	**51,899**	**14,122**

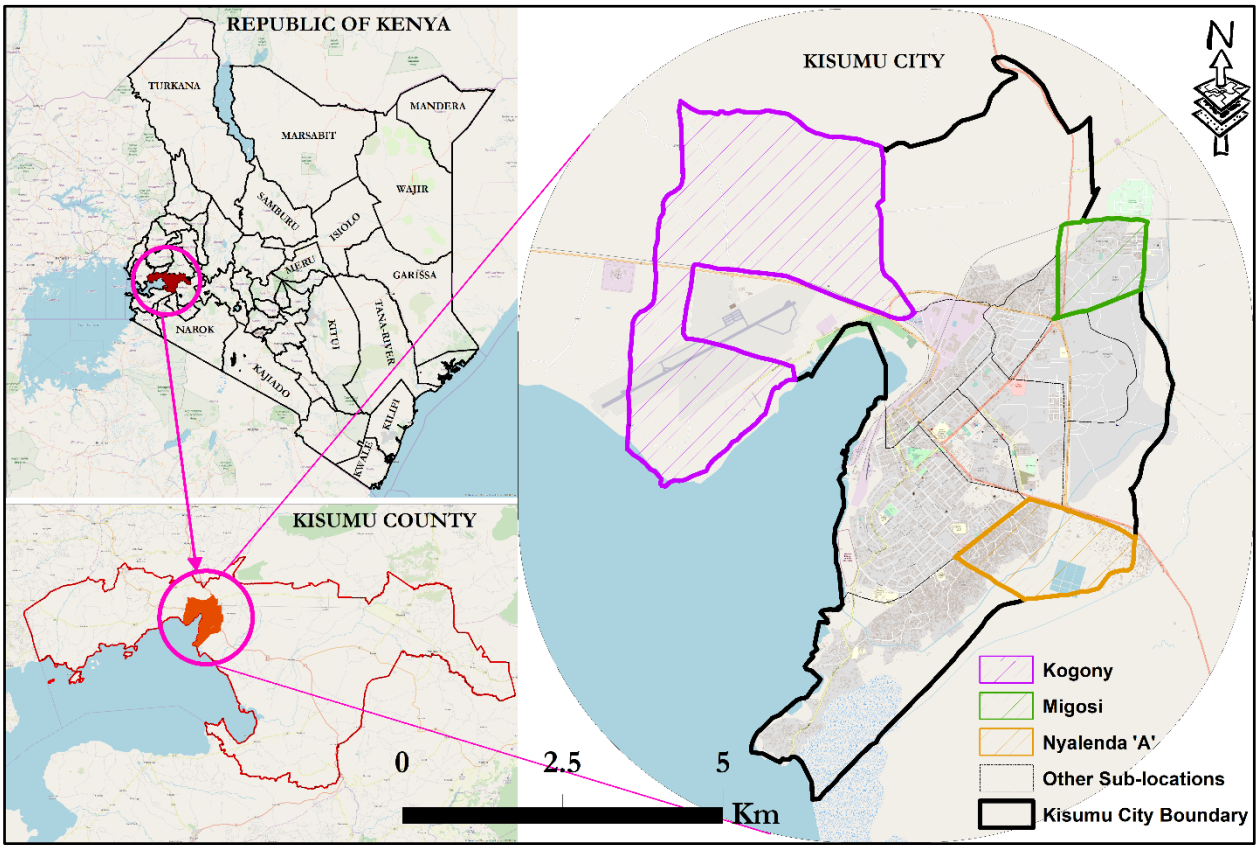


Figure 3-1: Study area.

3.1.2. Sampling Strategy and Sample Size

These are specific processes determined before any data is collected to obtain an optimum sample from a given population and study area (Kothari, 2004). The cluster sampling method was used in this study because of the large population in the study area. It made the work of the researcher and his field assistants less expensive to identify each sampling unit. In this case, the first clustering level was according to the study area sub-locations for purposive selection of the three-study area sub-locations. The second clustering level was defined by the roads within neighbourhoods in the three sub-locations. Each of these three sub-locations could be described to have households with similar socio-economic characteristics that informed the clustering. It was, therefore, deemed relevant by the researcher for ease of subsequent travel behaviour analysis. Built-up boundaries were taken as the limits of the cluster in cases where roads did not either exist or reached a dead end like Nyalenda "A".

Households residing in houses within the second clustering level constituted the sampling frame for sampling the individual members of households who were the respondents of the travel survey questionnaire. Therefore, to obtain a sample size shown in table 3-2, the following Slovin's formula was used to determine the minimum number of households that were necessary to carry out a representative study (Madhuwanthi et al., 2016):

$$n = \frac{\mathrm{N}}{(1 + \mathrm{NE}^2)}$$

Where;

$n =$ sample size

$N =$ population size (i.e. the total number of households)

$E =$ error tolerance.

Thus, considering a confidence level of 95% (i.e. precision) implied the margin of error of 5%, the minimum, optimum sample size was:

$$n = \frac{14{,}122}{\left(1 + (14{,}122 \times 0.05^2)\right)}$$
$$\approx 389$$

Each sub-location sample size (table 3-2) was arrived at by using the following Kothari (2004) formula:

$$\frac{\mathrm{n}}{N} \times p$$

Where;

$p =$ number of households in the sub-location. For example; Kogony sample size

$$= \frac{389}{14{,}122} \times 3{,}815$$
$$= 105$$

Table 3-2: Sample size per sub-location.

Name of Sub-location	Male	Female	Total	Households	Sample size
Kogony	7,099	6,827	13,926	3,815	105
Migosi	6,755	7,516	14,271	3,287	91
Nyalenda "A"	12,443	11,249	23,692	7,020	193
Total	**15,057**	**15,276**	**51,899**	**14,122**	**389**

Further to this, systematic sampling was used to identify each household where the travel survey questionnaire was administered. A street was identified within each neighbourhood in the three sub-locations after the second level clustering and a household were selected as the starting point for administering the questionnaire. The starting point was marked on the field map to take care of a situation where there could be a need to retrace any household later. The researcher then skipped the next nine households and administered the travel survey questionnaire in the tenth, twentieth households etc. until the required sample size was reached and achieved. The required sample size is as indicated in table 3-2.

3.2. Primary and Secondary Data Collection

Data for this study were collected from primary sources and secondary sources. Secondary data was collected from the Kisumu county government lands and physical planning office. Secondary data was mainly spatial data of existing Kisumu city roads network. The following steps below aided in primary data collection.

3.2.1. Field Assistants Training and Pilot Survey

Primary data was collected by six field assistants (four male and two female). The field assistants were recruited with the help of a research assistant whose help was brought in by the researcher. The research assistant is a lecturer at the school of planning and architecture of Maseno University. Four of the recruited field assistants were final year undergraduate Urban and Regional Planning students at the same university (three male and one female). The other female and male field assistants were final years undergraduate students of Disaster Risk Management at the school of planning and architecture of Maseno University and Building Construction Engineering at Pwani University respectively. The idea behind bringing on board research assistant and recruiting such calibre of field assistants was to tap into the primary data collection knowledge and experience they have of the study area. It was also to ensure that the assistants know the phenomenon being studied and practical hands-on research projects data collection experience.

The field assistants were trained on the 3rd of December 2018 on data collection ethics, hybrid data collection system (using both paper-based and computer-based questionnaire) and how to navigate the Kobo Collect application used in primary data collection. The training was to discuss the questionnaire, provide understanding and ensure data collected were of the desired quality. The researcher, research assistant and the field assistants brainstormed on how to bring an understanding of the questions in the local languages (Kiswahili and Dholuo) to create common grounds and ensure consistency in data collection. Each question was looked at to come up with a strategy on how to approach the questions to ensure the respondents understood and gave the right responses. The field assistants were paired according to their local knowledge of the study area to be ready for the pilot study the following day for one hour. After the piloting, a brief meeting was held to adjust the questionnaire, and some questions were rearranged in response to some responses from the pilot study.

3.2.2. Travel Survey Questionnaire Administration

Data from primary sources was collected using questionnaires administered through hybrid method (i.e. partly paper-based and computer-based, i.e. Kobo Collect) with the help of field assistants. It is what Kothari (2004) and Kumar (2011) refer to as an interview schedule because most sections of the study population are clustered over geographical administrative areas, and some respondents were not capable of answering the questions without an understanding and interpretation into the local dialects or languages (i.e. Kiswahili or Dholuo).

After obtaining consent for participation in the travel survey, respondents were sampled using systematic sampling as explained in section 3.1.2. These were residents of the city of Kisumu that travel to an activity (i.e. work/study) at least three days in a week and live in the three-study area sub-locations shown in figure 3-2 (i), (ii) and (iii). This criterion was spelt out and structured in the questionnaire to ensure the data collected was from the intended target group. It took the form of the first three questions in the questionnaire (see appendix 1). The other questions covered vital questions in the study on socio-demographic (i.e. gender, age, educational level, employment status, household head/type, marital status, household composition, NTM and MTM ownership, number of earners in household, household income), built environment (i.e. ease of access to most services, roadway design, availability of NTM infrastructure, quality of roads in the neighbourhood), trip-related (i.e. present and past mode use, travel time, purpose of the trip-work/study), attitudinal and perception characteristics (i.e. safety of the trip, cost of transport, time of travel, physical effort involved in the use of transport mode) as captured in appendix 1.

Twenty-one questions were closed-ended; one question was both closed-ended and open-ended. Closed-ended question try to restrict the respondents to select predefined fixed options while open-ended questions allow the interviewee to give their own opinions to the specific question (Bryman, 2012). The open-ended part of the question was to find out other reasons that led to the respondent change of transport mode. It was part of the responsibility of the researcher to make meaning out of the part on the question to facilitate clear interpretation. Other two questions were point location questions meant to capture respondents' households and workplace locations (geocoded). A total of 415 questionnaires were administered and responded to in the three-study area sub-locations as shown in figure 3-2 (i), (ii) and (iii). A summary of the collected data variables and attribute levels is given in table 3-3.

For the question of capturing the GPS location coordinates of the work/study location of respondents, it was not possible because ArcGIS could not work as the researcher was out of Eduroam wi-fi server connection to enable the researcher to load base maps for the point location. The remedy taken was to write down the names, and the addresses of the buildings where they work or nearest buildings or landmarks to where they work/study for those who are not based in offices. The researcher was to locate the GPS coordinates using GPS essentials software at the end of the day when verifying collected data for the day. The question was to help produce origin (i.e. household point locations) and destination (i.e. work/study point locations) matrix for the respondents. This question was, therefore, decided not to be part of the analysis. Its exclusion has affected objective three of the research which was mainly spatial analysis. This objective was therefore revised to suit the analysis of the collected household point locations data collected, the 44 digitised work/study destinations and the primary objective of the research. It was to map the household point locations in terms of transport mode used and the 44 digitised work/study locations to see if there is a clear pattern.

Table 3-3: Collected data variables and attribute level/dataset.

Variable	**Dataset**
Sub-location	Nominal data
Gender Household head/type Age	Categorical data
Marital status	
Household composition	Ratio/scale data
Employment status Respondent monthly income level	Categorical data
Estimated household monthly income	Ratio/scale data
Number of household members earning income	Ratio/scale data
Educational level	Categorical data
NTM & MTM ownership	Nominal data
Year individual changed mode Reasons that led to the change	Categorical data
Ease of access to most services (e.g. health facilities, educational institutions, supermarkets etc.) Availability of NMT infrastructure (pedestrian paths, cycling lanes, etc.)	Categorical data
Roadway design Quality of roads in the neighbourhood	Categorical data
Existing road network data	Spatial data
Household locations	Spatial data
46 work/study locations (digitised from google earth)	Spatial data
Present and past mode use	Nominal data
Travel time Purpose of the trip (i.e. work/study)	Categorical data

Safety of the trip Cost of transport Time of travel Physical effort involved in the use of transport mode(s)	Categorical data

i. Nyalenda "A"

ii. Kogony

iii. Migosi

Figure 3-2: Travel survey questionnaire administration process.

3.2.3. Ethical Considerations

Ethical issues discussed by Bryman (2012) related to integrity of a research such as informed consent, invasion of privacy and deception, any harm that might come to the participant, confidentiality, security and seeking permission from the relevant authorities to gain access to the field were critical to this research to help to get the information required. Before embarking on field work, permission was sought from the National Commission for Science, Technology and Innovation (NACOSTI). It is the government body that is mandated by law to authorise and issue permits on all research activities being carried out in Kenya. It was done by obtaining an introduction letter from ITC Faculty, the University of Twente explaining the purpose of the research. An application for research permit was made to NACOSTI through their online system. The permit for the period ending 12th December 2018 and a letter was issued to seek further clearance from the County Commissioner, the County Director of Education-Kisumu County and the County Government of Kisumu (see appendix 7). In this line, field assistants were trained to seek informed consent of respondents by making them aware of the type of information required from them, why the information is being sought, explaining to them the purpose of the research, how they were expected to participate, how it will directly or indirectly affect them (explained in section 3.2.1). The field assistants were also trained to explain to the respondents that the survey was a voluntary exercise and they were not under

any obligation to participate. A consent letter was signed by the researcher and delivered to the respondents who requested to be acknowledged for participation in the survey. In the whole exercise, the respondents' confidentiality was assured, and they were made aware that their individual identification was not attached to the travel survey questionnaire.

3.2.4. Post Fieldwork Data Processing

The data collected through a paper-based questionnaire was edited to ensure completeness, consistency and readability. It was followed by coding to ensure that the data was ordered in line with the computer-based questionnaire (Kobo Collect) to cure any omissions by either of the data collection methods. The data collected through a paper-based questionnaire was coded into the Microsoft Excel sheet for quality check. The data collected through a computer-based questionnaire was downloaded into a Microsoft Excel sheet for quality check, verification and validation with the data collected through the paper-based questionnaire. Data quality check was done by running a Microsoft Excel pivot table. After a quality check, verification and validation, a new Microsoft excel sheet was created to enter households point locations. A copy was saved in comma-separated values (CSV) and keyhole mark-up language (kml) formats ready to be imported into ArcGIS for analysis. A copy of the data from the Microsoft Excel sheet without households' points locations was imported and coded (i.e. the process of converting data into numeric format) into the Statistical Package for the Social Sciences (SPSS) ready for analysis. Statistical analysis and GIS grouping analysis were then employed to analyse the data collected from the travel survey. It was done using Microsoft Excel, SPSS and ArcGIS/ArcMap application software.

3.2.4.1. Statistical Analysis

After the data coding using code scheme (i.e. comprehensive document containing a detailed description of each variable, items or measures for the variable) created from the questionnaire, quantitative analysis was carried out using statistical analysis techniques. The statistical analysis techniques used were a descriptive analysis and Chi-Square tests of association.

Descriptive analysis is the mathematical explanation, aggregation and illustration of the variables of interests or association between the variables in the collected data. Thus, statistical (i.e. frequency tables, contingency tables, Chi-Square statistics tables etc.) and graphical (i.e. bar charts, column charts etc.) procedures summarising the data in a clear and understandable way is given (Kumar, 2011).

Chi-Square statistic (i.e. the test of independence analysis) is a distribution-free (non-parametric) tool designed to indicate the degree of evidence for an association or judge the significance of a relationship between attributes. It is often supplemented by Cramer's V or phi coefficient strength test to help give more detail information about the variables under study (Mchugh, 2013).

Most of the data collected from the travel survey questionnaire were categorical data. It required the researcher to employ an appropriate analysis method to help unravel the data for proper interpretation. Also, the main objective of this research was to determine the variables that are associated with mode choice in the city of Kisumu. Therefore, Chi-Square and Cramer's V statistics were considered appropriate because of the richness with respect to distribution of data, ease of computation, specific information given by the test, ability to help analyse multiple variables (i.e. for goodness-fit and test of independence) and the data from the travel survey questionnaire did not meet parametric assumptions (Scott, Flaherty, & Currall, 2013; Miller & Siegmund, 2016). Chi-Square statistic takes the general formula given by Bryman (2012):

$$\chi^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where

χ^2 = the cell Chi-Square value

O_{ij} = observed frequency of the cell in the ith row and j column (i.e. age by mode choice variables)

E_{ij} = expected frequency of the cell in the ith row and j column (i.e. age by mode choice variables)
In which case, its use should be hinged on the conditions that; the data are a random sample from the population about which inferences are to be made; all the attributes are a nominal or ordinal (i.e. categorical data), assumption that each item contributes data to only one cell. Therefore, the sum of all cell frequencies in the table must be the same as the number of items in the sample (i.e. each observation is independent of all the others or one observation per subject). Also, the other assumption is that no more than 20% of the expected counts are less than 5 and all individual expected count are 1 or greater.

3.2.4.2. Data Preparation Steps for the Chi-square Tests

To align data with satisfying the above assumptions, the following operations were carried out in SPSS. Continuous variables like the household composition and the number of people earning a living in a household were changed to categorical variables by counting within cases and then coded as shown in appendix 2. A cross-tabulation descriptive statistics counts were carried out to help identify attributes that fall short of having an expected count of less than 5 in the cell, and all individual expected count are 1 or greater. A number of data variables were found to violate the assumption. The different data variables were then collapsed using SPSS by recoding into different variables as shown appendix 3. The Chi-square (χ^2) tests were run based on the hypothesis that there is no significant association or relation between socio-demographic, built environment, trip-related, attitudinal and perception factors and present transport mode use (see appendix 4 for case processing summary and appendix 5 for Chi-Square contingency tables).

3.2.4.3. GIS Analysis

A geographical information system analysis was used to help explore more about how the households' points are clustered to help find out if there is a clear pattern. Grouping households by their present mode choice (i.e. present transport mode use) overlaid with work/study locations and road network to identify areas with similar physical and socio-demographic characteristics. Forty-four work/study locations were digitised from google earth map. These were from the names on work/study locations noted during fieldwork. Not all locations could be found on google earth. The assumption was these are the locations where most households travel to work/study. The output was visualised overlaid with the area-based map from the Environment Systems Research Institute (ESRI) online database.

3.3. Research Design Matrix

Table 3-4 displays the research design matrix to highlight the study specific objectives together with the research questions. Required data is indicated, the data source, the software used for analysis, data analysis methods/techniques and the anticipated results for each research question.

Table 3-4: Research design matrix.

Research Questions	Required Data	Sources of Data	Software Required	Data Analysis Methods	Anticipated Results
Specific objective 1: To identify factors influencing changes in the use of transport modes					
What is known about the factors that influence changes in mode choice?	The literature on factors influencing changes in mode choice	Online library search and review of the literature (secondary data sources)	Google search, Google Scholar, etc.	Content analysis	List of factors influencing changes in mode choice.
What research methods and research strategies have been employed	The literature on methods and research strategies employed in	Online library search and review of the literature (secondary data sources)	Google search, Google Scholar, etc.	Content analysis	Table of research methods which have been

in studying factors influencing mode choice?	studying factors influencing changes in mode choice.				employed in similar studies.
Which factors can be selected and on which basis for studying mode choice in the context of Kisumu?	Selected factors influencing changes in mode choice in Kisumu	Online library search and review of the literature (secondary data)	Google search, Google Scholar, etc.	Content analysis	Key findings of how these factors influence changes in mode choice.
Specific objective 2: To determine the factors influencing the use of transport modes in Kisumu					
Which transport modes are the residents using now (after the change-2018) and which ones were they using before the change?	Mode use variables	Travel survey questionnaire (primary data from fieldwork)	Excel and SPSS	Descriptive statistics analysis	Tables of sample characteristics and charts.
Which transport modes do the residents own now (after the change-2018) and which ones did they own before the change?	Mode(s) owned	Travel survey questionnaire (primary data from fieldwork)	Excel and SPSS	Descriptive statistics analysis	Charts of modal share ownership.
What are the reasons for the change in transport modes	Reasons for change	Travel survey questionnaire (primary data from fieldwork)	Excel and SPSS	Descriptive statistics analysis	Table of reasons for the change
Which factors are influencing the changes in mode choice in Kisumu?	Sample characteristics variables	Travel survey questionnaire (primary data from fieldwork)	SPSS	Chi-Square tests	Contingency tables, Chi-Square statistics.
How is the spatial distribution in the use of different transport modes in the city of Kisumu?	Households point locations, road network and work/study locations	Travel survey questionnaire (primary data from fieldwork)	ArcGIS/ArcMap	Grouping analysis	Map of households' points

4. RESULTS AND DISCUSSION

The primary emphasis of this thesis concerns investigating the determinants of the changes in the use of transport modes and the underlying factors influencing these changes. Therefore, this chapter presents the results and discussion of the analysis of data from the household travel survey.

4.1. Descriptive Statistics Analysis

In exploring the research questions under objectives two and three, the main themes that were identified to base the analysis results were first to descriptively analyse the sample in terms of their socio-demographic, built environment, attitudinal and perception characteristics. The second was to present descriptive statistics of mode choice changes over the years, regarding modal ownership, reasons for the change. In addition, Chi-Square tests of association between mode choice and all variables were undertaken as an attempt to identify factors influencing the changes in the use of transport mode. Figure 4-1 illustrates a schematic overview of the analysis undertaken.

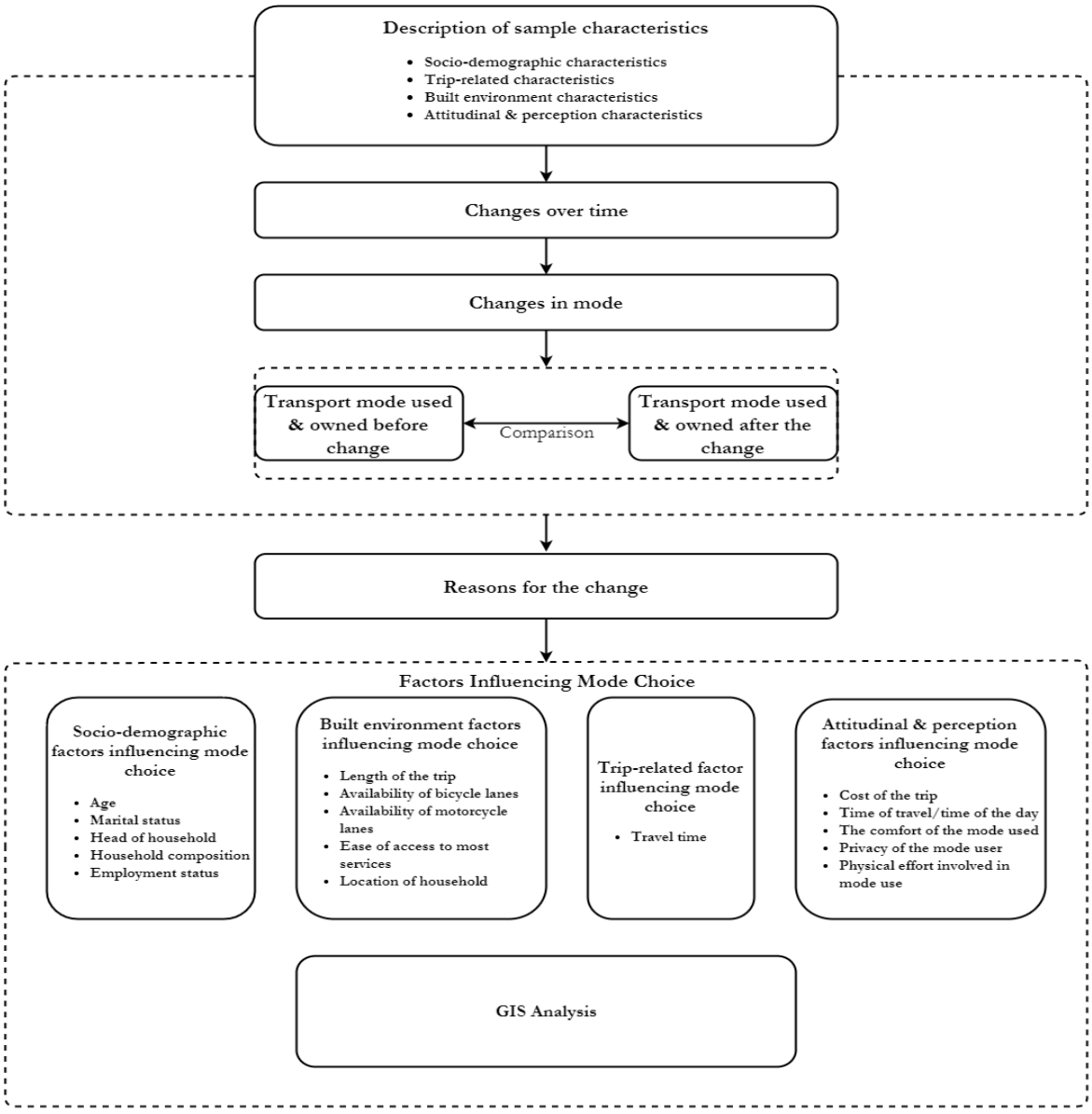


Figure 4-1: Analysis scheme.

4.1.1. Sample Socio-demographic Characteristics

Individual and household characteristics are presented in table 4-1. Results show that female respondents represent more than half of the sample in Kogony and Nyalenda. The middle-aged constituted the majority of the respondents across all the three sub-locations. Most of the respondents had a middle level (high school/secondary level) education. In terms of employment status, most of the respondents in Kogony and Nyalenda were self-employed, whereas in Migosi most of the respondents were in full-time and part-time employment. In Migosi, more interviews were held with household heads than at the other two sub-locations. Most respondents were married and in the lowest income category. Regarding household composition in the three sub-locations, most respondents had family members aged between 20-65 years.

Table 4-1: Sample socio-demographic characteristics

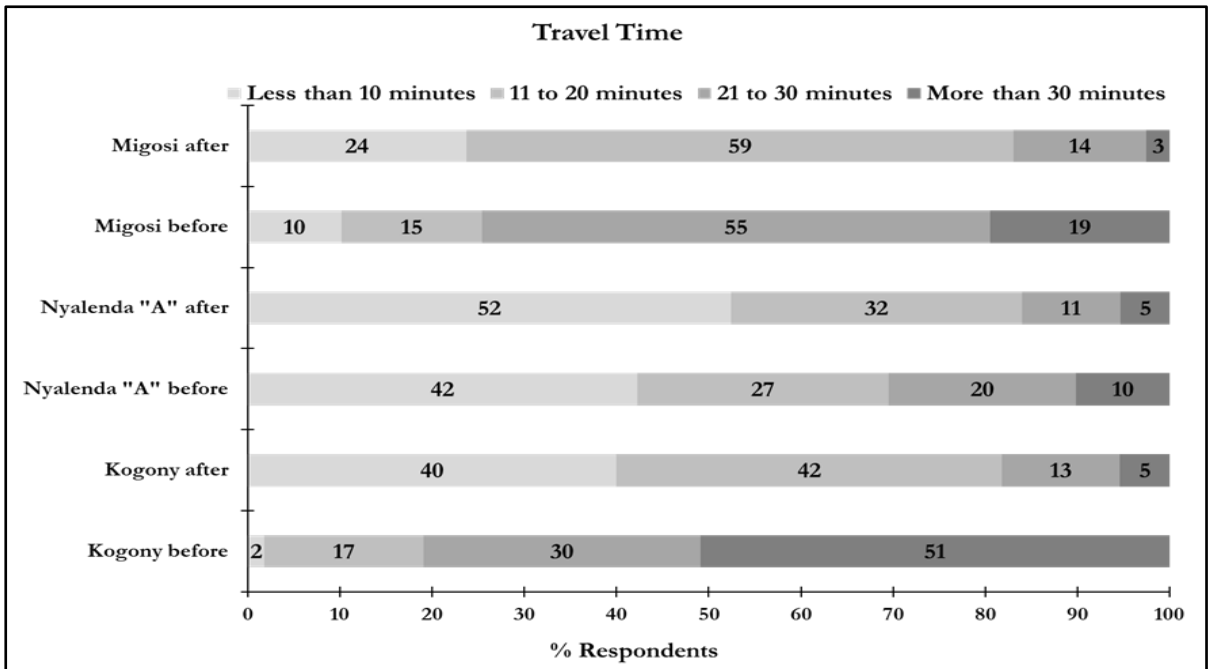
Variables	Kogony n=110 (%)	Nyalenda "A" n=187 (%)	Migosi n=118 (%)
Gender			
Male	40.9	39.6	51.7
Female	59.1	60.4	48.3
Age			
15-19 years	28.2	32.6	32.2
30-49 years	57.3	62.0	46.6
Above 50 years	14.5	5.4	21.2
Educational level			
Low	34.5	35.8	27.1
Middle	58.2	61.5	63.6
High	7.3	2.7	9.3
Employment status			
Employed (full-time and part-time)	14.5	16.0	35.6
Self-employed	59.1	52.4	27.1
Student	10.0	7.5	11.9
Unemployed/Job-seeker/Housewife/ Retired	16.4	24.1	25.4
Head of household			
No	52.7	54.5	40.7
Yes	47.3	45.5	59.3
Marital status			
Single	11.8	23.5	33.1
Married	80.0	71.7	50.8
Divorced/Separated/ Widowed	8.2	4.8	16.1
Income level			
Low	82.7	93.6	73.7
Middle	13.6	5.3	22.0
High	3.7	1.1	4.3
Households/Families having			
Couples with children aged under 2 years	5.9	13.7	5.4
Couples with children aged 2-12 years	24.8	25.4	16.8
Couples with teenagers aged 13-19 years	22.2	19.5	19.3
Adults only aged 20-65 years	46.2	40.7	54.7
Adults only aged over 65 years	0.9	0.7	3.8

4.1.2. Sample Trip-Related Characteristics

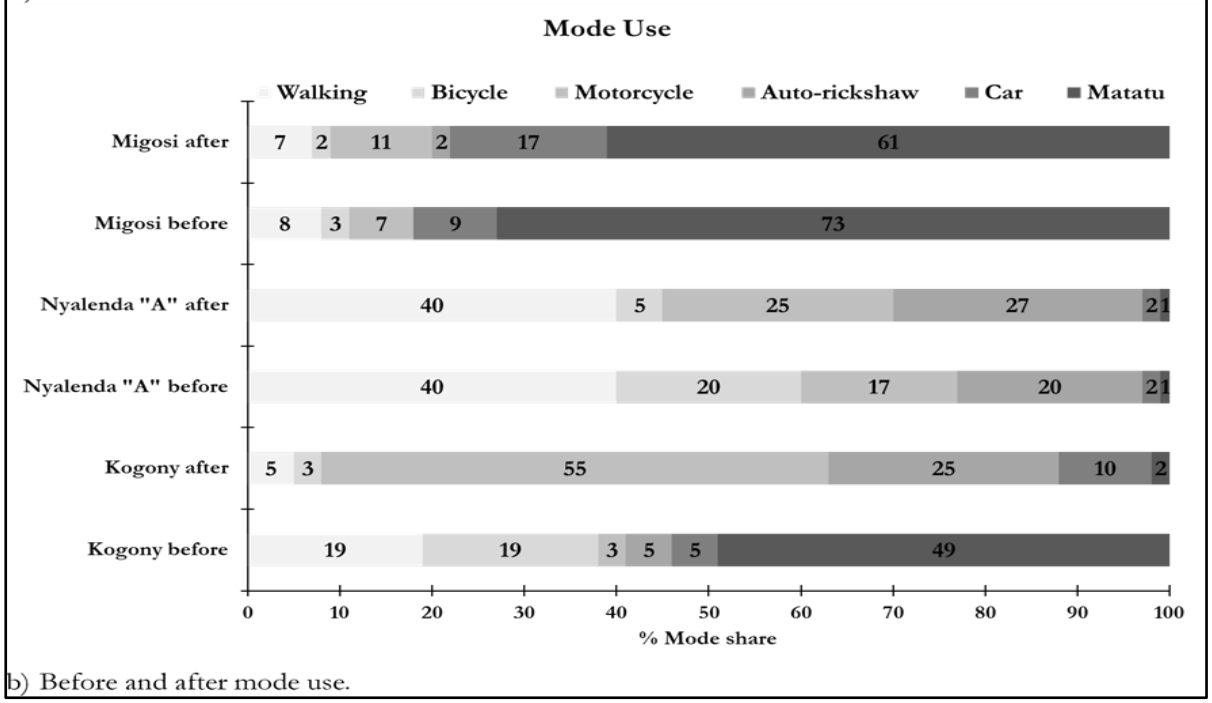
Figure 4-2a and 4-2b show the results of the sample trip-related characteristics which were, travel time and mode used respectively. Overall, most respondents in all the three sub-locations take less time to travel to work/study in the present time than in the past years before they changed their mode. Regarding mode use, in Kogony, most of the respondents were using private cars and matatus before they changed to use mainly motorcycles and auto-rickshaws. It is not the case in Nyalenda "A" where most of the respondents

walk or cycle to work/study destinations like before. Migosi respondents are more reliant on private cars and matatus like before but with a small reduction.

Most respondents take less time to travel to their work/study destination probably because they have changed the transport modes they were using. For example, in Kogony the percentage of the respondents who are using motorcycles and auto-rickshaw increased from before when most respondents were using matatus as shown in figure 4-2b. It points to the finding of Heinen et al. (2010) that travel time affects mode choice. In which case the perceived convenience of a trip in terms of the mode to be used declines with an increase in the travel time. It may also result in expending more effort depending on the mode used. Thus, travel time is an important component of a trip.



a) Before and after travel time.



b) Before and after mode use.

Figure 4-2: Before and after travel time and transport mode use.

4.1.3. Sample Built Environment Characteristics

Built environment-related questions were asked, and respondents answered using a Likert scale ranging from "not at all important" to "extremely important". This scale was re-coded in three categories- "not important", "somewhat important" and "very important". The result shown in figure 4-3 indicates that most of the sample respondents in the three sub-locations consider the design, quality of the roads in the neighbourhood, length of the trip and ease of access to most services as very important elements of the built environment that influences the transport mode they use. The availability of NMT infrastructure (i.e. pedestrian paths and bicycle lanes) and motorcycle lanes is considered very important by most respondents in Kogony and Nyalenda "A", but they are considered somewhat important by Migosi respondents as shown in figure 4-4. It is probably because Migosi respondents use public transport as shown in figure 4-2b. It connects to what Winters et al. (2010) found out that specific built environment elements like availability of NMT infrastructure, the design of roads etc. influenced decisions to cycle instead of driving for the case of Metro Vancouver, Canada.

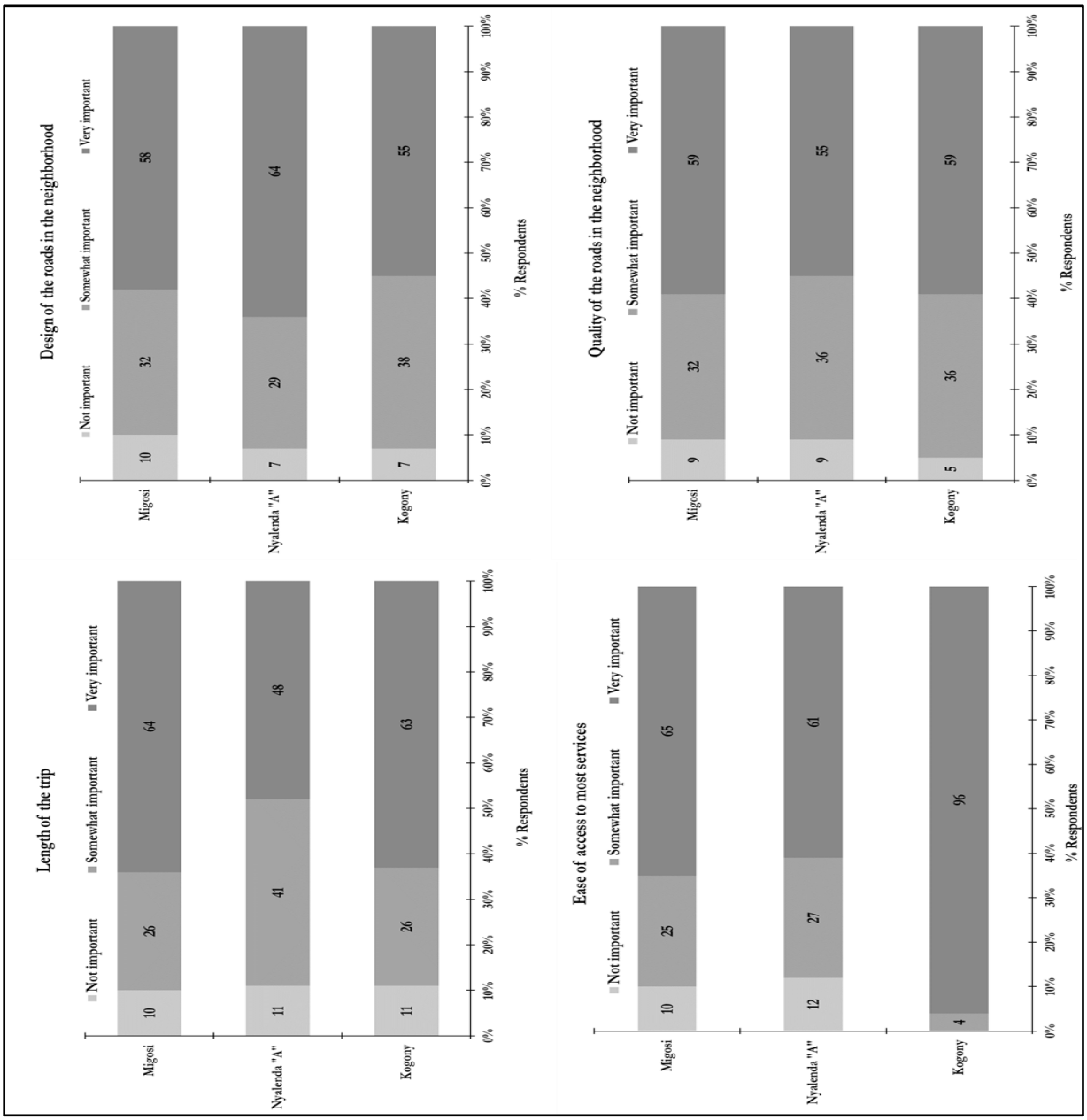


Figure 4-3: Importance of roadway design, quality, trip length and ease of access.

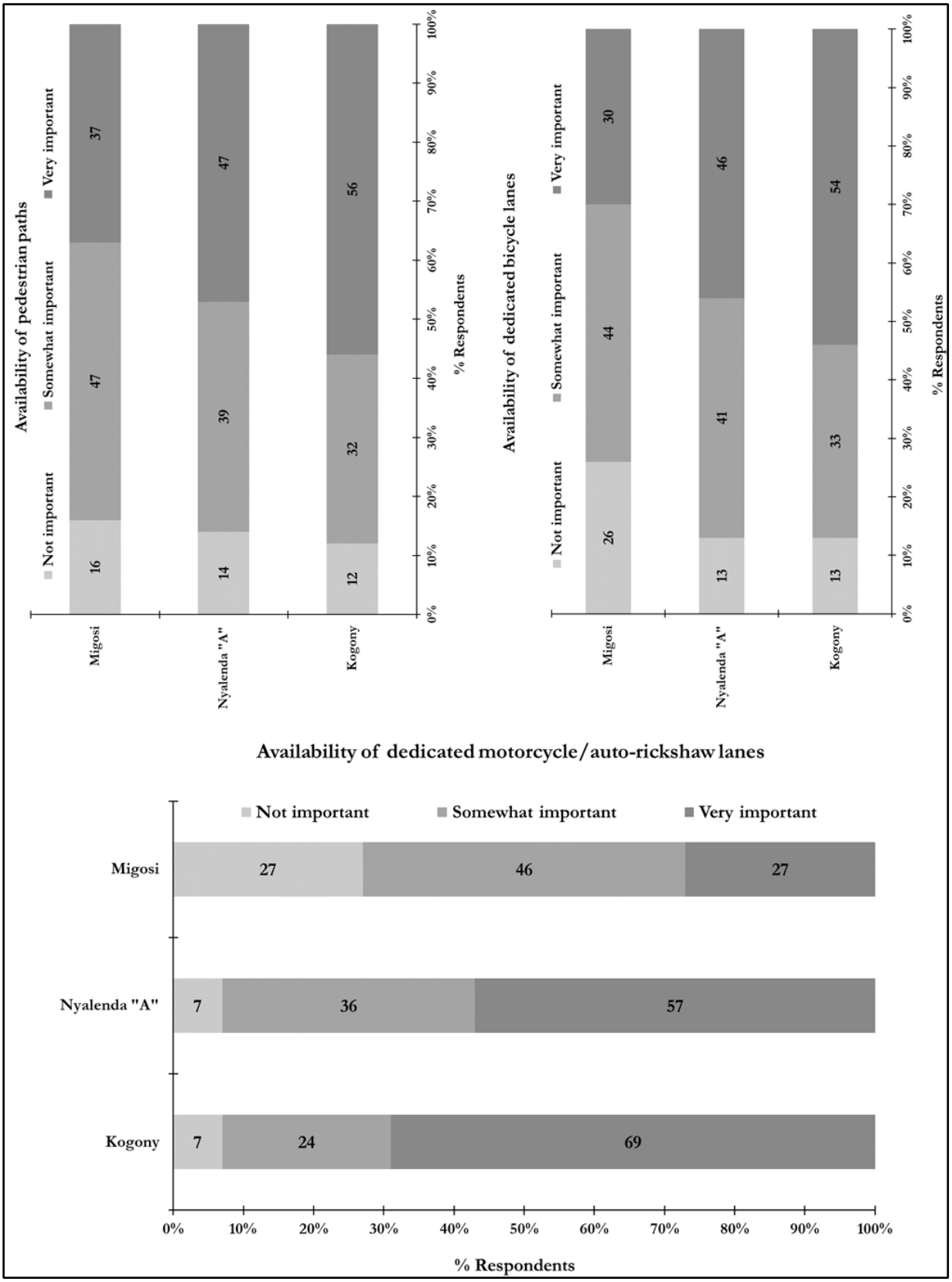


Figure 4-4: Importance of pedestrian paths, bicycle and motorcycle/auto-rickshaw lanes.

4.1.4. Sample Attitudinal and Perception Characteristics

Also, attitudinal and perception-related questions were asked about the mode they refer to, and respondents answered using a Likert scale ranging from "not at all important" to "extremely important" but re-coded to three categories. In figures 4-5 and 4-6, most of the respondents in Kogony and Nyalenda consider the safety of the trip, cost of the trip, time of travel, comfort of the transport mode, privacy of the mode user and physical effort involved in the use of transport mode as very important element before making a choice of transport mode to use to travel to work/study. However, the comfort of the transport mode, privacy of the mode user and physical effort involved scored much less in Migosi. It is probably because Migosi respondents use public transport as reflected earlier (see figure 4-2b). Safety is often mentioned in relation to a heightened risk of having an accident. As pointed out by Heinen et al. (2010) that safety of the trip, cost of the trip, etc. influences mode choice.

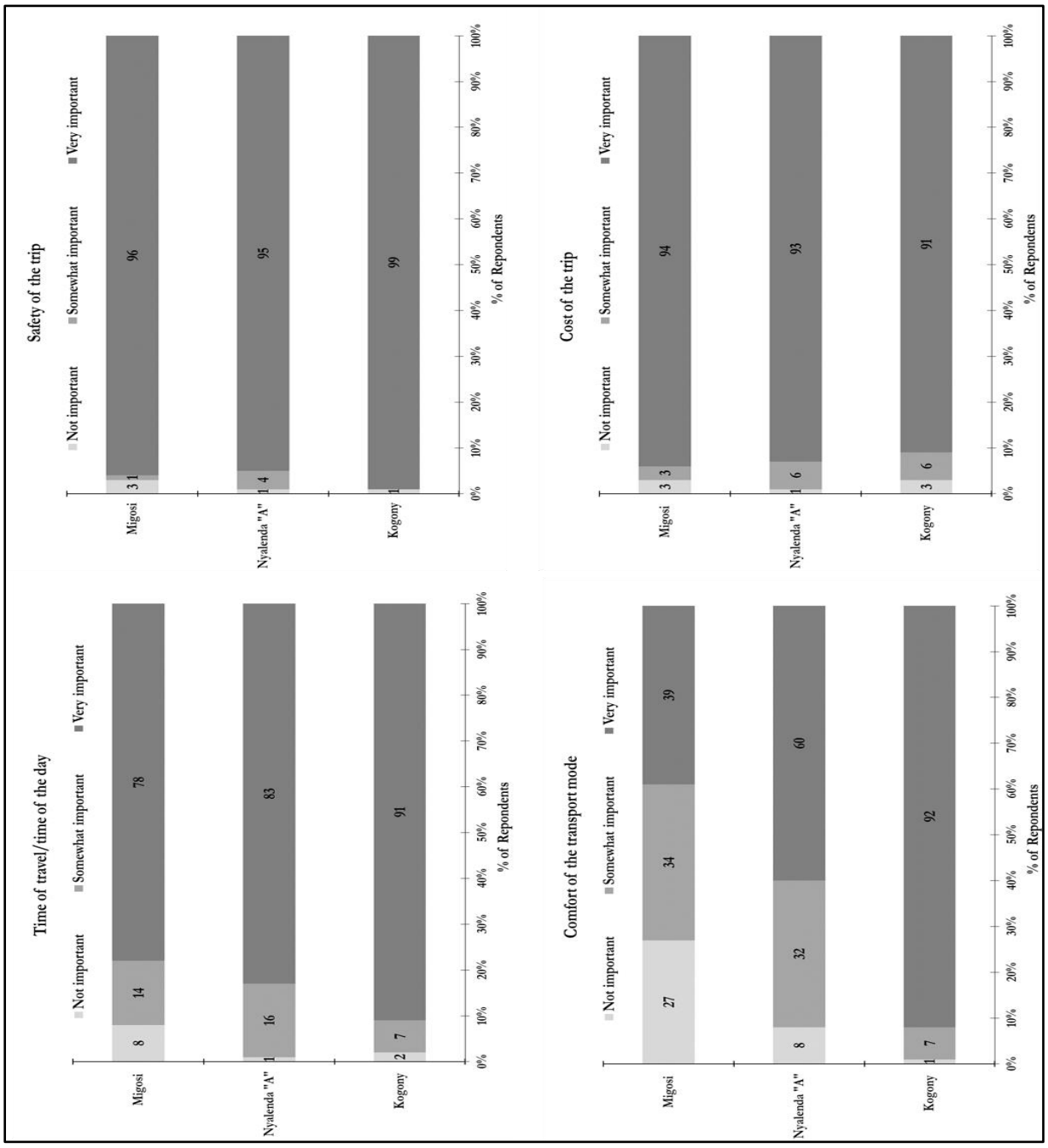


Figure 4-5: Importance of safety, cost, time and comfort to mode users.

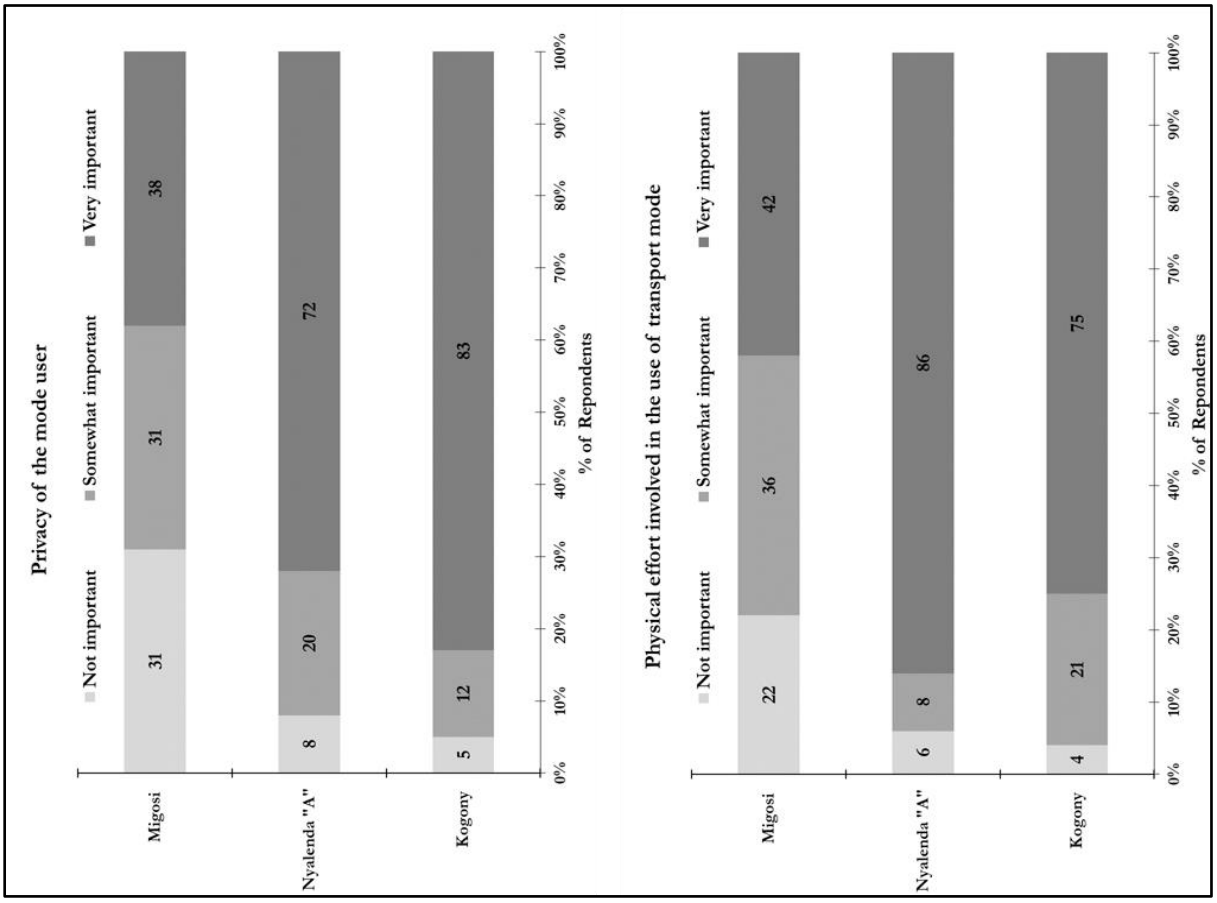


Figure 4-6: Importance of privacy and physical effort involved in the use of transport modes.

4.1.5. Changes Over Time

In investigating the change in the use of transport modes and when it took place, figure 4-7 shows that almost 90% of the sample respondents in Kogony reported have changed their transport mode to work/study, and almost half of it happened in the period between 2014-2018. As for Nyalenda "A", about 40% of respondents reported having changed their transport mode, and about 30% of them occurred over the last five years. Regarding Migosi only about 30% reported a change in transport mode and about 20% occurred within the last five years.

Therefore, the analysis of changes in the use of transport modes over time strongly suggests that Kogony respondents have changed the most over the years. Overall, the findings present a picture where most respondents are changing from NMT to MTM. The finding is validated by an increase in the use of motorcycles and auto-rickshaws over the years. This result fails to solidify Alando, Scheiner and Zuidgeest (2014) report that Kisumu is still predominantly a walking and cycling city. This may be a typical example of what is happening in other sub-locations of the city and most global south cities in the same socio-economic development league as reported by Nuriye, Jafri, and Asfaw (2014) in the case of Hawassa in Ethiopia and Olawo, Ochieng, Ombok and Achieng' (2014) on Kisumu west district.

On the other hand, the disparity in the findings of this research and what Alando, Scheiner and Zuidgeest (2014) found may be because the difference in time analysed. Alando, Scheiner and Zuidgeest (2014) used the retrospective survey to analyse the trends from three points in time (2004, 2009 and 2014) whereas this study used house travel survey to analyse two points in time (i.e. before and after the change) which may result to a bias caused by the retrospective survey. That is to say; it could have not been possible to minimize the memory recall effect associated with retrospective surveys thereby causing the bias.

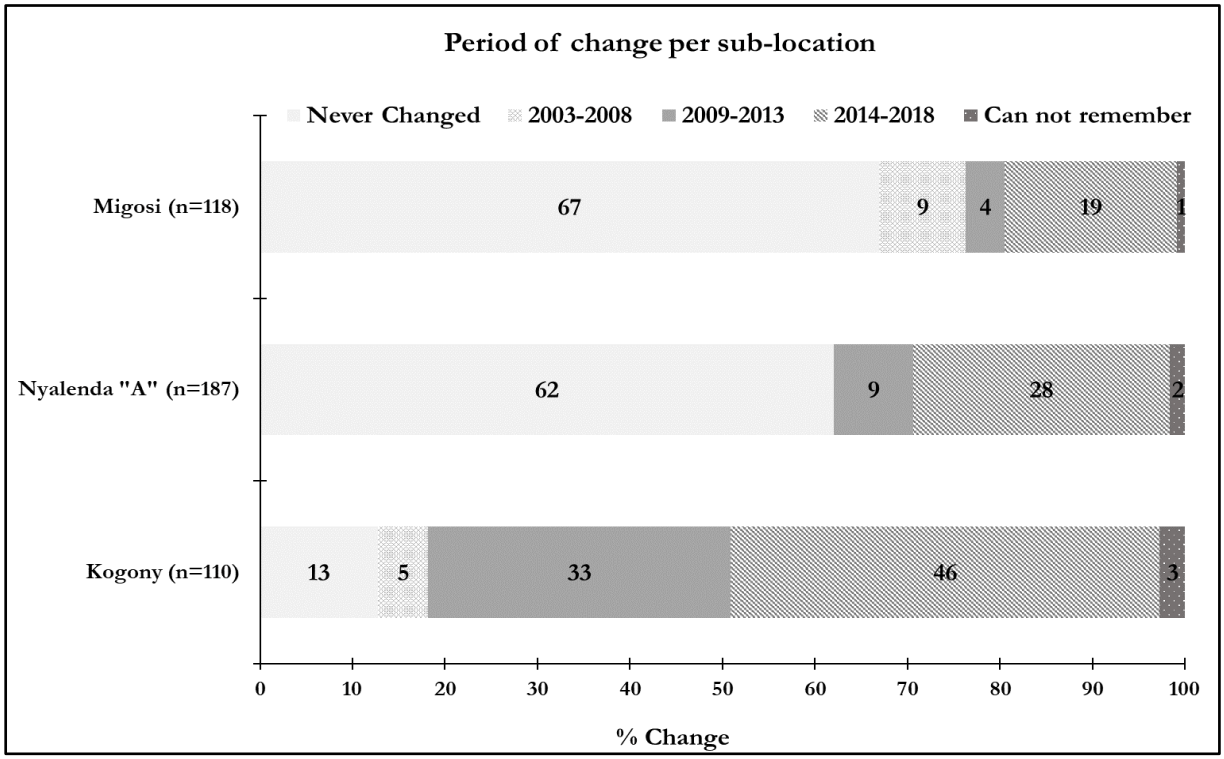


Figure 4-7: Transport mode choice change over the years.

4.1.6. Changes in Mode Use

To determine the change in the two points in time in order to reveal how the change is happening regardless of the sub-location, a cross-tabulation of the mode used before the change and mode used after the change (i.e. now) was done. Table 4-2 shows the overall changes in the use of transport mode is inclining towards the use of motorcycles and auto-rickshaws than before. For example, only 62% of respondents who used to walk are still doing so whereas 20% and 10 % are using motorcycles and auto-rickshaws respectively. Examining bicycle use, only 8% of respondents who used to cycle are still doing so whereas 50% and 23 % are using motorcycles and auto-rickshaws respectively, But, on the other hand, almost all car users continue to drive. It indicates that motorcycles usage is increasing in the three sub-locations and is slowly taking over as the preferred mode of transport. It may be the situation reflecting what is happening in the entire city. The finding fails to support Alando, Scheiner and Zuidgeest (2014) as discussed in section 4.1.5 but suggests that Kisumu may no longer be a walking and cycling city.

Table 4-2: Overall changes in mode use.

		Mode used now (After)					
		Walking (n=88)	Bicycle (n=15)	Motorcycle (n=121)	Auto-rickshaw (n=81)	Car (n=34)	Matatu (n=76)
Mode used before	Walking (n=105)	62	2	20	10	2	4
	Bicycle (n=62)	8	18	50	23	2	0
	Motorcycle (n=44)	9	2	59	16	5	9
	Auto-rickshaw (n=43)	23	0	14	63	0	0
	Car (n=19)	0	0	0	0	89	11
	Matatu (n=142)	3	1	26	15	8	46

4.1.7. Transport Mode Ownership and Mode Use Over the Years

In determining the transport mode use and ownership over the years, a cross-tabulation analysis of mode ownership by transport mode use (i.e. before and after the change) was carried out. Results shown in figures 4-8 confirm that the use of NMT (i.e. walk and bicycle) and passenger vehicles (private car and public transport or matatu) is reducing whereas the use of motorcycles and auto-rickshaws is increasing. Also, most of the respondents who own motorised modes of transport (MTM) prefer to use the same mode. The finding points to the same direction as discussed earlier in sections 4.1.5 and 4.1.6 that the residents of the city of Kisumu may be owning and using MTM than before.

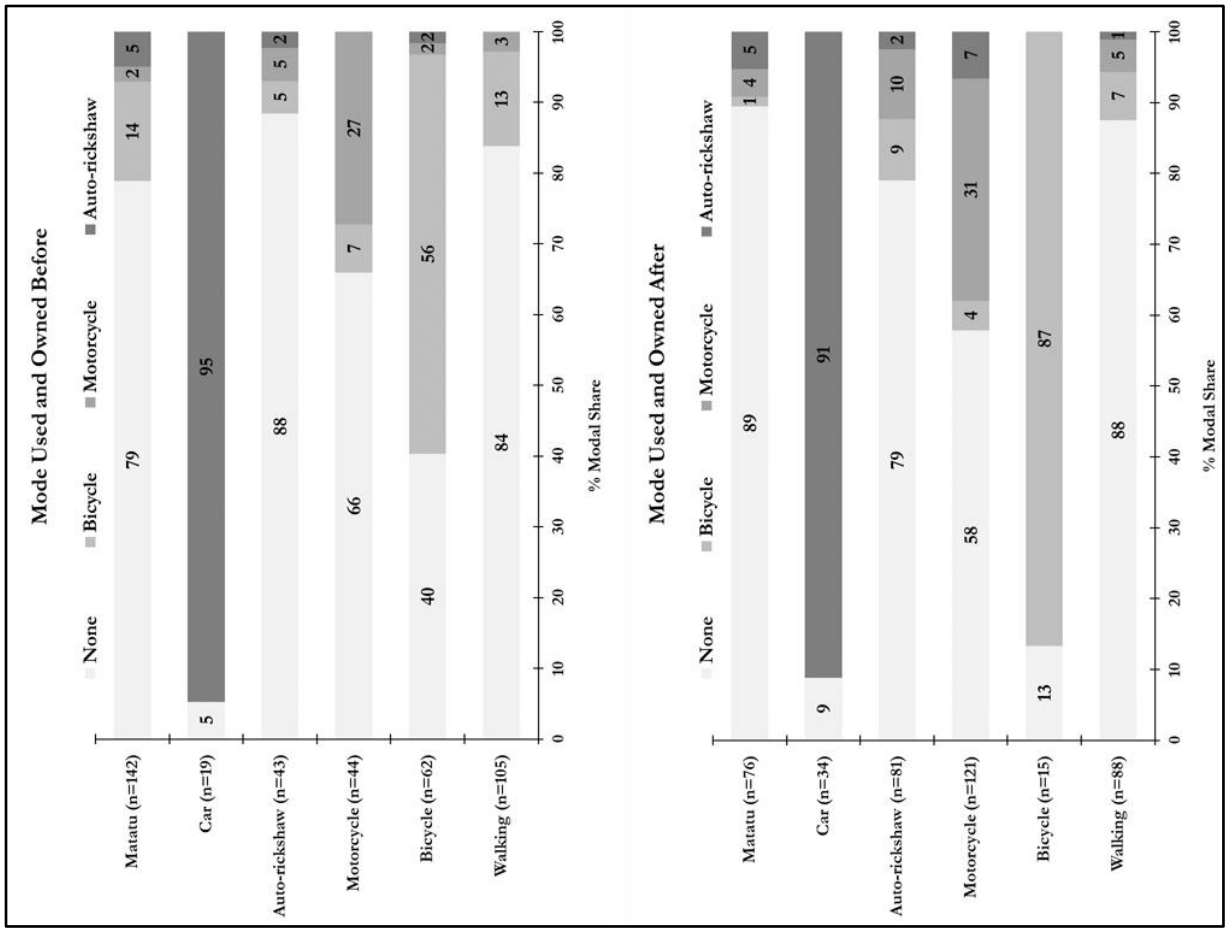


Figure 4-8: Mode ownership and mode use over the years.

4.1.8. Reasons for the Change of Transport Modes

In finding out the reasons for the change of transport modes, respondents were asked the main reasons that made them change the transport mode they use. A predefined set of reasons were given in the questionnaire (see appendix 1) for the respondent to choose and also other reasons were explored. Out of 415 responses, only 182 gave reasons why they changed the modes they used. The reasons the respondents gave were analysed in relation to the transport mode used before the change. It was to help understand the motivation behind the change. Overall, the reasons can be categorised as socio-economic, built environment, trip-related, attitudinal and political reasons. As table 4-3 shows, most respondents changed their transport mode because of the circumstance around their socio-economic situation. It is also evident that most of the respondents who changed their transport mode are those who used to either walk or cycled to work/study destination. It validates the finding discussed in section 4.1.5 that the change is mainly from NMT to MTM. Therefore, as pointed out by Parkin (2012), changing from NMT to MTM is not independent of physical, social, economic, cultural and political factors

Table 4-3: Reasons for change in transport modes.

Mode Used Before	Reasons for Change	Number of Responses
Walking	I got more money/affordable/cheap/cutting cost/hard economic times	24
	Relatively long/short travel distances	3
	Disabilities due to a major accident	2
	Inflexibilities of the structure of Matatu routes	2
	I was single now I am married	3
	Post-election violence	1
Bicycle	I got more money/affordable/cheap/cutting cost/hard economic times	28
	Bicycle consumes a lot of time and energy as compared to auto-rickshaw	6
	Relatively long/short travel distances	2
	Bicycles were overtaken by auto-rickshaw	2
	Given a motorcycle by my father to start my own business	1
	Inflexibilities of the structure of Matatu routes	2
	Lack of affordable means of public transport	2
Motorcycle	I got more money/affordable/cheap/cutting cost/hard economic times	12
	Motorcycles are prone to accidents/safety	2
	Relatively long/short travel distances	2
	Inflexibilities of the structure of Matatu routes	2
Auto-rickshaw	I got more money/affordable/cheap/cutting cost/hard economic times	5
	Relatively long/short travel distances	3
	Cost of transport	6
	Inflexibilities of the structure of Matatu routes	1
Matatu	I got more money/affordable/cheap/cutting cost/hard economic times	43
	Inflexibilities of the structure of Matatu routes	2
	Relatively long travel distances	8

	Inflexibilities of the structure of Matatu routes	8
	I inherited it from my late husband	2
	I was single now I am married	1
	Inadequate means of public transport in the city of Kisumu	2
Car	I got more money/affordable/cheap/cutting cost/hard economic times	1
	My car got spoilt	2

4.1.9. Factors Influencing Mode Choice

After establishing that there are changes in the use of transport mode, it was imperative to find out the factors influencing the use of the transport modes (i.e. mode used after the change or now). It must be taken to note that almost all the questions in the travel survey questionnaire were meant to collect data describing the current characteristics of the respondents (i.e. after the change or now) apart from the transport modes used, modes owned and travel time (see appendix 1). It called for an appropriate method because all the data was categorical. Therefore, the Chi-Square (χ^2) test of association was used.

Chi-Square is a nonparametric statistical test to determine if two or more variables of the samples are related or independent or not. Thus, the test is used to discover if there is a relationship between two categorical variables (Ugoni & Walker, 1995; Zibran, 2007). The analysis was based on the hypothesis that there is no significant association or no relationship between the chosen socio-demographic, built environment, trip-related, attitudinal and perception variables and the present mode choice (i.e. mode used after the change or now). Other parameters related to the test are explained in the methodology chapter under statistical analysis (section 3.2.4.1).

From the analysis, twenty variables violated the assumption that no more than 20% of the expected counts are less than 5, and all individual expected count are 1 or greater as shown in appendix 5 and 6. It means that the data collected from some of the listed individual variable classes resulted in a negligible cell count (see appendix 5). On the other hand, there was also no significant relationship between households with teenagers of age group 13-19 years, households with adults aged 20-65 years, number of people earning in a household, safety of the trip, design of roads, quality of roads, availability of pedestrian paths and the use of transport modes as shown in table 4-4. The result suggests that these variables do not influence the use of transport modes. But, there is a statistically significant association between each of the remaining eight variables (see appendix 6) and the use of transport modes as explained in the following sections. It must be taken to note that among the statistically significant variables, almost all the variables had a small Cramer's V signifying the strength of the relationship. The residential location (sub-location) was the only variable that produced a large Cramer's V association.

Table 4-4: Non-significant variables.

Variable	Chi-Square Statistic	Degree of Freedom (df)	Significance Level (p>0.05)	Cramer's V
Households with teenagers 13-19 years	10.73	5	0.06	0.1
Households with adults 20-65 years	3.25	5	0.66	0.1
Number of people earning in a household	3.63	5	0.60	0.1
Safety of the Trip	16.84	10	0.08	0.1
Design of the roads	15.41	10	0.12	0.1
Quality of roads	15.92	10	0.10	0.1
Availability of pedestrian paths	5.31	10	0.87	0.1

4.1.9.1. Socio-demographic Factors Influencing Mode Choice

After running the Chi-Square tests, the statistically significant variables were cross-tabulated with mode choice. It was to find out if the results reveal a pattern of the variables influence on mode choice. A look at the results of the variable household heads and mode used now reveals a small difference in how the respondents who are household heads and those who do not use the different individual transport modes. But when the transport modes are categorized as motorised transport modes (MTM) and non-motorised transport modes (NMT), the result in figure 4-9 shows that just under half of all the respondents are household heads, but 78% use MTM and 22% use NMT. For the remaining half of the respondents who are not household heads, 73% use MTM and 27% use NMT. These differences are significant (χ^2 =26.97, df = 5, $p < 0.001$, N = 415) and validated by moderate association of Cramer's V = 0.3.

The results point to what was found out by Kalter and Geurs (2015) in the Netherlands case. Although the context and the singular transport mode considered for the Netherlands case may be different, in the context of Kisumu, being a household head or not may have the effect of intra-household interaction in decision making regarding the transport mode to use.

Also, in figure 4-9, just over half of all the respondents are female, but 74% use MTM and 26% use NMT. For the remaining male respondents, 77% use MTM and 23% use NMT. These differences are significant (χ^2 =25.80, df = 5, $p < 0.001$, N = 415) and validated by small association of Cramer's V = 0.2. The finding suggests that gender-based differences exist in mode choice. It tends to validate the findings Yang, Li, Wang, Zhao, and Chen (2013) of who researched on gender-based differences in mode choice in Suzhou, China using structural equation modelling (SEM). But the results fails to confirm Snellen (1999) finding in the case of the Netherlands where gender showed no significant effect.

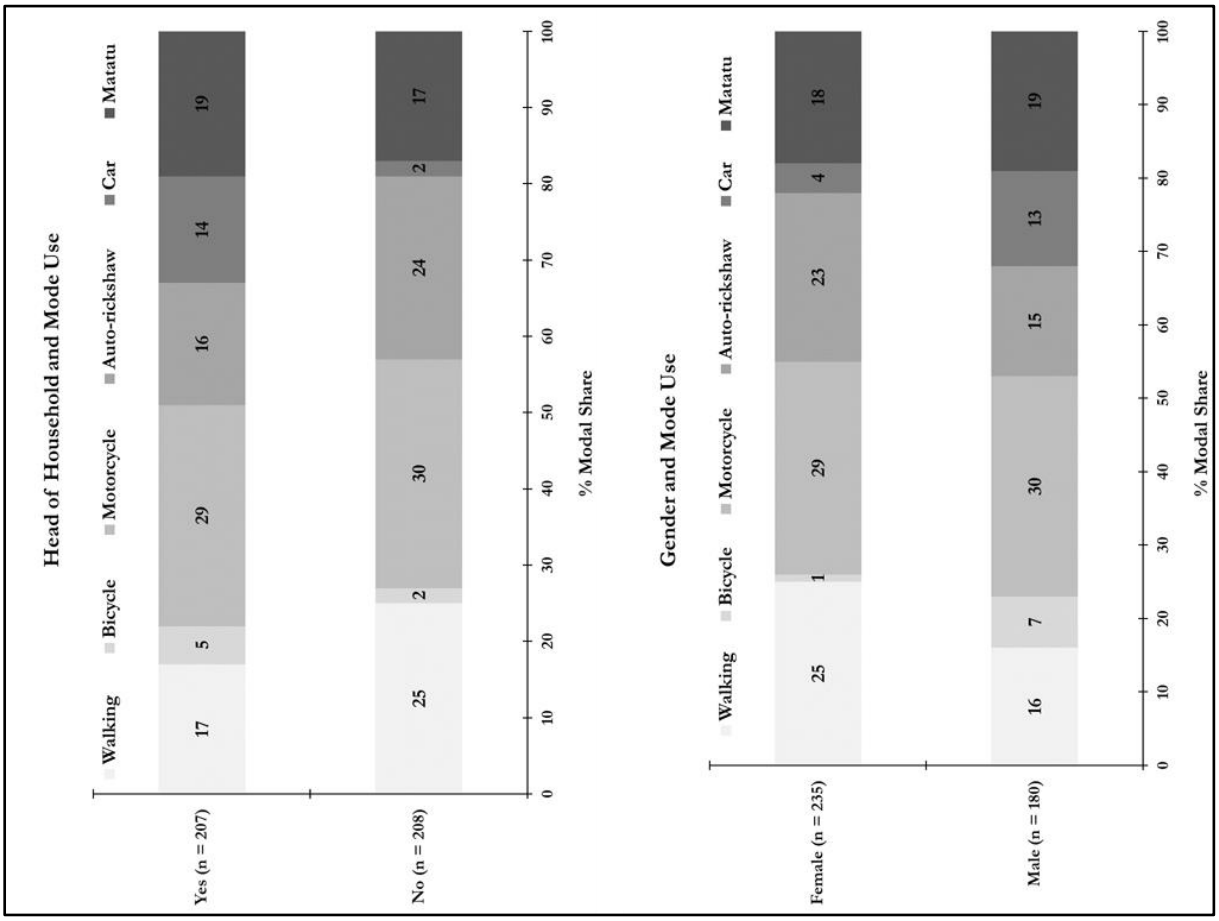


Figure 4-9: Household head, gender and mode use.

For the 34.5% of all the respondents whose households had children under two years, 68% use MTM whereas 32% use NMT. In the other category which had no children under two years, 79% use MTM and 21% use NMT. The differences are significant (χ^2 =26.01, df = 5, p < 0.001, N = 415) and validated by moderate association of Cramer's V = 0.3 as shown in figure 4-10.

The 66.3% of all the respondents whose households had children aged 2-12 years, 73% use MTM and 27% use NMT. On the other hand, the category which had no children aged 2-12 years, 78% use MTM and 22% use NMT. The differences are significant (χ^2 =27.57, df = 5, p < 0.001, N = 415) and validated by moderate association of Cramer's V = 0.3 also shown in figure 4-10.

Thus, the findings suggest that most respondents from families with no children use MTM (i.e. motorcycles, cars and matatus) than those from families with children. The findings fail to clearly point out what McCarthy, Delbosc, Currie, and Molloy (2017) found out that majority of factors influencing the use of transport modes among families with young children tend to aid car use.

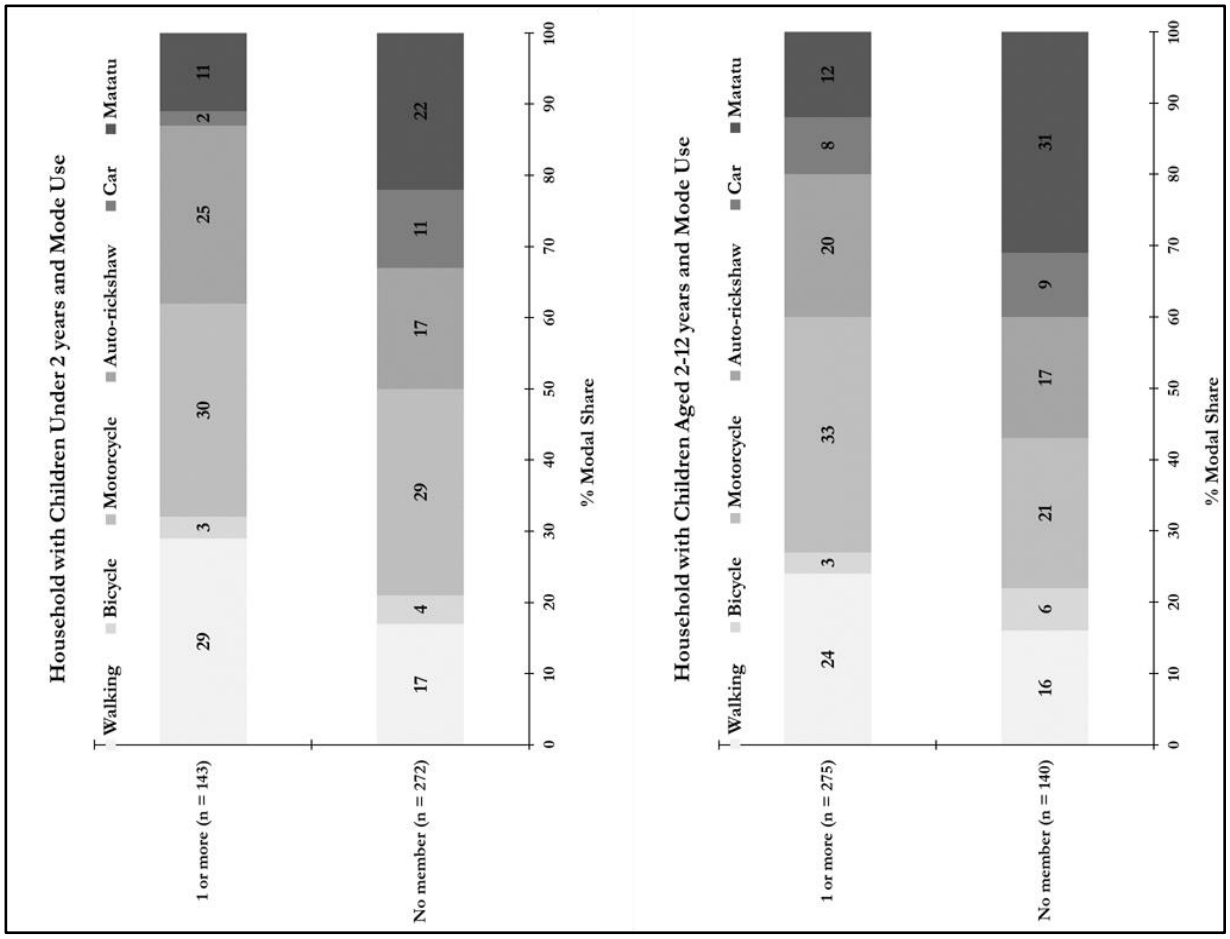


Figure 4-10: Household with children under 2 years, children aged 2-12 years and mode use.

4.1.9.2. Built Environment Factors Influencing Mode Choice

The built environment variables that were found to have a statistically significant relationship to transport mode choice are as shown in table 4-5.

Table 4-5: Built environment variables influencing transport mode choice.

Variable	Chi-Square Statistic	Degree of Freedom (df)	Significance Level (p<0.05)	Cramer's V
Residence of the respondent/Sub-location	320.10	10	0.00	0.6
Length of the trip	19.86	10	0.03	0.2
Availability of bicycle lanes	29.14	10	0.00	0.2

Figure 4-11 shows that the sub-location or neighbourhood of the respondent is a factor that influences mode choice. In which case most of the respondents in Migosi use public transport and private cars whereas most of the Kogony respondents use motorcycles. In Nyalenda "A" most respondents walk to work/study destinations may be because they are closer to the central business district where most of the jobs are located. The finding confirms what Dunlap (2015) found out that household location influences mode choice.

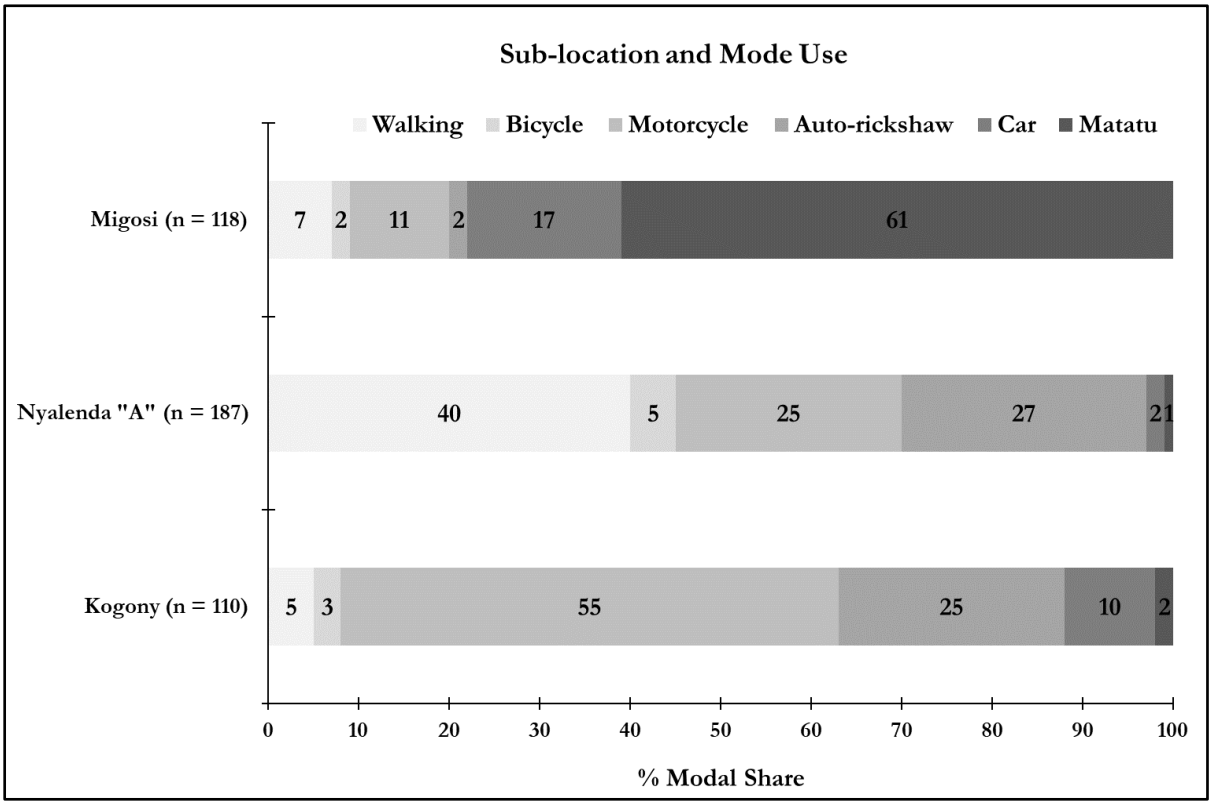


Figure 4-11: Respondents residence and mode use.

The results shown in figure 4-12 presents an overall picture where most respondents consider elements related to the mode they use as very important to them. In this case length of the trip is considered as a very important factor of the built environment by most respondents who use motorcycles, autorickshaw and matatus (i.e. public transport) whereas most of the respondents who cycle consider the availability of availability of dedicated bicycle lanes as a very important element of the built environment.

The results validate Heinen et al. (2010) findings that the length of the trip and availability of cycling infrastructure are all factors that influence the use of transport modes. It confirms the finding of Mckibbin (2011) who researched the influence of the built environment on mode choice-evidence from a journey to work in Sydney, Australia. Ding, Wang, Liu, Zhang, and Yang (2017) used structural equation model (SEM) and discrete choice model (DCM) to study the case of Baltimore metropolitan area and agrees that built environment influences travel mode choice through car ownership and travel distance.

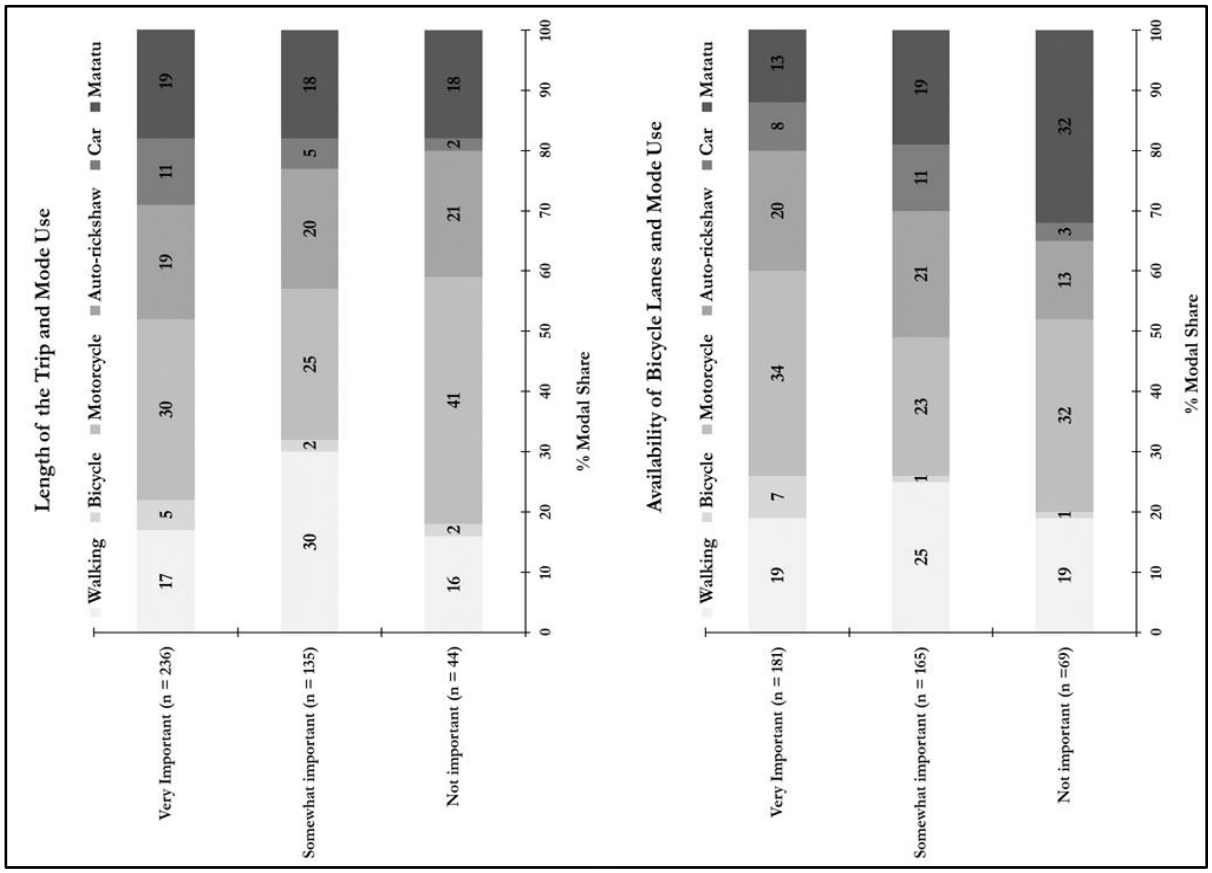


Figure 4-12: Length of the trip, availability of bicycle lanes and mode use.

4.1.9.3. Attitudinal and Perception Factors Influencing Mode Choice

As shown in figure 4-13, most of the respondents who use motorcycles consider the privacy of the individual mode user as very important whereas it is not important to most of few respondents who use matatus (i.e. public transport). Also, in figure 4-13, 66% of all the respondents that consider the privacy of the mode used as a very important element before using a transport mode to travel to work/study destination, 74% use MTM and 26% use NMT. The remaining respondents consider it to be somewhat important and not important respectively. These differences are significant (χ^2 =52.98, df = 10, $p < 0.001$, N = 415) and validated by moderate association of Cramer's V = 0.3. The finding combines the perception of all respondents who use MTM, but the researcher is of the opinion that the test does not reveal much into the variable as per the contrary finding in section 4.1.4 figure 4-6 for Migosi respondents.

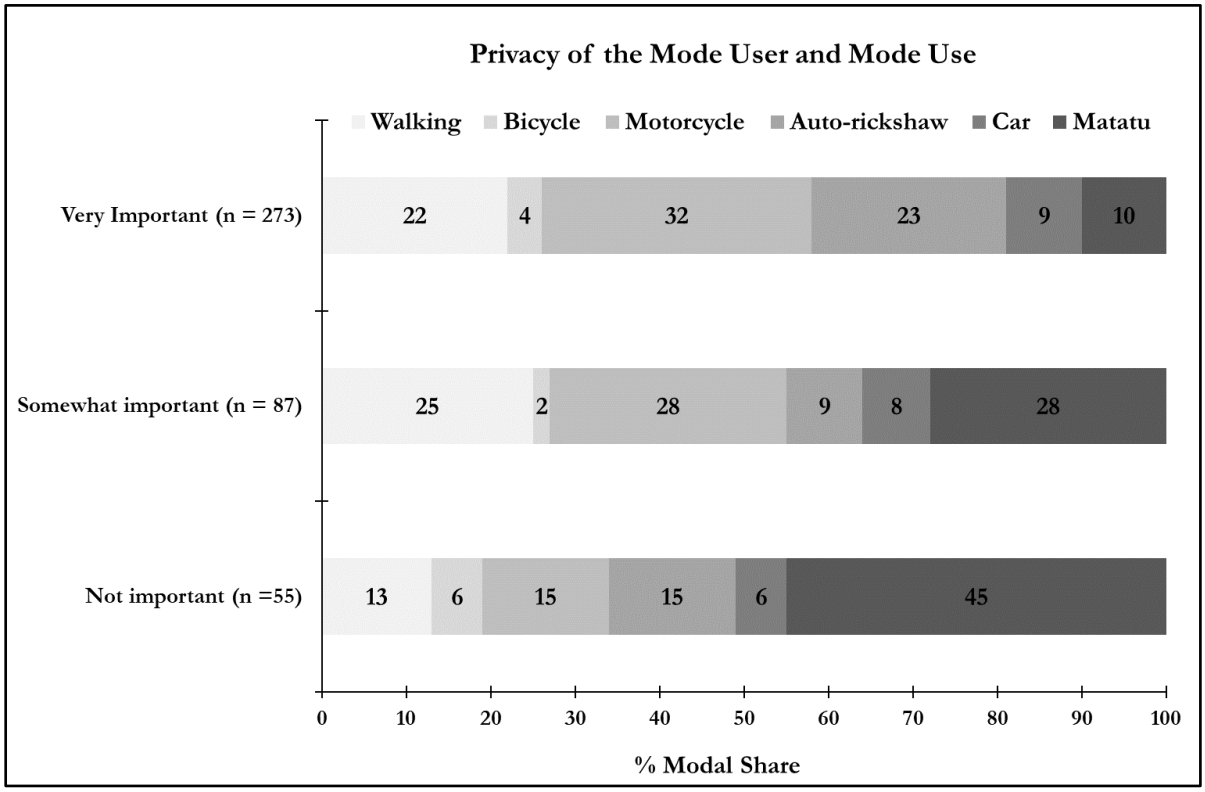


Figure 4-13: Privacy of the mode user and mode use.

4.2. GIS Output Map

Figure 4-14 shows households transport mode use spatial distribution. The household locations do not reveal any clear pattern in mode use at first glance, and therefore the researcher did not explore the spatial analysis option. Most of the roads that serve the three sub-locations are unpaved whereas most of the city centre roads are paved. It reveals the dilapidated nature and quality of the roads in the neighbourhoods around the city (see appendix 8 and 9). An exploration of Kogony by way of googling earth images reveal paths that serve the mode users. It reveals incomplete road network data obtained from the county government planning office thereby making it difficult for the researcher to perform spatial analysis.

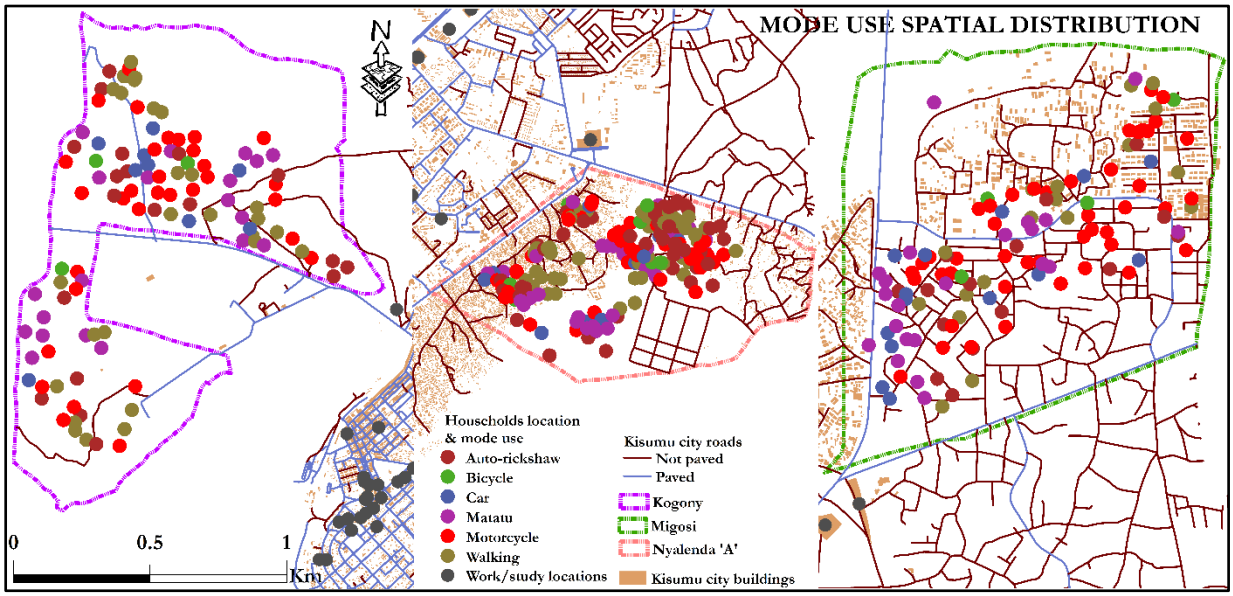


Figure 4-14: Study area mode choice spatial distribution.

5. CONCLUSION AND RECOMMENDATIONS

This study investigated the determinants of the changes in the use of transport modes in Kisumu and the underlying factors influencing these changes. To this end, the first task was to identify factors influencing the changes in the use of transport modes and the second was to determine the factors influencing the changes in the use of transport modes in Kisumu.

To accomplish the first thematic task, a literature review carried out identified four categories of factors (i.e. socio-demographic, built environment, trip-related, attitudinal and perception factors) as conceptualized in figure 2-1, section 2.4. For the second objective, a travel survey questionnaire (see appendix 1) was developed for primary data collection. Field data collection technique employed was a hybrid system (partly paper-based and computer-based, i.e. Kobo Collect software). Statistical analysis techniques employed were descriptive and the Chi-Square test of association to help find out which factors are influencing mode choice in Kisumu.

The analysis revealed that most changes in the use of transport modes in the city of Kisumu occurred in the last five years. It is coupled by an increase in the use and ownership of motorcycles especially in the far-flung city neighbourhoods like Kogony. On the other hand, the reasons advanced by the respondents why they changed the mode revolved around socio-economic, built environment, trip-related, attitudinal and political reasons based on the neighbourhood (sub-locations) one resides. Also, the findings from the Chi-Square tests of association suggest that gender, whether one is a household head or not, whether a household consists of children under 2 years and 2-12 years, length of the trip, availability of bicycle lanes and privacy of the mode user influence the changes in the use of transport mode in the city of Kisumu. In this case, the researcher is of the opinion that the Chi-Square test of association did not reveal much into how the variables affect mode choice. The researcher may not, therefore, make a definite conclusion as to which variables influence mode choice in Kisumu but only present the listed variables as the results suggest. Thus, socio-demographic factors have the most variables (i.e. gender, household head, household having children under 2 years and household having children 2-12 years) that may be influencing mode choice in the city of Kisumu followed by built environment factors (i.e. length of the trip and availability of bicycle lanes) and attitudinal and perception factors (i.e. privacy of the mode user).

5.1. Recommendations

The findings call for the County Government of Kisumu to work with stakeholders in promoting the benefits of non-motorised transport modes. The local government also need to facilitate policymakers to work with the local community to formulate sustainable transportation policies to include non-motorised transport modes. This study hopes to bring a better understanding to city planners in Kisumu and other similar jurisdictions on factors influencing mode choice to help them develop effective and targeted people and place-based policies. It is also expected that this study will contribute to the academic body of knowledge on the factors influencing mode choice in Global South cities like Kisumu.

5.2. Limitations and Future Research

The researcher went for late fieldwork and had a short time to analyse the data. Nevertheless, categorical data analysis has methodological limitations inherent in this line of research. It calls for careful interpretation of the results as there may be a limited insight into causality. One notable weakness is that almost all the variables had a small Cramer's V signifying the strength of the relationship (see section 4.1.9). Residential location (sub-location) was the only variable that produced a significant Cramer's V association. Households that hold a particular attitude toward a specific type of travel may choose to locate in a neighbourhood enabling the pursuit of the preferred kind of trip. To this end, it would be of interest for future studies to look at multi-variable analysis in the same context using a household travel survey over large sample size.

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APPENDICES

Appendix 1: Travel Survey Questionnaire.

Analysis of Factors Influencing the Changes in the Use of Transport Modes in Kisumu, Kenya

TRAVEL SURVEY QUESTIONNAIRE

The purpose of this questionnaire is to gather characteristics of households and trip-related information of adult residents who live in the city of Kisumu (particularly residents who live in Kogony, Migosi and Nyalenda "A") concerning the use of transport modes.

All information provided will only be used for academic purposes and will, therefore, be treated with confidentiality. The questionnaire will last for about 15 minutes.

Thank you in advance for your cooperation.
Best regards, Ouma Edwin Okoyo – MSc Candidate University of Twente, The Netherlands

The following questions are about your individual characteristics and travel related information currently (2018) and the past years.

1. Enumerator, please ask the respondent; ***Are you a resident of the city of Kisumu*?** If *yes*, proceed and ask question **2**. If *no*, DO NOT proceed with the interview.
   - ☐ Yes
   - ☐ No
2. ***Do you travel to an activity (i.e. work/study) at least 3 days a week within the city of Kisumu?*** If *yes*, proceed and ask question **3**. If *no*, DO NOT proceed with the interview.
   - ☐ Yes
   - ☐ No
3. ***Which sub-location do you live*?** Please read to the respondent the names of the sub-locations from the list below. Tick the one, the respondent, tells you. If the respondent DOES NOT live in any of the listed sub-locations, DO NOT proceed with the interview but find and administer the questionnaire to adult residents of the city of Kisumu who live in the listed sub-locations ONLY.
   - ☐ Kogony
   - ☐ Nyalenda "A"
   - ☐ Migosi
4. **Gender.**
   - ☐ Male
   - ☐ Female
5. ***Which age group do you belong*?** Read to the respondent the age groups in the list below and help them by ticking the age group he/she tells you. Please tick one.
   - ☐ 15-19
   - ☐ 20-29
   - ☐ 30-39
   - ☐ 40-49
   - ☐ 50-59
   - ☐ 60-69
   - ☐ Above 70
6. ***What is the highest education level you have acquired*?** Read to the respondent the educational categories in the list below and help by ticking the one he/she tells you. Please tick one.
   - ☐ None
   - ☐ CPE/KCPE

- ☐ KAPE
- ☐ KJSE
- ☐ EACE/KCE/KCSE
- ☐ KACE/EAACE
- ☐ Certificate
- ☐ Diploma
- ☐ Degree
- ☐ Postgraduate
- ☐ Basic/Post Literacy Certificate
- ☐ Other

7. ***What is your employment status?*** Read to the respondent the employment status categories in the list below and help them by ticking the employment status category he/she tells you. Please tick one.

- ☐ Employed full time
- ☐ Employed part-time
- ☐ Self-employed
- ☐ Student
- ☐ Housewife
- ☐ Retired
- ☐ Unemployed/Job-seeker
- ☐ Other (specify)

_____

8. ***Are you the head of your household?***

- ☐ Yes
- ☐ No

9. ***What is your marital status?*** Read to the respondent the marital status categories in the list below and help them by ticking the marital status he/she tells you. Please tick one.

- ☐ Single
- ☐ Married
- ☐ Divorced/Separated
- ☐ Widowed

10. ***How many people in the following age categories live in your household?*** Please help the respondent by reading the age group categories and filling in the exact number for each below.

a. Children aged under 2 years

_____

b. Children aged 2-12 years

_____

c. Teenagers aged 13-19 years

_____

d. Adults aged 20-65 years

_____

e. Adults aged over 65 years

_____

11. Please, talk to the respondent to think about the main mode of transport he/she is using now (presently) and the one he/she used in the past years, please ask the respondent; ***Please, tell me the main mode of transport you presently use frequently and the one you used frequently in the past to go to work/school/college?***

Mode of Transport	Now/Present (2018)	Past (before 2018)
Walking		
Bicycle (self)		
Bicycle (taxi)		
Motorcycle (self)		
Motorcycle (taxi)		
Auto-rickshaw (self)		
Auto-rickshaw (taxi)		
Private car		
Public transport (Matatu)		
Other (specify)		

12. ***Have you changed the main mode of transport you used frequently in the past?*** If *yes*, please help the respondent answer questions **13** and **14**. If *no*, please GO TO question **15** and SKIP questions **13** and **14**.
    - ☐ Yes
    - ☐ No
13. If *yes*, ***which year did you change the main mode of transport you use?***

    _____
14. ***What are the reasons that made you to change your mode of transport?*** Please read to the respondent the listed reasons below and help by ticking the ones he/she tells you. Ask if there is any other not listed.
    - ☐ I got more money
    - ☐ I got a new job with pay rise
    - ☐ I was an employer (run my own business)
    - ☐ I was single now I am married with children
    - ☐ I was unemployed/a student now I am working
    - ☐ I moved to live in a place far away from my workplace
    - ☐ Motorcycles became more affordable
    - ☐ Building and upgrading of more roads in the city
    - ☐ Second-hand cars became more affordable
    - ☐ Growth and expansion of the city of Kisumu
    - ☐ Increasing public transportation costs
    - ☐ Lack of affordable means of public transport (matatu)
    - ☐ Inadequate means of public transport (matatu)
    - ☐ Relatively shorter travel distances
    - ☐ Inflexibilities of the structure of matatu routes (public transport)
    - ☐ Others (specify)

      _____
      _____
      _____
15. ***How long are you taking to travel to your work/school/college presently or currently (in minutes)?*** Read to the respondent the time range in the list below and help them by ticking the time range he/she tells you. Please tick one.
    - ☐ Less than 10 minutes
    - ☐ 11 to 20 minutes
    - ☐ 21 to 30 minutes
    - ☐ 31 to 40 minutes
    - ☐ 41 to 50 minutes
    - ☐ 51 to 60 minutes
    - ☐ Over 60 minutes

16. ***How long were you taking to travel to your work/school/college in the past (in minutes)?*** Read to the respondent the time range in the list below and help them by ticking the time range he/she tells you. Please tick one.
    - ☐ Less than 10 minutes
    - ☐ 11 to 20 minutes
    - ☐ 21 to 30 minutes
    - ☐ 31 to 40 minutes
    - ☐ 41 to 50 minutes
    - ☐ 51 to 60 minutes
    - ☐ Over 60 minutes
17. ***Which mode(s) of transport do you own now and in the past***? Read to the respondent the modes of transport in the list below and help the respondent by ticking the mode(s) he/she tells you. If the mode(s) the respondent own is not listed, please tick "other" and specify. If the respondent does not own any, please tick "none." Please, you can tick many.

Mode(s) of Transport Owned	Now/Present/Current	Past
Bicycle		
Motorcycle		
Auto-rickshaw		
Car		
None		
Other (specify)		

18. ***How important do the listed reasons below influence your decision to use a given transportation mode, i.e. Walking, Bicycle, Motorcycle, Private car, Public Transport and Auto-rickshaw***? Please, read to the respondent the listed reasons in the table below and help she/he rank them in their order of importance per mode as per the respondent perception.

	Extremely important	Very important	Somewhat important	Not so important	Not at all important
Safety of the trip					
Cost of the trip/transport					
Time of travel/Time of the day					
Design of the roads in the neighbourhood					
Quality of the roads in the neighbourhood (unpaved and paved)					
The length of the trip/journey					
Availability of pedestrian paths					
Availability of dedicated Bicycle lanes					
Availability of dedicated Motorcycle/ Auto-rickshaw lanes					
Comfort of transport mode					
Privacy of the individual user					
Ease of access to most services					
Physical effort involved in the use of transport mode					

19. For the previous question **18** on the reasons that influence your decision to use a given transportation mode; ***Which transport mode did you refer to?***
    - ☐ Walking
    - ☐ Bicycle
    - ☐ Motorcycle
    - ☐ Private car
    - ☐ Public transport (matatu)
    - ☐ Auto-rickshaw

20. ***Which income group do you belong to***? Read to the respondent the monthly income groups in the list below and help them by ticking the income group he/she tells you. Please tick one.
    - ☐ Below Kshs. 10,000
    - ☐ Kshs. 10,001- Kshs. 20,000
    - ☐ Kshs. 20,001- Kshs. 30,000
    - ☐ Kshs. 30,001- Kshs. 40,000
    - ☐ Kshs. 40,001- Kshs. 50,000
    - ☐ Kshs. 50,001- Kshs. 60,000
    - ☐ Kshs. 60,001- Kshs. 70,000
    - ☐ Kshs. 70,001- Kshs. 80,000
    - ☐ Kshs. 80,001- Kshs. 90,000
    - ☐ Kshs. 90,001- Kshs. 100,000
    - ☐ Above Kshs. 100,000

21. ***How many people living in your household earn a living (have means of income)*****?** Please fill in the exact number the respondent tells you below.

    _____

22. ***What is the estimated total monthly income of your household (in Kenya Shillings)*****?** Please fill in the exact number the respondent tells you below.

    _____

23. ***Where do you stay* (*location of your house, i.e. estate or neighbourhood*)**? Please capture the GPS coordinates and name of the estate or neighbourhood.

    X-Coordinate:_____

    Y-Coordinate:_____

    Name of estate and block number or nearest landmark to your house in the neighbourhood:_____

    _____

24. ***Where is the location of your workplace/school/college***? Please capture the GPS coordinates of the workplace/school/college and the name of the workplace or nearest building to workplace.

    X-Coordinate:_____

    Y-Coordinate:_____

    Name of workplace or nearest building/landmark to workplace/school/college: _____

    _____

    _____

Appendix 2: Transformed Continuous Variables.

Factor	Variable	Class
SDF	Household composition-Children aged under 2 years	0-no member 1- 1 or more
	HH composition-Children aged 2-12 years	0-no member 1- 1 or more
	Household composition -Teenagers aged 13-19 years	0-no member 1- 1 or more
	Household composition -Adults aged 20-65 years	0-no member 1- 1 or more
	Household composition -Adults aged over 65 years	0-no member 1- 1 or more
	Number of people earning a living in your household	0-no member 1- 1 or more

Appendix 3: Recoded Variables.

Factor	Variable	Class
SDF	Education level	1-Low (0-None, 1-CPE/KCPE, 2-KAPE, 3-KJSE, 10-Basic/Post Literacy Certificate) 2-Middle (4-EACE/KCE/KCSE, 5-KACE, 6-Certificate, 7-Diploma,) 3-High (8-Degree, 9-Postgraduate)
	Income level	1-Low (1-Below Kshs. 10,000, 2-Kshs. 10,001-Kshs.20,000, 3-Kshs. 20,001-Kshs.30,000) 2-Middle (4-Kshs. 30,001-Kshs. 40,000, 5-Kshs. 40,001-Kshs.50,000, 6-Kshs. 50,001-Kshs.60,000) 3-High (7-Kshs. 60,001-Kshs.70,000, 8-Kshs. 70,001-Kshs.80,000, 9-Kshs. 80,001-Kshs.90,000, 10-Kshs. 90,001-Kshs.100,000, 11-Above Kshs, 100,000)
	Employment status	1-Employed (1-Employed full time, 2-Employed part-time) 2-Self-employed (3) 4-Student (4) 5-Unemployed (5-Housewife, 6-Retired, 7-Unemployed/Job-seeker)
	Age	1-15-19 years (1-15-19 years, 2-20-29 years) 2-30-49 years (3-30-39 years,4-40-49 years) 3-Above 50 years (5-50-59 years, 6-60-69 years, 7-Above 70 years)
	Present mode(s) owned	0-None (0) 1-Bicycle (1) 2-Motorcycle (2) 3-Auto-rickshaw (3) 4-Car (4) 5-Multiple modes (5 -Bicycle & Motorcycle, 6-Bicycle, Motorcycle and Car, 7 -Motorcycle & Auto-rickshaw, 8-Motorcycle, Auto-rickshaw & Car, 9-Motorcycle and Car)
	Past mode(s) owned	-None (0) 1-Bicycle (1) 2-Motorcycle (2) 3-Auto-rickshaw (3) 4-Car (4)

		5-Multiple modes (5 -Bicycle & Motorcycle, 6-Bicycle, Motorcycle and Car, 7 -Motorcycle & Auto-rickshaw, 8-Motorcycle, Auto-rickshaw & Car, 9-Motorcycle and Car)
TRF	Present travel time	1-Less than 10 minutes (1- Less than 10 minutes 2-11-20 minutes (2-11-20 minutes 3-21-30 minutes (3-21-30 minutes 4-More than 30 minutes (4-31-40 minutes, 41-50 minutes, 51-60 minutes, Over 60 minutes)
	Past travel time	1-Less than 10 minutes (1- Less than 10 minutes 2-11-20 minutes (2-11-20 minutes 3-21-30 minutes (3-21-30 minutes 4-More than 30 minutes (4-31-40 minutes, 41-50 minutes, 51-60 minutes, Over 60 minutes)
	Present mode use	1-Walk (1-Walk) 2-Bicycle (2-Bicycle-self and 3- Bicycle-taxi) 3-Motorcycle (4-Motorcycle-self, 5- Motorcycle -taxi) 4-Auto-rickshaw (6-Autorickshaw-self, 7- Autorickshaw -taxi) 5-Car/Matatu (8-Private car) 6- Matatu (9-Public transport-matatu)
	Past mode use	1-Walk (1-Walk) 2-Bicycle (2-Bicycle-self and 3- Bicycle-taxi) 3-Motorcycle (4-Motorcycle-self, 5- Motorcycle -taxi) 4-Auto-rickshaw (6-Autorickshaw-self, 7- Autorickshaw -taxi) 5-Car/Matatu (8-Private car) 6- Matatu (9-Public transport-matatu)
BEF	Design of the roads in the neighbourhood	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
	Quality of the roads in the neighbourhood	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
	Length of the trip/journey	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
	Availability of pedestrian paths	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
	Availability of dedicated bicycle lanes	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)

	Availability of dedicated motorcycle/auto-rickshaw lanes	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
	Ease of access to most services	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
AT&PF	Safety of the trip	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
	Cost of the trip	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
	Time of travel/time of the day	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
	The comfort of the transport mode	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
	Privacy of the individual user	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)
	Physical effort involved in the use of transport mode	1-Not important (1-Not at all important, 2-Not so important) 2-Somewhat important (3) 3-Very important (4-Very important, 5-Extremely important)

Appendix 4: Chi-Square Contingency Tables Case Processing Summary.

Variables	Valid N	Valid Percent	Missing N	Missing Percent	Total N	Total Percent
Sub-location * Mode used now	415	100.0%	0	0.0%	415	100.0%
Gender * Mode used now	415	100.0%	0	0.0%	415	100.0%
Educational Level * Mode used now	415	100.0%	0	0.0%	415	100.0%
Income Group * Mode used now	415	100.0%	0	0.0%	415	100.0%
Present Travel Time * Mode used now	415	100.0%	0	0.0%	415	100.0%
Age Group * Mode used now	415	100.0%	0	0.0%	415	100.0%
Present Mode(s) Owned * Mode used now	415	100.0%	0	0.0%	415	100.0%
Household Children Under 2years * Mode used now	415	100.0%	0	0.0%	415	100.0%
Household Children 2-12 years * Mode used now	415	100.0%	0	0.0%	415	100.0%
Household Teenagers 13-19 years * Mode used now	415	100.0%	0	0.0%	415	100.0%
Household Adults 20-65 years * Mode used now	415	100.0%	0	0.0%	415	100.0%
Household Adults Over 65 years * Mode used now	415	100.0%	0	0.0%	415	100.0%
Number Household Members Earning * Mode used now	415	100.0%	0	0.0%	415	100.0%
Marital Status * Mode used now	415	100.0%	0	0.0%	415	100.0%
Employment Status * Mode used now	415	100.0%	0	0.0%	415	100.0%
Safety of the trip * Mode used now	415	100.0%	0	0.0%	415	100.0%
Cost of the trip * Mode used now	415	100.0%	0	0.0%	415	100.0%
Time of travel/time of the day * Mode used now	415	100.0%	0	0.0%	415	100.0%
Design of the roads * Mode used now	415	100.0%	0	0.0%	415	100.0%
Quality of the roads * Mode used now	415	100.0%	0	0.0%	415	100.0%
Length of the trip * Mode used now	415	100.0%	0	0.0%	415	100.0%
Availability of pedestrian paths * Mode used now	415	100.0%	0	0.0%	415	100.0%
Availability of bicycle lanes * Mode used now	415	100.0%	0	0.0%	415	100.0%
Availability of motorcycle lanes * Mode used now	415	100.0%	0	0.0%	415	100.0%
Comfort of transport mode * Mode used now	415	100.0%	0	0.0%	415	100.0%
Privacy of individual user * Mode used now	415	100.0%	0	0.0%	415	100.0%

Ease of access of most services * Mode used now	415	100.0%	0	0.0%	415	100.0%
Physical effort involved in mode use * Mode used now	415	100.0%	0	0.0%	415	100.0%
Sub-location * Mode used now	415	100.0%	0	0.0%	415	100.0%

Appendix 5: Chi-Square Variables Contingency Tables.

Sub-location		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Kogony	Count	5	3	61	28	11	2
	Expected Count	23.3	4.0	32.1	21.5	9.0	20.1
	% within Sub-location	4.5%	2.7%	55.5%	25.5%	10.0%	1.8%
	Standardized Residual	-3.8	-0.5	5.1	1.4	0.7	-4.0
	Adjusted Residual	-5.0	-0.6	7.1	1.8	0.8	-5.2
Nyalenda "A"	Count	75	10	47	51	3	1
	Expected Count	39.7	6.8	54.5	36.5	15.3	34.2
	% within Sub-location	40.1%	5.3%	25.1%	27.3%	1.6%	0.5%
	Standardized Residual	5.6	1.2	-1.0	2.4	-3.1	-5.7
	Adjusted Residual	8.5	1.7	-1.6	3.6	-4.4	-8.5
Migosi	Count	8	2	13	2	20	73
	Expected Count	25.0	4.3	34.4	23.0	9.7	21.6
	% within Sub-location	6.8%	1.7%	11.0%	1.7%	16.9%	61.9%
	Standardized Residual	-3.4	-1.1	-3.6	-4.4	3.3	11.1
	Adjusted Residual	-4.5	-1.3	-5.1	-5.8	4.1	14.5
Gender		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Male	Count	29	12	54	27	24	34
	Expected Count	38.2	6.5	52.5	35.1	14.7	33.0
	% within Gender	16.1%	6.7%	30.0%	15.0%	13.3%	18.9%
	Standardized Residual	-1.5	2.2	0.2	-1.4	2.4	0.2
	Adjusted Residual	-2.2	2.9	0.3	-2.0	3.3	0.3
Female	Count	59	3	67	54	10	42
	Expected Count	49.8	8.5	68.5	45.9	19.3	43.0
	% within Gender	25.1%	1.3%	28.5%	23.0%	4.3%	17.9%
	Standardized Residual	1.3	-1.9	-0.2	1.2	-2.1	-0.2
	Adjusted Residual	2.2	-2.9	-0.3	2.0	-3.3	-0.3
Educational Level		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Low	Count	28	9	45	33	3	19
	Expected Count	29.1	5.0	39.9	26.7	11.2	25.1
	% within Educational Level	20.4%	6.6%	32.8%	24.1%	2.2%	13.9%
	Standardized Residual	-0.2	1.8	0.8	1.2	-2.5	-1.2
	Adjusted Residual	-0.3	2.3	1.2	1.6	-3.1	-1.6
Middle	Count	60	6	72	45	18	53
	Expected Count	53.9	9.2	74.1	49.6	20.8	46.5
	% within Educational Level	23.6%	2.4%	28.3%	17.7%	7.1%	20.9%
	Standardized Residual	0.8	-1.0	-0.2	-0.6	-0.6	1.0
	Adjusted Residual	1.5	-1.7	-0.5	-1.2	-1.0	1.7
High	Count	0	0	4	3	13	4
	Expected Count	5.1	0.9	7.0	4.7	2.0	4.4

	% within Educational Level	0.0%	0.0%	16.7%	12.5%	54.2%	16.7%
	Standardized Residual	-2.3	-0.9	-1.1	-0.8	7.9	-0.2
	Adjusted Residual	-2.6	-1.0	-1.4	-0.9	8.5	-0.2

Income group		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Low	Count	85	15	103	79	6	65
	Expected Count	74.9	12.8	102.9	68.9	28.9	64.6
	% within Income Group	24.1%	4.2%	29.2%	22.4%	1.7%	18.4%
	Standardized Residual	1.2	0.6	0.0	1.2	-4.3	0.0
	Adjusted Residual	3.4	1.7	0.0	3.5	-11.5	0.1
Middle	Count	3	0	17	2	18	11
	Expected Count	10.8	1.8	14.9	10.0	4.2	9.3
	% within Income Group	5.9%	0.0%	33.3%	3.9%	35.3%	21.6%
	Standardized Residual	-2.4	-1.4	0.6	-2.5	6.8	0.5
	Adjusted Residual	-2.9	-1.5	0.7	-3.0	7.5	0.6
High	Count	0	0	1	0	10	0
	Expected Count	2.3	0.4	3.2	2.1	0.9	2.0
	% within Income Group	0.0%	0.0%	9.1%	0.0%	90.9%	0.0%
	Standardized Residual	-1.5	-0.6	-1.2	-1.5	9.6	-1.4
	Adjusted Residual	-1.7	-0.7	-1.5	-1.7	10.1	-1.6

Present travel time		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Less than 10 minutes	Count	54	3	64	31	9	9
	Expected Count	36.0	6.1	49.6	33.2	13.9	31.1
	% within Present Travel Time	31.8%	1.8%	37.6%	18.2%	5.3%	5.3%
	Standardized Residual	3.0	-1.3	2.1	-0.4	-1.3	-4.0
	Adjusted Residual	4.4	-1.7	3.2	-0.5	-1.8	-5.7
11 to 20 minutes	Count	9	9	45	41	21	50
	Expected Count	37.1	6.3	51.0	34.2	14.3	32.0
	% within Present Travel Time	5.1%	5.1%	25.7%	23.4%	12.0%	28.6%
	Standardized Residual	-4.6	1.1	-0.8	1.2	1.8	3.2
	Adjusted Residual	-6.8	1.4	-1.3	1.7	2.4	4.6
21 to 30 minutes	Count	16	0	9	7	2	17
	Expected Count	10.8	1.8	14.9	10.0	4.2	9.3
	% within Present Travel Time	31.4%	0.0%	17.6%	13.7%	3.9%	33.3%
	Standardized Residual	1.6	-1.4	-1.5	-0.9	-1.1	2.5
	Adjusted Residual	1.9	-1.5	-1.9	-1.1	-1.2	3.0
More than 30 minutes	Count	9	3	3	2	2	0
	Expected Count	4.0	0.7	5.5	3.7	1.6	3.5
	% within Present Travel Time	47.4%	15.8%	15.8%	10.5%	10.5%	0.0%
	Standardized Residual	2.5	2.8	-1.1	-0.9	0.4	-1.9

	Adjusted Residual	2.9	2.9	-1.3	-1.0	0.4	-2.1
Age group		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
15-29 years	Count	31	3	41	24	0	31
	Expected Count	27.6	4.7	37.9	25.4	10.7	23.8
	% within Age Group	23.8%	2.3%	31.5%	18.5%	0.0%	23.8%
	Standardized Residual	0.7	-0.8	0.5	-0.3	-3.3	1.5
	Adjusted Residual	0.9	-1.0	0.7	-0.4	-4.1	2.0
30-49 years	Count	49	10	70	52	16	37
	Expected Count	49.6	8.5	68.2	45.7	19.2	42.9
	% within Age Group	20.9%	4.3%	29.9%	22.2%	6.8%	15.8%
	Standardized Residual	-0.1	0.5	0.2	0.9	-0.7	-0.9
	Adjusted Residual	-0.1	0.8	0.4	1.6	-1.1	-1.5
Above 50 years	Count	8	2	10	5	18	8
	Expected Count	10.8	1.8	14.9	10.0	4.2	9.3
	% within Age Group	15.7%	3.9%	19.6%	9.8%	35.3%	15.7%
	Standardized Residual	-0.9	0.1	-1.3	-1.6	6.8	-0.4
	Adjusted Residual	-1.0	0.1	-1.6	-1.9	7.5	-0.5
Present Mode(s) Owned		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
None	Count	77	2	70	64	3	68
	Expected Count	60.2	10.3	82.8	55.4	23.3	52.0
	% within Present Mode(s) Owned	27.1%	0.7%	24.6%	22.5%	1.1%	23.9%
	Standardized Residual	2.2	-2.6	-1.4	1.2	-4.2	2.2
	Adjusted Residual	4.3	-4.7	-3.0	2.3	-7.8	4.4
Bicycle	Count	6	13	5	7	0	1
	Expected Count	6.8	1.2	9.3	6.2	2.6	5.9
	% within Present Mode(s) Owned	18.8%	40.6%	15.6%	21.9%	0.0%	3.1%
	Standardized Residual	-0.3	11.0	-1.4	0.3	-1.6	-2.0
	Adjusted Residual	-0.4	11.7	-1.8	0.4	-1.8	-2.3
Motorcycle	Count	4	0	38	8	0	3
	Expected Count	11.2	1.9	15.5	10.3	4.3	9.7
	% within Present Mode(s) Owned	7.5%	0.0%	71.7%	15.1%	0.0%	5.7%
	Standardized Residual	-2.2	-1.4	5.7	-0.7	-2.1	-2.2
	Adjusted Residual	-2.6	-1.5	7.3	-0.9	-2.3	-2.5
Auto-rickshaw	Count	1	0	8	2	31	4
	Expected Count	9.8	1.7	13.4	9.0	3.8	8.4
	% within Present Mode(s) Owned	2.2%	0.0%	17.4%	4.3%	67.4%	8.7%
	Standardized Residual	-2.8	-1.3	-1.5	-2.3	14.0	-1.5
	Adjusted Residual	-3.3	-1.4	-1.9	-2.8	15.5	-1.8

Household Children Under 2years		Walking	Bicycle	Motorcycle	Auto-rickshaw	Car	Matatu
No member	Count	46	11	78	46	31	60
	Expected Count	57.7	9.8	79.3	53.1	22.3	49.8
	% within Household Children Under 2years	16.9%	4.0%	28.7%	16.9%	11.4%	22.1%
	Standardized Residual	-1.5	0.4	-0.1	-1.0	1.8	1.4
	Adjusted Residual	-3.0	0.6	-0.3	-1.8	3.3	2.7
1 or more	Count	42	4	43	35	3	16
	Expected Count	30.3	5.2	41.7	27.9	11.7	26.2
	% within Household Children Under 2years	29.4%	2.8%	30.1%	24.5%	2.1%	11.2%
	Standardized Residual	2.1	-0.5	0.2	1.3	-2.5	-2.0
	Adjusted Residual	3.0	-0.6	0.3	1.8	-3.3	-2.7

Household Children 2-12 years		Walking	Bicycle	Motorcycle	Auto-rickshaw	Car	Matatu
No member	Count	23	8	30	24	12	43
	Expected Count	29.7	5.1	40.8	27.3	11.5	25.6
	% within Household Children 2-12 years	16.4%	5.7%	21.4%	17.1%	8.6%	30.7%
	Standardized Residual	-1.2	1.3	-1.7	-0.6	0.2	3.4
	Adjusted Residual	-1.7	1.6	-2.5	-0.9	0.2	4.7
1 or more	Count	65	7	91	57	22	33
	Expected Count	58.3	9.9	80.2	53.7	22.5	50.4
	% within Household Children 2-12 years	23.6%	2.5%	33.1%	20.7%	8.0%	12.0%
	Standardized Residual	0.9	-0.9	1.2	0.5	-0.1	-2.4
	Adjusted Residual	1.7	-1.6	2.5	0.9	-0.2	-4.7

Household Teenagers 13-19 years		Walking	Bicycle	Motorcycle	Auto-rickshaw	Car	Matatu
No member	Count	32	6	43	30	10	42
	Expected Count	34.6	5.9	47.5	31.8	13.4	29.9
	% within Household Teenagers 13-19 years	19.6%	3.7%	26.4%	18.4%	6.1%	25.8%
	Standardized Residual	-0.4	0.0	-0.7	-0.3	-0.9	2.2
	Adjusted Residual	-0.6	0.1	-1.0	-0.5	-1.2	3.2
1 or more	Count	56	9	78	51	24	34
	Expected Count	53.4	9.1	73.5	49.2	20.6	46.1
	% within Household Teenagers 13-19 years	22.2%	3.6%	31.0%	20.2%	9.5%	13.5%

	Standardized Residual	0.4	0.0	0.5	0.3	0.7	-1.8
	Adjusted Residual	0.6	-0.1	1.0	0.5	1.2	-3.2
Household Adults 20-65 years		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
No member	Count	2	0	3	0	0	1
	Expected Count	1.3	0.2	1.7	1.2	0.5	1.1
	% within Household Adults 20-65 years	33.3%	0.0%	50.0%	0.0%	0.0%	16.7%
	Standardized Residual	0.6	-0.5	0.9	-1.1	-0.7	-0.1
	Adjusted Residual	0.7	-0.5	1.1	-1.2	-0.7	-0.1
1 or more	Count	86	15	118	81	34	75
	Expected Count	86.7	14.8	119.3	79.8	33.5	74.9
	% within Household Adults 20-65 years	21.0%	3.7%	28.9%	19.8%	8.3%	18.3%
	Standardized Residual	-0.1	0.1	-0.1	0.1	0.1	0.0
	Adjusted Residual	-0.7	0.5	-1.1	1.2	0.7	0.1
Household Adults Over 65 years		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
No member	Count	85	15	115	80	23	73
	Expected Count	82.9	14.1	114.0	76.3	32.0	71.6
	% within Household Adults Over 65 years	21.7%	3.8%	29.4%	20.5%	5.9%	18.7%
	Standardized Residual	0.2	0.2	0.1	0.4	-1.6	0.2
	Adjusted Residual	1.1	1.0	0.5	2.0	-6.9	0.8
1 or more	Count	3	0	6	1	11	3
	Expected Count	5.1	0.9	7.0	4.7	2.0	4.4
	% within Household Adults Over 65 years	12.5%	0.0%	25.0%	4.2%	45.8%	12.5%
	Standardized Residual	-0.9	-0.9	-0.4	-1.7	6.4	-0.7
	Adjusted Residual	-1.1	-1.0	-0.5	-2.0	6.9	-0.8
Number Household Members Earning		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
No member	Count	0	0	1	1	0	2
	Expected Count	0.8	0.1	1.2	0.8	0.3	0.7
	% within Number Household Members Earning	0.0%	0.0%	25.0%	25.0%	0.0%	50.0%
	Standardized Residual	-0.9	-0.4	-0.2	0.2	-0.6	1.5
	Adjusted Residual	-1.0	-0.4	-0.2	0.3	-0.6	1.6
1 or more	Count	88	15	120	80	34	74
	Expected Count	87.2	14.9	119.8	80.2	33.7	75.3

	% within Number Household Members Earning	21.4%	3.6%	29.2%	19.5%	8.3%	18.0%
	Standardized Residual	0.1	0.0	0.0	0.0	0.1	-0.1
	Adjusted Residual	1.0	0.4	0.2	-0.3	0.6	-1.6
Marital Status		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Single	Count	23	5	23	15	0	30
	Expected Count	20.4	3.5	28.0	18.7	7.9	17.6
	% within Marital Status	24.0%	5.2%	24.0%	15.6%	0.0%	31.3%
	Standardized Residual	0.6	0.8	-0.9	-0.9	-2.8	3.0
	Adjusted Residual	0.8	1.0	-1.3	-1.1	-3.3	3.7
Married	Count	59	10	92	59	27	35
	Expected Count	59.8	10.2	82.2	55.0	23.1	51.6
	% within Marital Status	20.9%	3.5%	32.6%	20.9%	9.6%	12.4%
	Standardized Residual	-0.1	-0.1	1.1	0.5	0.8	-2.3
	Adjusted Residual	-0.2	-0.1	2.3	1.1	1.5	-4.5
Divorced/Separated/Widowed	Count	6	0	6	7	7	11
	Expected Count	7.8	1.3	10.8	7.2	3.0	6.8
	% within Marital Status	16.2%	0.0%	16.2%	18.9%	18.9%	29.7%
	Standardized Residual	-0.7	-1.2	-1.5	-0.1	2.3	1.6
	Adjusted Residual	-0.8	-1.2	-1.8	-0.1	2.5	1.9
Employment Status		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Employed	Count	7	2	25	14	16	24
	Expected Count	18.7	3.2	25.7	17.2	7.2	16.1
	% within Employment Status	8.0%	2.3%	28.4%	15.9%	18.2%	27.3%
	Standardized Residual	-2.7	-0.7	-0.1	-0.8	3.3	2.0
	Adjusted Residual	-3.4	-0.8	-0.2	-1.0	3.8	2.4
Self-employed	Count	47	8	65	46	9	20
	Expected Count	41.3	7.0	56.9	38.1	16.0	35.7
	% within Employment Status	24.1%	4.1%	33.3%	23.6%	4.6%	10.3%
	Standardized Residual	0.9	0.4	1.1	1.3	-1.7	-2.6
	Adjusted Residual	1.4	0.5	1.8	2.0	-2.5	-4.0
Student	Count	6	1	13	6	0	13
	Expected Count	8.3	1.4	11.4	7.6	3.2	7.1
	% within Employment Status	15.4%	2.6%	33.3%	15.4%	0.0%	33.3%
	Standardized Residual	-0.8	-0.3	0.5	-0.6	-1.8	2.2
	Adjusted Residual	-0.9	-0.4	0.6	-0.7	-2.0	2.5
Unemployed	Count	28	4	18	15	9	19
	Expected Count	19.7	3.4	27.1	18.2	7.6	17.0
	% within Employment Status	30.1%	4.3%	19.4%	16.1%	9.7%	20.4%

	Standardized Residual	1.9	0.3	-1.8	-0.7	0.5	0.5
	Adjusted Residual	2.4	0.4	-2.4	-0.9	0.6	0.6
Safety of the trip		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Not important	Count	2	0	2	1	0	2
	Expected Count	1.5	0.3	2.0	1.4	0.6	1.3
	% within Safety of the trip	28.6%	0.0%	28.6%	14.3%	0.0%	28.6%
	Standardized Residual	0.4	-0.5	0.0	-0.3	-0.8	0.6
	Adjusted Residual	0.5	-0.5	0.0	-0.4	-0.8	0.7
Somewhat important	Count	6	0	2	0	0	0
	Expected Count	1.7	0.3	2.3	1.6	0.7	1.5
	% within Safety of the trip	75.0%	0.0%	25.0%	0.0%	0.0%	0.0%
	Standardized Residual	3.3	-0.5	-0.2	-1.2	-0.8	-1.2
	Adjusted Residual	3.8	-0.6	-0.3	-1.4	-0.9	-1.4
Very important	Count	80	15	117	80	34	74
	Expected Count	84.8	14.5	116.6	78.1	32.8	73.3
	% within Safety of the trip	20.0%	3.8%	29.3%	20.0%	8.5%	18.5%
	Standardized Residual	-0.5	0.1	0.0	0.2	0.2	0.1
	Adjusted Residual	-3.1	0.8	0.2	1.3	1.2	0.5
Cost of the trip		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Not important	Count	3	2	1	0	1	2
	Expected Count	1.9	0.3	2.6	1.8	0.7	1.6
	% within Cost of the trip	33.3%	22.2%	11.1%	0.0%	11.1%	22.2%
	Standardized Residual	0.8	2.9	-1.0	-1.3	0.3	0.3
	Adjusted Residual	0.9	3.0	-1.2	-1.5	0.3	0.3
Somewhat important	Count	9	0	6	5	1	1
	Expected Count	4.7	0.8	6.4	4.3	1.8	4.0
	% within Cost of the trip	40.9%	0.0%	27.3%	22.7%	4.5%	4.5%
	Standardized Residual	2.0	-0.9	-0.2	0.3	-0.6	-1.5
	Adjusted Residual	2.3	-0.9	-0.2	0.4	-0.6	-1.7
Very important	Count	76	13	114	76	32	73
	Expected Count	81.4	13.9	112.0	74.9	31.5	70.3
	% within Cost of the trip	19.8%	3.4%	29.7%	19.8%	8.3%	19.0%
	Standardized Residual	-0.6	-0.2	0.2	0.1	0.1	0.3
	Adjusted Residual	-2.5	-0.9	0.8	0.5	0.4	1.3
Time of travel/time of the day		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Not important	Count	3	0	2	1	6	1
	Expected Count	2.8	0.5	3.8	2.5	1.1	2.4

	% within Time of travel/time of the day	23.1%	0.0%	15.4%	7.7%	46.2%	7.7%
	Standardized Residual	0.1	-0.7	-0.9	-1.0	4.8	-0.9
	Adjusted Residual	0.2	-0.7	-1.1	-1.1	5.1	-1.0
	Count	15	2	13	12	1	11
	Expected Count	11.5	2.0	15.7	10.5	4.4	9.9
Somewhat important	% within Time of travel/time of the day	27.8%	3.7%	24.1%	22.2%	1.9%	20.4%
	Standardized Residual	1.0	0.0	-0.7	0.4	-1.6	0.4
	Adjusted Residual	1.3	0.0	-0.9	0.5	-1.8	0.4
	Count	70	13	106	68	27	64
	Expected Count	73.8	12.6	101.5	67.9	28.5	63.7
Very important	% within Time of travel/time of the day	20.1%	3.7%	30.5%	19.5%	7.8%	18.4%
	Standardized Residual	-0.4	0.1	0.5	0.0	-0.3	0.0
	Adjusted Residual	-1.2	0.3	1.3	0.0	-0.7	0.1
Design of the roads		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
	Count	9	0	10	4	1	9
	Expected Count	7.0	1.2	9.6	6.4	2.7	6.0
Not important	% within Design of the roads	27.3%	0.0%	30.3%	12.1%	3.0%	27.3%
	Standardized Residual	0.8	-1.1	0.1	-1.0	-1.0	1.2
	Adjusted Residual	0.9	-1.2	0.2	-1.1	-1.1	1.4
	Count	30	3	48	25	6	23
	Expected Count	28.6	4.9	39.4	26.3	11.1	24.7
Somewhat important	% within Design of the roads	22.2%	2.2%	35.6%	18.5%	4.4%	17.0%
	Standardized Residual	0.3	-0.9	1.4	-0.3	-1.5	-0.3
	Adjusted Residual	0.4	-1.1	2.0	-0.4	-1.9	-0.5
	Count	49	12	63	52	27	44
	Expected Count	52.4	8.9	72.0	48.2	20.2	45.2
Very important	% within Design of the roads	19.8%	4.9%	25.5%	21.1%	10.9%	17.8%
	Standardized Residual	-0.5	1.0	-1.1	0.5	1.5	-0.2
	Adjusted Residual	-0.8	1.6	-2.0	1.0	2.5	-0.3
Quality of the roads		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
	Count	9	0	9	6	1	7
	Expected Count	6.8	1.2	9.3	6.2	2.6	5.9
Not important	% within Quality of the roads	28.1%	0.0%	28.1%	18.8%	3.1%	21.9%
	Standardized Residual	0.9	-1.1	-0.1	-0.1	-1.0	0.5
	Adjusted Residual	1.0	-1.1	-0.1	-0.1	-1.1	0.5
Somewhat important	Count	41	3	42	24	8	27
	Expected Count	30.7	5.2	42.3	28.3	11.9	26.6

	% within Quality of the roads	28.3%	2.1%	29.0%	16.6%	5.5%	18.6%
	Standardized Residual	1.8	-1.0	0.0	-0.8	-1.1	0.1
	Adjusted Residual	2.6	-1.2	-0.1	-1.1	-1.5	0.1
	Count	38	12	70	51	25	42
	Expected Count	50.5	8.6	69.4	46.5	19.5	43.6
Very important	% within Quality of the roads	16.0%	5.0%	29.4%	21.4%	10.5%	17.6%
	Standardized Residual	-1.8	1.2	0.1	0.7	1.2	-0.2
	Adjusted Residual	-3.0	1.8	0.1	1.1	2.0	-0.4
Length of the trip		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
	Count	7	1	18	9	1	8
	Expected Count	9.3	1.6	12.8	8.6	3.6	8.1
Not important	% within Length of the trip	15.9%	2.3%	40.9%	20.5%	2.3%	18.2%
	Standardized Residual	-0.8	-0.5	1.4	0.1	-1.4	0.0
	Adjusted Residual	-0.9	-0.5	1.8	0.2	-1.5	0.0
	Count	41	2	34	27	7	24
	Expected Count	28.6	4.9	39.4	26.3	11.1	24.7
Somewhat important	% within Length of the trip	30.4%	1.5%	25.2%	20.0%	5.2%	17.8%
	Standardized Residual	2.3	-1.3	-0.9	0.1	-1.2	-0.1
	Adjusted Residual	3.2	-1.6	-1.2	0.2	-1.6	-0.2
	Count	40	12	69	45	26	44
	Expected Count	50.0	8.5	68.8	46.1	19.3	43.2
Very important	% within Length of the trip	16.9%	5.1%	29.2%	19.1%	11.0%	18.6%
	Standardized Residual	-1.4	1.2	0.0	-0.2	1.5	0.1
	Adjusted Residual	-2.4	1.8	0.0	-0.3	2.4	0.2
Availability of pedestrian paths		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
	Count	11	1	20	12	3	12
	Expected Count	12.5	2.1	17.2	11.5	4.8	10.8
Not important	% within Availability of pedestrian paths	18.6%	1.7%	33.9%	20.3%	5.1%	20.3%
	Standardized Residual	-0.4	-0.8	0.7	0.1	-0.8	0.4
	Adjusted Residual	-0.5	-0.9	0.9	0.2	-0.9	0.4
	Count	36	5	44	31	12	34
	Expected Count	34.4	5.9	47.2	31.6	13.3	29.7
Somewhat important	% within Availability of pedestrian paths	22.2%	3.1%	27.2%	19.1%	7.4%	21.0%
	Standardized Residual	0.3	-0.4	-0.5	-0.1	-0.3	0.8
	Adjusted Residual	0.4	-0.5	-0.7	-0.2	-0.5	1.1
	Count	41	9	57	38	19	30
Very important	Expected Count	41.1	7.0	56.6	37.9	15.9	35.5

	% within Availability of pedestrian paths	21.1%	4.6%	29.4%	19.6%	9.8%	15.5%
	Standardized Residual	0.0	0.8	0.1	0.0	0.8	-0.9
	Adjusted Residual	0.0	1.0	0.1	0.0	1.1	-1.4
Availability of bicycle lanes		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Not important	Count	13	1	22	9	2	22
	Expected Count	14.6	2.5	20.1	13.5	5.7	12.6
	% within Availability of bicycle lanes	18.8%	1.4%	31.9%	13.0%	2.9%	31.9%
	Standardized Residual	-0.4	-0.9	0.4	-1.2	-1.5	2.6
	Adjusted Residual	-0.5	-1.1	0.5	-1.5	-1.8	3.2
Somewhat important	Count	41	2	38	35	18	31
	Expected Count	35.0	6.0	48.1	32.2	13.5	30.2
	% within Availability of bicycle lanes	24.8%	1.2%	23.0%	21.2%	10.9%	18.8%
	Standardized Residual	1.0	-1.6	-1.5	0.5	1.2	0.1
	Adjusted Residual	1.5	-2.1	-2.2	0.7	1.6	0.2
Very important	Count	34	12	61	37	14	23
	Expected Count	38.4	6.5	52.8	35.3	14.8	33.1
	% within Availability of bicycle lanes	18.8%	6.6%	33.7%	20.4%	7.7%	12.7%
	Standardized Residual	-0.7	2.1	1.1	0.3	-0.2	-1.8
	Adjusted Residual	-1.1	2.9	1.8	0.4	-0.3	-2.6
Availability of motorcycle lanes		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Not important	Count	10	0	13	5	2	22
	Expected Count	11.0	1.9	15.2	10.1	4.3	9.5
	% within Availability of motorcycle lanes	19.2%	0.0%	25.0%	9.6%	3.8%	42.3%
	Standardized Residual	-0.3	-1.4	-0.6	-1.6	-1.1	4.0
	Adjusted Residual	-0.4	-1.5	-0.7	-1.9	-1.2	4.8
Somewhat important	Count	34	5	28	29	17	35
	Expected Count	31.4	5.3	43.2	28.9	12.1	27.1
	% within Availability of motorcycle lanes	23.0%	3.4%	18.9%	19.6%	11.5%	23.6%
	Standardized Residual	0.5	-0.2	-2.3	0.0	1.4	1.5
	Adjusted Residual	0.7	-0.2	-3.4	0.0	1.8	2.1
Very important	Count	44	10	80	47	15	19
	Expected Count	45.6	7.8	62.7	42.0	17.6	39.4
	% within Availability of motorcycle lanes	20.5%	4.7%	37.2%	21.9%	7.0%	8.8%

	Standardized Residual	-0.2	0.8	2.2	0.8	-0.6	-3.2
	Adjusted Residual	-0.4	1.2	3.7	1.2	-0.9	-5.2
The comfort of transport mode		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Not important	Count	9	0	5	8	2	23
	Expected Count	10.0	1.7	13.7	9.2	3.9	8.6
	% within Comfort of transport mode	19.1%	0.0%	10.6%	17.0%	4.3%	48.9%
	Standardized Residual	-0.3	-1.3	-2.4	-0.4	-0.9	4.9
	Adjusted Residual	-0.4	-1.4	-3.0	-0.5	-1.0	5.8
Somewhat important	Count	28	2	27	21	7	24
	Expected Count	23.1	3.9	31.8	21.3	8.9	20.0
	% within Comfort of transport mode	25.7%	1.8%	24.8%	19.3%	6.4%	22.0%
	Standardized Residual	1.0	-1.0	-0.8	-0.1	-0.6	0.9
	Adjusted Residual	1.3	-1.2	-1.2	-0.1	-0.8	1.2
Very important	Count	51	13	89	52	25	29
	Expected Count	54.9	9.4	75.5	50.6	21.2	47.4
	% within Comfort of transport mode	19.7%	5.0%	34.4%	20.1%	9.7%	11.2%
	Standardized Residual	-0.5	1.2	1.6	0.2	0.8	-2.7
	Adjusted Residual	-1.0	2.0	3.0	0.4	1.4	-4.8
Privacy of individual user		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Not important	Count	7	3	9	8	3	25
	Expected Count	11.7	2.0	16.0	10.7	4.5	10.1
	% within Privacy of individual user	12.7%	5.5%	16.4%	14.5%	5.5%	45.5%
	Standardized Residual	-1.4	0.7	-1.8	-0.8	-0.7	4.7
	Adjusted Residual	-1.7	0.8	-2.2	-1.0	-0.8	5.6
Somewhat important	Count	22	2	24	8	7	24
	Expected Count	18.4	3.1	25.4	17.0	7.1	15.9
	% within Privacy of individual user	25.3%	2.3%	27.6%	9.2%	8.0%	27.6%
	Standardized Residual	0.8	-0.6	-0.3	-2.2	0.0	2.0
	Adjusted Residual	1.0	-0.7	-0.4	-2.7	-0.1	2.5
Very important	Count	59	10	88	65	24	27
	Expected Count	57.9	9.9	79.6	53.3	22.4	50.0
	% within Privacy of individual user	21.6%	3.7%	32.2%	23.8%	8.8%	9.9%
	Standardized Residual	0.1	0.0	0.9	1.6	0.3	-3.3
	Adjusted Residual	0.3	0.1	1.9	3.1	0.6	-6.2
Ease of access to most services		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Not important	Count	16	0	3	5	0	10
	Expected Count	7.2	1.2	9.9	6.6	2.8	6.2

	% within Ease of access of most services	47.1%	0.0%	8.8%	14.7%	0.0%	29.4%
	Standardized Residual	3.3	-1.1	-2.2	-0.6	-1.7	1.5
	Adjusted Residual	3.8	-1.2	-2.7	-0.7	-1.8	1.7
Somewhat important	Count	22	2	14	23	4	19
	Expected Count	17.8	3.0	24.5	16.4	6.9	15.4
	% within Ease of access of most services	26.2%	2.4%	16.7%	27.4%	4.8%	22.6%
	Standardized Residual	1.0	-0.6	-2.1	1.6	-1.1	0.9
	Adjusted Residual	1.3	-0.7	-2.8	2.0	-1.3	1.1
Very important	Count	50	13	104	53	30	47
	Expected Count	63.0	10.7	86.6	58.0	24.3	54.4
	% within Ease of access to most services	16.8%	4.4%	35.0%	17.8%	10.1%	15.8%
	Standardized Residual	-1.6	0.7	1.9	-0.7	1.1	-1.0
	Adjusted Residual	-3.5	1.3	4.2	-1.4	2.2	-2.1
Physical effort involved in mode use		**Walking**	**Bicycle**	**Motorcycle**	**Auto-rickshaw**	**Car**	**Matatu**
Not important	Count	3	0	5	9	5	21
	Expected Count	9.1	1.6	12.5	8.4	3.5	7.9
	% within Physical effort involved in mode use	7.0%	0.0%	11.6%	20.9%	11.6%	48.8%
	Standardized Residual	-2.0	-1.2	-2.1	0.2	0.8	4.7
	Adjusted Residual	-2.4	-1.3	-2.7	0.2	0.9	5.5
Somewhat important	Count	7	0	23	13	11	27
	Expected Count	17.2	2.9	23.6	15.8	6.6	14.8
	% within Physical effort involved in mode use	8.6%	0.0%	28.4%	16.0%	13.6%	33.3%
	Standardized Residual	-2.5	-1.7	-0.1	-0.7	1.7	3.2
	Adjusted Residual	-3.1	-1.9	-0.2	-0.9	2.0	3.9
Very important	Count	78	15	93	59	18	28
	Expected Count	61.7	10.5	84.8	56.8	23.8	53.3
	% within Physical effort involved in mode use	26.8%	5.2%	32.0%	20.3%	6.2%	9.6%
	Standardized Residual	2.1	1.4	0.9	0.3	-1.2	-3.5
	Adjusted Residual	4.3	2.6	1.9	0.6	-2.3	-7.0

Appendix 6: Chi-Square Test of Association Results.

Variable	χ^2	df	Cramer's V	Significance Level (p<.05)	Chi-Square test satisfied
Sub-location	320.10	10	0.6	0.00	2 cells (11.1%) have expected count less than 5. The minimum expected count is 3.98.
Gender	25.80	5	0.2	0.00	0 cells (.0%) have expected count less than 5. The minimum expected count is 6.51.
Educational level	86.32	10	0.3	0.00	5 cells (27.8%) have expected count less than 5. The minimum expected count is 0.87.
Income group	181.86	10	0.5	0.00	8 cells (44.4%) have expected count less than 5. The minimum expected count is 0.40
Present Travel Time	104.46	15	0.3	0.00	7 cells (29.2%) have expected count less than 5. The minimum expected count is 0.69.
Head of household	26.97	5	0.3	0.00	0 cells (.0%) have expected count less than 5. The minimum expected count is 7.48.
Age Group	67.45	10	0.3	0.00	3 cells (16.7%) have expected count less than 5. The minimum expected count is 1.84.
Present Mode(s) Owned	432.52	15	0.6	0.00	6 cells (25.0%) have expected count less than 5. The minimum expected count is 1.16.
Household Children Under 2years	26.01	5	0.3	0.00	0 cells (.0%) have expected count less than 5. The minimum expected count is 5.17.
Household Children 2-12 years	27.57	5	0.3	0.00	0 cells (.0%) have expected count less than 5. The minimum expected count is 5.06.
Household Teenagers 13-19 years	10.73	5	0.1	0.06	0 cells (.0%) have expected count less than 5. The minimum expected count is 5.89.
Household Adults 20-65 years	3.25	5	0.1	0.66	6 cells (50.0%) have expected count less than 5. The minimum expected count is 0.22.
Household Adults Over 65 years	49.58	5	0.3	0.00	4 cells (33.3%) have expected count less than 5. The minimum expected count is 0.87.
Number Household Members Earning	3.63	5	0.1	0.60	6 cells (50.0%) have expected count less than 5. The minimum expected count is 0.14.

Design of Roads	15.41	10	0.1	0.12	3 cells (16.7%) have expected count less than 5. The minimum expected count is 1.19.
Quality of Roads	15.92	10	0.1	0.10	2 cells (11.1%) have expected count less than 5. The minimum expected count is 1.16.
Length of the Trip	19.86	10	0.2	0.03	3 cells (16.7%) have expected count less than 5. The minimum expected count is 1.59.
Availability of Pedestrian Paths	5.31	10	0.1	0.87	2 cells (11.1%) have expected count less than 5. The minimum expected count is 2.13.
Availability of Bicycles Lanes	29.14	10	0.2	0.00	1 cell (5.6%) have expected count less than 5. The minimum expected count is 2.49.
Availability of Motorcycle Lanes	49.28	10	0.2	0.00	2 cells (11.1%) have expected count less than 5. The minimum expected count is 1.88.
Ease of access to most services	42.20	10	0.2	0.00	3 cells (16.7%) have expected count less than 5. The minimum expected count is 1.23.
Safety of the Trip	16.84	10	0.1	0.08	12 cells (66.7%) have expected count less than 5. The minimum expected count is 0.25.
Cost of the Trip	20.36	10	0.2	0.03	11 cells (61.1%) have expected count less than 5. The minimum expected count is 0.33.
Time of travel or time of the day	30.99	10	0.2	0.01	8 cells (44.4%) have expected count less than 5. The minimum expected count is 0.47.
The comfort of the mode used	48.35	10	0.2	0.00	3 cells (16.7%) have expected count less than 5. The minimum expected count is 1.70.
Privacy of the mode user	52.98	10	0.3	0.00	3 cells (16.7%) have expected count less than 5. The minimum expected count is 1.99.
Physical effort involved in mode use	75.57	10	0.3	0.00	3 cells (16.7%) have expected count less than 5. The minimum expected count is 1.55.
Marital Status	38.51	10	0.3	0.00	3 cells (16.7%) have expected count less than 5. The minimum expected count is 1.34.
Employment Status	53.59	15	0.2	0.00	4 cells (16.7%) have expected count less than 5. The minimum expected count is 1.41.

Appendix 7: Research permit.

THIS IS TO CERTIFY THAT:
MR. EDWIN OUMA OKOYO
of ITC, UNIVERSITY OF TWENTE,
4626-200 Nairobi,has been permitted to
conduct research in *Kisumu County*

on the topic: *ANALYSIS OF FACTORS INFLUENCING THE CHANGES IN THE USE OF TRANSPORT MODES IN KISUMU, KENYA*

for the period ending:
12th December,2019

Permit No : NACOSTI/P/18/65695/27173
Date Of Issue : 12th December,2018
Fee Recieved :Ksh 1000

Applicant's Signature

Director General
National Commission for Science, Technology & Innovation

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014.

CONDITIONS

1. **The License is valid for the proposed research, location and specified period.**
2. **The License and any rights thereunder are non-transferable.**
3. **The Licensee shall inform the County Governor before commencement of the research.**
4. **Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies.**
5. **The License does not give authority to transfer research materials.**
6. **NACOSTI may monitor and evaluate the licensed research project.**
7. **The Licensee shall submit one hard copy and upload a soft copy of their final report within one year of completion of the research.**
8. **NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice.**

National Commission for Science, Technology and innovation
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Website: www.nacosti.go.ke

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH LICENSE

Serial No.A 22378

CONDITIONS: see back page

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No. **NACOSTI/P/18/65695/27173**

Date: **12th December, 2018**

Edwin Ouma Okoyo
University of Twente
NETHERLANDS

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Analysis of factors influencing the changes in the use of transport modes in Kisumu, Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **Kisumu County** for the period ending **12th December, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Kisumu County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

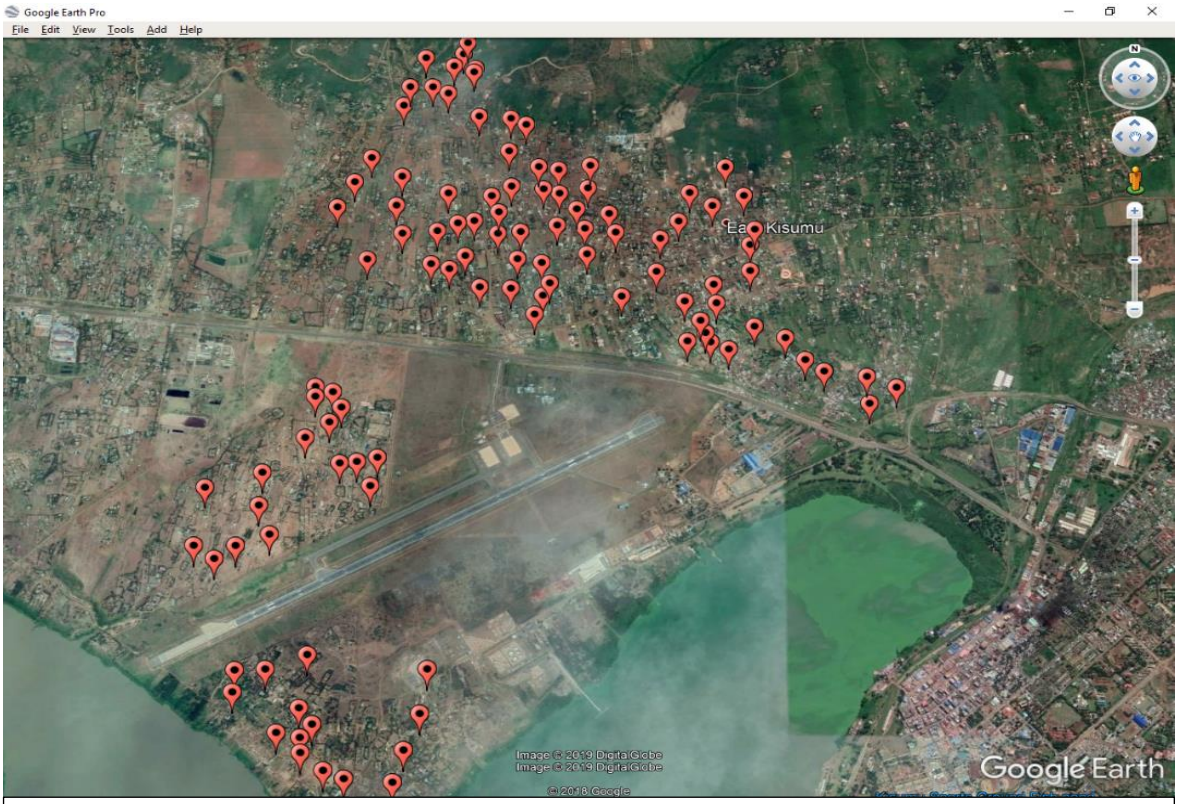
GODFREY KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

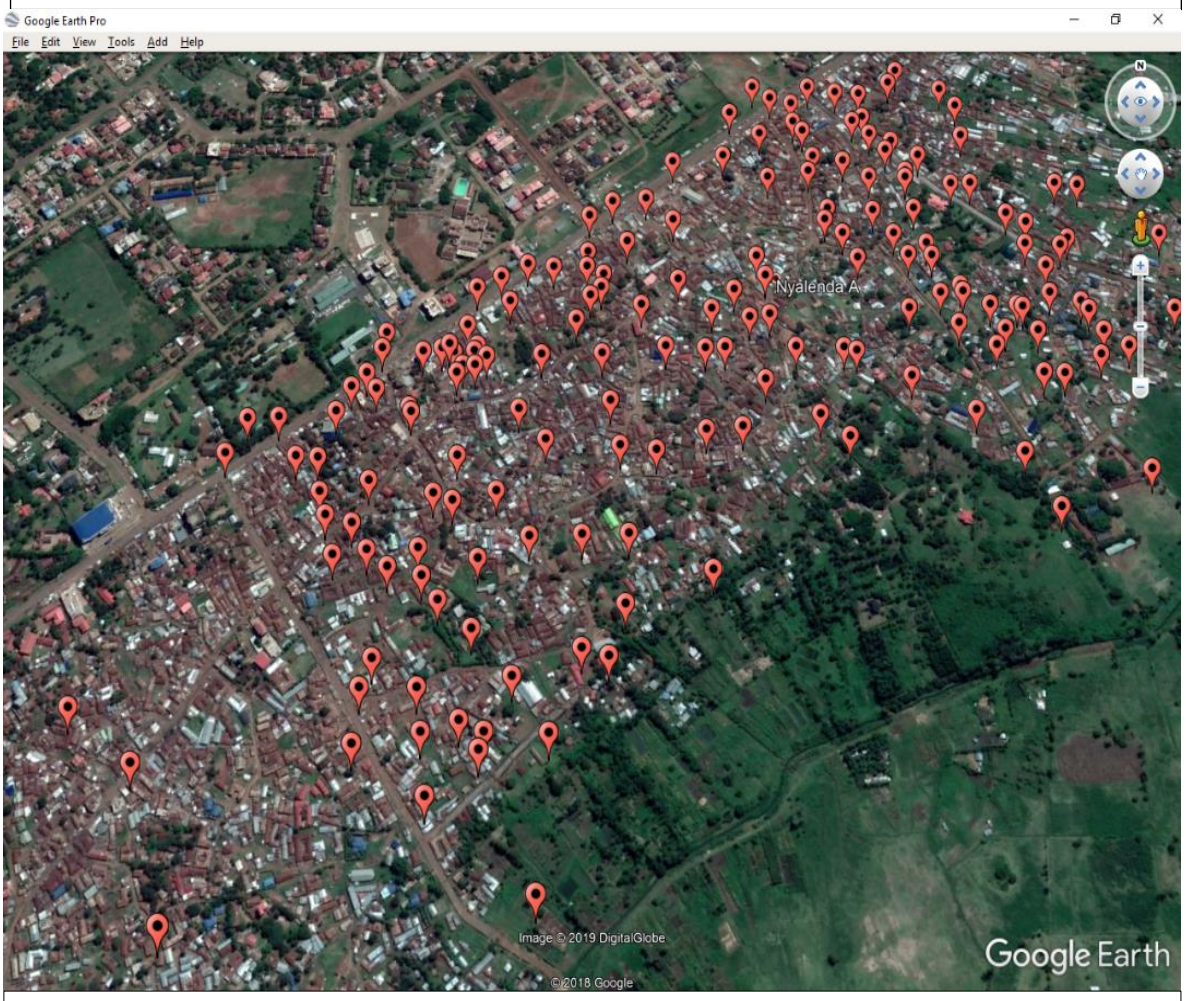
The County Commissioner
Kisumu County.

The County Director of Education
Kisumu County.

Appendix 8: Study area google earth images.



a) Kogony



b) Nyalenda "A"


Google Earth Pro
File Edit View Tools Add Help
Lolwe Estate
Kondele
Migosi
Image © 2019 DigitalGlobe
Google Earth

c) Migosi

Appendix 9: Typical state of neighbourhood and city centre roads.

c) Typical Kogony neighbourhood road

c) Typical Nyalenda "A" neighbourhood road

c) Typical Migosi neighbourhood road

d) Typical city centre road