

**SPATIAL ANALYSIS OF FACTORS INFLUENCING ACCESS TO PUBLIC
PRIMARY SCHOOL, KIMUMU WARD- UASIN GISHU COUNTY.**

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DECLARATION

DECLARATION BY THE STUDENT

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DEDICATION

This work is dedicated to Almighty God for His guidance and protection throughout my academic journey. To my spouse, I will always cherish your moral support and your strong belief of education as an equalizer. I also dedicate this work to my Loved sons Charlton, Lawrence and Martin from whom my motivation to work hard was derived.

ABSTRACT

Planning guidelines in Kenya recommends a school for a specified population. With regard to primary schools, it provides that pupils should attend a school close to their homes within a distance not exceeding 2 km. It is expected that all pupils who attend public primary schools will go to the nearest school. However, it has not been established if these provisions are met in siting of schools and also, if parents enrol their children to the closest public primary school. Descriptive and spatial analysis study was carried out in Kimumu Ward, Uasin Gishu County to determine school attendance patterns, factors influencing school choice and adequacy of schools in the study area. Four hundred and twenty-six pupils from 8 public primary schools participated in the study. Which involved mapping of schools and pupils' homes. Questionnaires were used to collect data on factors parents consider when selecting schools. Projected 2018 study area population and 2 km buffer zones around the schools were used to mathematically and visually describe adequacy of primary schools. Voronoi maps were used to delineate school catchment areas for identification of those attending versus not attending close school. Logistic regression model was used to determine factors that influenced choice of a school. Findings on the Voronoi delineated catchments revealed that 69% of the pupils were enrolled in schools not close to their homes. The regression analysis depicted academic performance ($P = .043$), availability of public means of transport ($P \leq .001$), pupil-desk ratio ($P \leq .001$) and home-school distance ($P \leq .001$) influenced choice of a public primary school. Academic performance and availability of public means of transport were found to be the strongest factors that influence the choice of a school with beta (β) values of 2.348 and 0.705 respectively for unstandardized and standardized beta. The study concludes that schools in the study area are adequate but due to different parent tastes and preferences pupils are seen travelling beyond the recommended school distances. The study recommends that planning policy should not only consider distance in siting schools but also factors including academic performance, efficient transport system and availability of space in schools which make schools attractive.

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LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS

AP	- Academic Performance
ASCH	- Attending School Close Home
CBD	- Central Business District
CIDP	- County Integrated Development Plan
ECDE	- Early Childhood Development Education
EFA	- Education for All
FPE	- Free Primary Education
IIEP	- International Institution for Educational Planning
KCPE	- Kenya Certificate of Primary Education
LCPS	- Low Cost Private Schools
LRM	- Logistic Regression Model
MAT	- Minimum Aggregate Travel
MOE	- Ministry of Education
MoEST	- Ministry of education science and technology
NAPSCH	- Not attending public school closest to home
ND	- Network Distance
PDR	- Pupil Desk Ratio
PSVs	- Public Service Vehicle
PT	- Public Transport
P-Tap- R	- Pupil Tap Ratio

P-Teacher-R	- Pupil Teacher Ratio
P-Toilet-R	- Pupil Toilet/latrine Ratio
SDGs	- Sustainable Development Goals
SSE	- Error sum of squares
SSR	- Regression sum of squares
SST	- Total sum of squares
TSC	- Teachers Service Commission
UPE	- Universal primary education

LIST OF DEFINITIONS

Access — refers to availability and usage of schools within a walking distance

Bussing — using school bus to pick and drop pupils from home to school mostly a characteristic of the private schools. However, some parents of the public institutions may plan to hire PSVs that pick and drop children to school

Closest school — the nearest school to the pupil's home as defined by Voronoi

Closest school — a school defined by a maximum distance of 2Km

Manambas — are the employees to PSVs vehicle who control boarding and alighting of passengers to and from a vehicle.

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CHAPTER ONE

INTRODUCTION

1.1 Background Information

Education is an important tool for socio-economic and political development, it is vital to achieving other developmental goals and improving the living standards of people (Hanushek & Wößmann, 2007; Ojiambo, 2009). These among others, are the reasons emphasis has been placed on the education sector globally. Some of the key initiatives to promote education include the International Conference on Education for All that was held in Jomtien in 1990, Dakar UNESCO declaration of 2000 on Education for All, Millennium Development Goals (MDGs, 2000) and the Sustainable Development Goals (SDGs) of 2016. Further, the country has domesticated these protocols in the Kenya Vision 2030, the Kenyan Constitution 2010 (article 43, f) and her other development agendas that are geared to ensure education is delivered as a socio-economic right in a sustainable manner.

School offer services to citizens of a country and many countries globally display varied policies towards enrolment of students. Some countries assign students to schools based on their catchment areas. For example, in the Haward and Fairfax Counties of USA students attend schools assigned to their home address. Similar is the *Hukou* System in China where only children who have local temporary residential permits are enrolled to a public school (Zhou & Cheung, 2017). Contrary, Kenya has an open enrolment system

but with policies that strive to ensure that distance to different categories of school are within walkable distances (Physical Planning Handbook, 2007, Oberti, 2007; Yi, 2004).

Planning as a discipline is hinged on the principle of ensuring equitable access to services. This is not only because, access to services is vital to maintaining a vibrant neighbourhood (Klaassen, 1988). But also, because, services affect the distribution of wealth among citizens in a way that resources are expended to overcome distance

Kenya's Planning Handbook (2007) contains distance to different categories of schools. This distance for primary schools is recommended as 2 km from pupils' home to school. However, it is observed that pupils do not always attend schools within their village, town, county, and region. It is common to see primary school children moving from one estate to another using motorized transport to attend a primary school. This contradicts the obvious expectation that people use the most immediate and available facilities as pioneered by Clarence Perry's neighbourhood unit concept of 1929 (as cited in Jason, 2013).

Besides financial cost long distance to access school has environmental impact including increasing in per capita carbon foot print. Other studies have shown that attending neighbourhood's schools leads to reduce emissions by 14 to 15 percent, improved health and reduced traffic compared to attending schools beyond the neighbourhoods (Larouche *et al.*, 2013).

1.2 Statement of the problem

It is highly desirable that each pupil attend his or her neighbourhood school. Kenyan Planning Standards in particular, supports this desire by stating that the distance covered by children to school should not exceed 2 kilometres to a primary school. In addition, it provides that there should be a one streamed school for every 4000 people (Planning handbook Kenya, 2007). However, the patterns of pupils travelling long distance to attend public schools has been observed in the study area and it is not clear why it occurs. Could this be because there are no schools within walking distance in the study area? Or the choice of public primary school to attend is affected by other factors?

This study therefore, seeks to determine public primary schools attendance patterns in the study area with a view of establishing the extent to which pupils attend schools nearest to their homes. In addition factors influencing choice of schools to attend will be sought and further establish whether primary school distribution in Kimumu Ward complies with the Kenya Physical Planning Standards.

1.3 General objectives

The overall objective of this research was to study Primary schools' access and factors influencing it in Kimumu Ward. Towards achieving this goal, the following specific objectives were addressed.

1.3.1 Specific objectives

1. To determine the percentage of pupils enrolled to public primary school closest to their homes in Kimumu Ward
2. To determine factors that influence choice of public primary school attendance in the area of study
3. To determine the extent to which distribution of public Primary schools in Kimumu Ward comply with Planning Standards in Kenya.

1.3.1 Research questions

1. What percentage of pupils within a catchment, enrol to school other than those close to their homes?
2. What considerations do parents factor when enrolling a child to a school?
3. Which areas do not have a school within 2 kilometres buffer?
4. Are schools adequate in the study area?
5. What percentage of pupils travel to school beyond the distance stipulated by Physical Planning Handbook?

1.4 Justification and significance of the study

Globally efforts have been geared to ensure basic education for all. With free primary education in Kenya, it is expected that parents not only take their children to school but to their closest public school to reduce both travel logistical costs and other related

environmental costs. In addition some studies have shown that there is negative relationship between distance and students' academic performance (Burde & Linden, 2009). Therefore, knowledge on school access in terms of the adequacy, distances travelled by pupils to school and factors that influence school preference is important to parents, policy makers and education planners. The findings of this study therefore will help to inform that access to school is no longer a function of distance alone. But there exist other factors that influence access to schools. In addition, understanding the population and schools available will help avert overcrowding and straining school facilities that would otherwise derail efforts to offer good learning environments for school children.

1.5 Scope of the study

The study was carried out in public primary schools only excluding their corresponding Early Childhood Development Education centres (ECDE) centres Kimumu Ward in Uasin Gishu County. The study appreciates the fact the private schools exist in the area but since they differ from the public schools because of fees payment the study confined itself to studying the public schools only.

1.6 Structure of the thesis report

This thesis is structured in five chapters. Chapter one describes the background information to the study where importance of education, role of planning and enrolment trends to school are discussed. Chapter two reviews literature that supports this study by shading light on the advantages of attending close schools. It also looks at patterns of

school choice and highlights stipulated standards on school adequacy. The third chapter details the materials, methods and data that has been used. The fourth and final chapters detail the results, discussions, conclusions and recommendations from this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter looks at literature related to planning of schools and choice patterns guidelines on school as prescribed in the Kenya Physical Planning Handbook. It points on both local and global patterns of school attendance and factors reported as reasons for attending or not attending school in close proximity to homes. It further seeks to give an explanation on why schools should be close to homes and sums up by describing how to compute and visualize optimal distribution of school as provided by the Kenya Physical Planning Handbook.

2.2 School attendances patterns

The debate on neighbourhood school attendance has been raging in the developed nations lately due to the environmental impact attached to pupil journeys to school and further by the changes such as *No child is left behind movements* as the case of the movements in America (Dee & Jacob, 2011).

A study carried out among a group of 75 parents in Islington in North London found that that most parents choose school through their housing choice (Butler, 2003). The contrary was also reported in a study carried out in Philadelphia that shows middle-class urban parents actively choosing to send their children to a public primary school within their neighbourhood but not through housing market choices or relocations (Nelson,

2018). More so, studies have shown that there are decreasing enrolments to public neighbourhood schools from 80% to 63% from year 1993 and 2007 respectively in the United States as found out by (Cullen, Jacob, & Levitt, 2005). In Boston the reduction is much lower with more than 60% of public school students attending non-local school (Brick *et al.*, 2003). Goyette (2008), observed two constellations of parents that is the middle-class families who choose schools in their privileged neighbourhood while the low-class families who do not choose their neighbourhood schools. In England, a study carried out in 2007 and 2013 estimates that more than 50% of all school-aged children do not attend their nearest school (Allen, 2007; Ferrari and Green, 2013).

There are reasons that may explain why children are not attending their local school as they used to be in the past. To begin with the increased school journeys is due to Legislation promoting autonomy of parents to school choice (Parsons, 2000). Secondly, increased school size in terms of enrolment consequently increases catchment area of the school. Finally, sub-urbanization and decentralization that has dispersed families with school aged children to low density new build housing estates on the outskirts or also referred to as Peri-urban settlement, with little enforcement of the land subdivision directive to consider provision of land for public utility and social amenities such as schools.

2.3 Advantages of attending close school

Varied opinions on attending a neighbourhood school have been put forward but advantages have always been stated to include environmental benefits through reduced

per capita carbon emission and other non-environmental benefits that include; convenience, active walk to school, reduced expenses, health benefits, good performance, reduced child's fatigue, increased child's security and possibility of pupils helping with house chores after school among many positive associations as discussed in section 2.3.1.

2.3.1 Environmental benefits

As a Global concern travel to school mode has changed over decades from active walk to use of automobiles. In US for example, 12% of the pupils used automobiles to school in 1969 as opposed to 50% of the pupils who by the year 2000 were using public transport to school (Beck & Greenspan, 2008; McDonald, Brown and Marchetti, 2011) and pupils travelling to school accounts for 22% of the total public transport. It should be noted that transport sector contributes about 20% of the global carbon emission this is according to a report by the 5th Intergovernmental Panel on Climate Change report (IPCC, 2014).

Clearly, attending a neighbourhood school encourages walkability and reduces the need for a motorized transport, hence a direct contribution to emissions reduction. As such, some of the strategies to reduce per capita greenhouse gas emission is by encouraging pupils to attend their neighbourhood schools by active travel walking or biking.

2.3.2 Convenience and cost reduction

Convenience refers to reaching place directly, Nelson (2018b) points out that parents would rather use close school for the convenience accrued by enrolling a child there. With availability of road network distance covered by car or pedestrians varies with the distance to be covered. However, other factors influence the time to travel which include speed restrictions, density of cars or commuters, number of lanes and waiting at traffic lights. This also varies temporally during day and night, normal and rush hours, weekday and weekends, low season and peak season. Hence time becomes an important decision for life activities for this case the need that a child travel more hours to school is not attractive.

Generally, cost of travelling increases with distance. However, in monetary terms cost is not proportional to distance. In particular in public transport fare is non additive because of other costs associated to them that varies with type of transport mode used Jørgensen, and Preston (2007).

2.3.3 Improves child's academic performance

In Kenya the academic performance is measured in the standard test KCPE exams. Average to good performance begins at 250/500 to 500/500 marks. Studies have shown that children are sensitive to distance. A randomized study in rural north-western Afghanistan indicated that for every mile that children must travel to school, test scores fall by 0.19 standard deviations (Burde & Linden, 2009). This is supported by other

studies which have demonstrated that reduced home school distance is associated with improved performance/students outcomes (Dickerson & McIntosh, 2013; Nyandwi & Nzalayaimisi, 2014).

2.4 Overview of factors that influence the choice of primary school attendance

Research on parental preferences are hinged generally on the assumption that parents act rational; that they weigh their preferences and constraints in order to arrive at a final school selection (Bast and Walberg, 2004; Hanushek *et al.*, 2007). But, studies have shown changing trends such that parents and countries are now warming up to school choice as opposed to the earlier policies of strict attendance to neighbourhood school. Such cases include the “*houkou*” in China and the pre-Katrina as for the case of New Orleans, Horne (2011) among many other. The post -Katrina has seen a sharp rise in out of catchment school attendance with research showing between years 2011-2012 in New Orleans where it was reported that above 40% of students attended a school outside their neighbourhood (Zimmerman and Vaughan, 2013).

Literature reveals that there exist academic and non-academic factors that influence school choice, which are closely or otherwise associated with the race and socio economic characteristics of the parents (Hastings, Kane and Staiger, 2009). These factors include distance, mode of transport, academic performance, security, location, proximity, physical facilities, race, socio-economic characteristics or social class, age of the pupil as discussed in 2.4.1:

2.4.1 Distance and mode of transport use to school

Distance to school is the core determinant of the choice linked to cost and transport mode selected by the pupils (Müller, Tscharaktschiew & Haase, 2008). The shorter the distance the more attractive for children to walk (Easton & Ferrari, 2015; Egwing, 2004; Timperio *et al.*, 2006). People choose different modes of transport because of health safety, cost, distance and time (Roth, Millett and Mindell, 2012). A study show that most parents choose to drive their children to school because of child's safety Ibrahim *et al.* (2014); Roya *et al.* (2012) availability of money, proximity to parents workplace Ibrahim *et al.* (2014), child's age among other factors are also listed to be considerable factors. Other factors such as parent selecting a school due to its convenience are mentioned by (Hastings, Kane, & Staiger, 2005).

Hatamzadeh, Habibian, & Khodaii (2017) states that population density, distance, time and intrinsic factors were mentioned among the adolescent boys and girls for inactive commuting to school. While factors such as weather, heavy bags and safety were cited less to be barriers to inactive commuting to school (Nelson *et al.*, 2008).

2.4.2 Age

Age is a determinant of active commuting to school. Nelson *et al.* (2008) points out that the walkable distance determines active commuting and of importance among the adolescent in Belgium and a criterion threshold of 2.5 mile is ideal for walking. In addition, a study carried out in Norfolk, UK found out that 1.4, 1.6, and 3 km are ideal

walkable distances for children of the ages 10, 11 and 14 years respectively. Similar findings has been found by D'Haese *et al.* (2011) and Van Dyck *et al.* (2010) However studies in Nigeria show that pupils are still walking to school beyond 5 km including in an urban densely populated states (Duze, 2010) while rural areas have been reported to be characterised by long school journeys with children walking beyond 10 kilometres to school (Adele, 2008; Al-Qudsi, 2003; Kristiensena and Pratiknob, 2006).

2.4.3 Academic factors

School academic performance also referred to by others as test score is mentioned to be the key factor that parents look for in a school (Yaacob *et al.*, 2015; Roda and Wells, 2013; Dustan and Ngo, 2018; Burges, 2009; Hausman and Goldring, 2000; Ibrahim *et al.*, 2014; Schneider, 2003). A study carried out in Kuala Lumpur using a regression analysis indicated that quality of teaching (with a beta value of 0.359) made a significant contribution to school choice (Bin & Sabri, 2011). Also, a study in Ghana showed that academic quality is a factor that influence decision to choose a school (Anyan, 2010). This quality of education is measured by the results obtained in a standardized test.

Findings in a study carried out by Maangi (2014) in Getembe Division Kisii County showed that parents prefer private to public schools because of quality of education (measured by student teacher ratio). The study concluded by stating that quality of school tends to influence parental choice. Some studies looked at it from a social economic perspective of the parent. Schneider *et al.* (1998) found out that low income families and

minority may value other factors other than performance. Whereas on the contrary, a study carried out in Charlotte-Mecklenburg school District in North Carolina on the analysis of parent choice found out that high-income families of high-achieving students place more weights on test scores while low-income families qualifying for free or reduced lunch prices and those living in low income families they substantially attach preference to schools mean test scores. Similar findings were reported by Hastings, Kane, & Staiger (2005) in their findings that showed preference for measures of academic achievement increasing in income and baseline academic ability. Bernal (2005) points out that the middle class who in their study referred them to moderate choosers value the academic quality of the school and would enrol their children to that school irrespective of its distance from home.

2.4.4 Safety

In a study carried out in Indiana, it was found out that parents consider security of their children while choosing schools Weinschrott and Kilgore (1998). Bell (2009) in another study notes that poor parents may rank safety slightly higher because they are surrounded by schools in which safety cannot be taken for granted. Further, other researchers demonstrate that for some parents security remain their top priority for them to choose a school Armor & Peiser (1997).

2.4.5 Physical facilities

Provision of adequate school facilities is associated with improved teaching and learning environment. Parents are attracted to a school based on availability of the facilities (Ibrahim *et al.*, 2014; Schneider, 2003). In a survey, Yaacob *et al.* (2015) found that parents choose private school as opposed to public school because of new and quality of the facilities provided Hsu and Yuan-fang (2013) agrees by noting that the second most important factor parents considered in school choice was school educational environment that included quality of the facilities, cleanliness of campus, library and enough space in the classrooms.

2.4.6 Location and Proximity

Generally, a study on parental preferences on school selection has reported that most parents prefer a school that is near to pupil residence. A study by Duze (2010) carried out in top ten most densely populated and educationally advantaged states in Nigeria, points out that proximity to a school is highly valued and explains this as the reason why most companies and institutions locate schools right in their staff quarters. Teske, Fitzpatrick & Kaplan (2007), Zimmerman (2013) and Burgess *et al.* (2009) found out that parents are willing to enrol their children to schools closer to their homes so long as the school are of high quality. (Yaacob, Osman, & Bachok, 2014) also points out that, parents choose private over public schools because of their strategic position and close distance to home. Fiske (2002) in a survey of kindergarten parents in Cambridge in 1998 finds that most

parents consider a school that is close to their homes when selecting a school. Similar observations were made by Hsu and Yuan-fang (2013) who found that location and transportation had the highest correlation with parents' choice; parents cared most about distance and time taken to travel to school. However, studies have shown that proximity varies with the parent's level of income; those with resources are likely to send their children to a performing school outside their catchment areas as opposed to those without

In employing statistical modelling, Gómez, Chumacero, & Paredes (2012) measured the distance between homes and schools and found that most parents make trade-offs between quality and proximity). A survey done in 2013 by Zimmerman and Vaughan, points out that transportation, proximity and school quality are key to parent's decision making. Further, a parent for example was reported saying "am willing to drive her across town, but for me to do that I have to think that the school is really much better than something I could get closer to home"(Zimmerman and Vaughan, 2013). Also, Yaacob *et al.* (2015) found that distance to school as an the important factor considered by children.

Location as pointed out by Egwing *et al.* (2004) determines the accessibility and modes of transport used when going to school. Parents are therefore reported to use location as a the most influential criteria for choosing a school (Dahari and Ya, 2011; Ibrahim *et al.*, 2014).

Bernal (2005b) points that middle class families have more resources and send their children to school they considered better no matter the distance. The observation points

out to the fact that mobility is less frequent amongst the lower social class as opposed to their high social class counterparts.

2.4.7 Ranking the factors for school choice

The coefficients of determinations betas have been found useful in ranking the influence of an independent variable on the dependent. There are two types of betas namely standardized and unstandardized. Both are useful but the difference is the latter is used when the units of measure for the variables are not uniform. Unstandardized beta is automatically generated by SPSS as an output after a model is built from the dependent and independent variables from the SPSS. On the other hand, the former (standardized) logistics regression is calculated as described in section 2.4.8

2.4.8 Procedure for standardizing the Beta

The following procedure is followed when standardizing the beta (β) more found in (Menard, 1995).

- i) Calculate the LRM to obtain the unstandardized logistic regression coefficient (b) beta
- ii) From the same model output the value R^2 is given then, find its square root and name it R.
- iii) Use the SPSS transform bar to generate predicted value of Y

iv) Use the predicted value of Y to calculate the predicted value of logit(Y), using the equation:

$$\text{Logit}(\hat{y}) = \ln(\hat{y}/1-\hat{y}) \dots\dots\dots \text{Equation 1}$$

- i. ^slogit (ŷ): this is the descriptive statistic of logit (ŷ) including the standard deviation.
- ii. Calculate the standard deviation of all the independent variables found in your model and denote it as s_x
- iii. substitute the above values in the equation below:

$$bu_{xy} = (b_{xy})(s_x)(R)^{\wedge} \text{logit}(\hat{y}) \dots\dots\dots \text{Equation 2}$$

Where,

bu_{xy} — Standardized Logistic regression coefficient,

b_{xy} —Unstandardized logistic regression,

s_x — Standard deviation of the independent variables,

R — Square root of coefficient of determination or R squared,

^slogit (ŷ) — Standard deviation of logit y

2.4.9 School choice comparison developed and developing countries.

Many case studies have focused on developed countries and middle-income countries that have almost achieved universal intake to the basic education system as pointed out by Nishimura & Yamano (2013). The existing studies on low-income nations are based on comparisons on cost effectiveness of public and private schools with more emphasis on the supply-side factors (King, James, and Suryadi, 1996). In addition, studies have shown an emphasis of universal primary education and consequential reduced quality and efficiency (Nishimura & Yamano, 2008). There are also other studies that have estimated price and quality of education between private and public schools on the choices made by parents (Alderman, Orazem, and Paterno, 2001; Glick and Sahn, 2006). Further, more emphasis in third world countries has been placed on expansion at the expense of academic quality (Avenstrup, Liang and Nellemann, 2004) such as the case of free primary education, 2013. Hence wealthier households choose to enrol their children in the private schools where quality is guaranteed, leaving the public schools with poor quality and with pupils from poor households as found out by Nishimura & Yamano (2008). Furthermore, there are no studies that have explored what happens for choices made by parents between public schools while enrolling their children.

2.5 Adequacy of schools and the optimal distribution of public primary in Kenya

In order to understand adequacy and optimal distribution of schools in the study area, acquaintance with the standards and policies pertaining the provision of services in Kenya is necessary. In Kenya, planning standards and guidelines for a school are

contained in the Physical Planning Handbook, (2007). It provides a set of gazette rules and regulations that guide the standardization of physical planning process and practice including planning for primary schools. A summary is presented in Table 2.1.

Table 2.1: Planning requirements for a school in catchment area

Type of school	Catchment population	Area in ha.	No. of streams	Classes	Distance to school	Population of students	Area of teacher quarters
Primary	4000	3.9ha	1	1-8	2 km	320	0.8ha

(Source: Physical Planning Handbook, 2017)

Based on the Table 2.1, it is evident that the intention is to make school be within walkable distances and to serve a certain population. Further, space is considered important with exact specifications given for the different levels based on the amenities expected. One would be interested to know to what extent the planning handbook provisions have been observed. This study is therefore interested to find out the extent to which distance to school and catchment population of the school comply with Physical Planning guidelines this guidelines

2.6 Theoretical framework

These sections present detailed examination of two theories thought to be applicable to the research problem under consideration. These theories are the spatial interaction

model, gravity model and distance decay theories as discussed below, although other theories might exist and not mentioned due to limitation of this study.

2.6.1 Spatial interaction in supply and demand

Spatial interaction in supply and demand is a general concept that refers to the movement of people between places and within places. This concept dates to the 20th century by Edward Ullman. He notably pointed out three forces for spatial interaction to occur: complementarity, transferability, and intervening opportunity. Complementarity referred to the presence of a demand or deficit at one location and a supply or surplus at another without which there is no economic rationale for any movement.

Transferability refers to the cost of overcoming distance measured in real economic terms of either time or travel cost. The cost of overcoming distance is known as the “friction of distance.” If the friction of distance is too great, interaction will not occur in spite of a complementary supply-demand relationship. Friction of distance depends on prevailing transportation technology and the price of energy. In general, the friction of distance has decreased over time, which is the prime factor in globalization and the emergence of megacities. Intervening opportunity is the third basis for interaction although it typically is considered as the reason for lack of interaction between two complementary locations. Complementarity will only generate a flow if there is no intervening, or closer, location. The flow of goods that would otherwise occur between two complementary locations

may be diverted to a third location if it represents an intervening opportunity: a closer complementary alternative with a cheaper overall cost of transportation.

Spatial interaction model has been applied in a number of studies for example, Duan, *et al.* (2017) carried out a study in Shanghai China in which they explored an approach for spatial interaction analysis based on the mobile phone data and found that close regions have frequent interactions

2.6.2 Distance decay theory and Gravity model

Distance decay is an important principle of spatial analysis. It is a term used to describe the effect of distance on interaction between two detached locations. It describes decline of influence with increased distance and therefore closely relates to Tobler, (1970) first law of geography that “All things are related but near things are more related than far things (as cited in Miller, 2004). Decay, refers to the diminishing influence of a phenomenon, attribute, or activity when two locales are far away from each other. It can be mathematically represented by the expression $I = 1/d^2$, where I is a measure of spatial interaction and d is distance (Pun-Cheng, 2017).

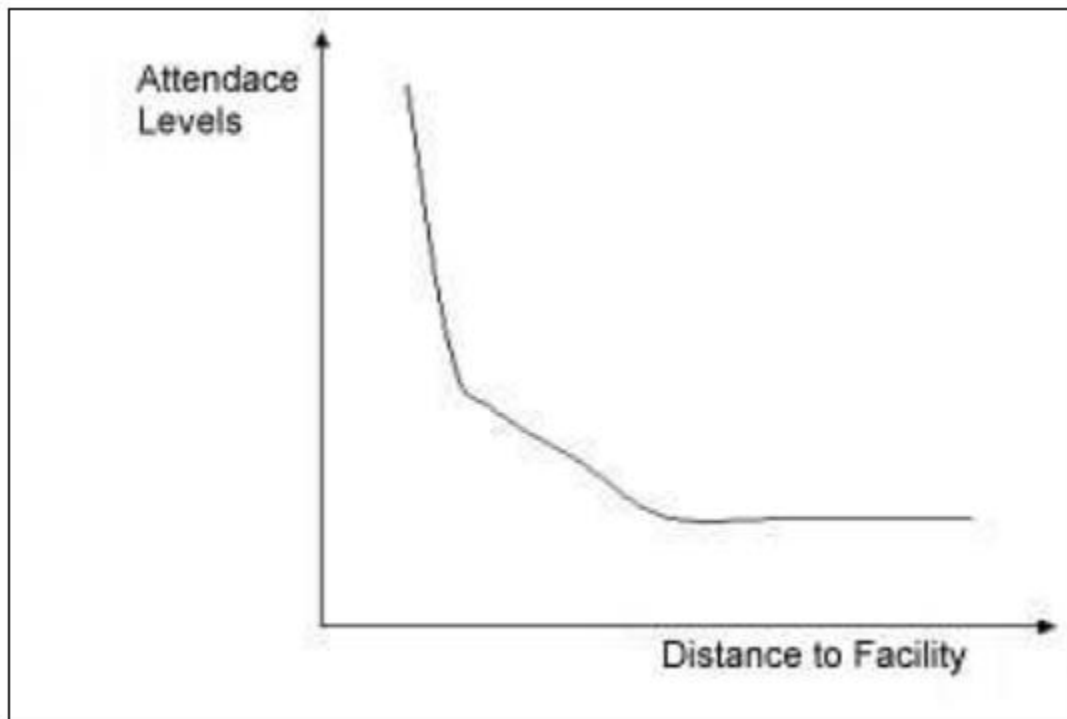


Figure 2.1: Association of distance and service use

Distance decay is closely related to Gravity model. The gravity model begins with Newtonian law for the gravitational force between two objects. The theory establishes that, the attraction between two objects depends on their sizes and distances between them and expressed as follows in the equation:

$$G = \frac{M_1 M_2}{D_{12}} \dots \dots \dots \text{Equation 3}$$

For the case of this study M_1 and M_2 represents the schools that the parent compares to make choice while D_{12} represents the distances between the two schools. This model has been used to develop models such as for international and or regional trades as well as to determine how attractive facilities are with respect to demand in operational research.

With respect to facility accessibility, the Newtonian theory implies that large facilities close to population will attract many people while small facilities at large distances will attract very few people. This model has been applied by Odhiambo & Imwati (2014) in a study that used Geo-Information Systems for Educational Services Provision and Planning in ASAL areas of Garissa District. Distance on the other hand refers to the physical separations between two places as represented on the map or else the topographical distance. Distance has been defined and used by previous theories such as the Central Place and land use theory. Which were developed without the existence of the modern means of transport.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter presents the procedures used to obtain and analyse data to address the objectives of this study, namely determination of a) the percentage of pupils enrolled in public primary schools greater than two kilometres from their homes b) factors that influence the choice of public primary school attendance c) the optimal distribution of public primary schools in Kimumu Ward. It commences by describing the study area, presentation of the research design, and concludes by describing how data was collected and analysed

3.2 Description of the study area

The study was conducted in Uasin Gishu County, Kimumu Ward consisting Kimumu and Sigot Locations. The study area lies between latitude $00^{\circ} 31'$ and $00^{\circ} 35'$ and longitude $35^{\circ} 16'$ East and $35^{\circ} 20'$ at an altitude of 2095 m above the sea level and covers an area of 22.9 square kilometres as shown figure 3.1.

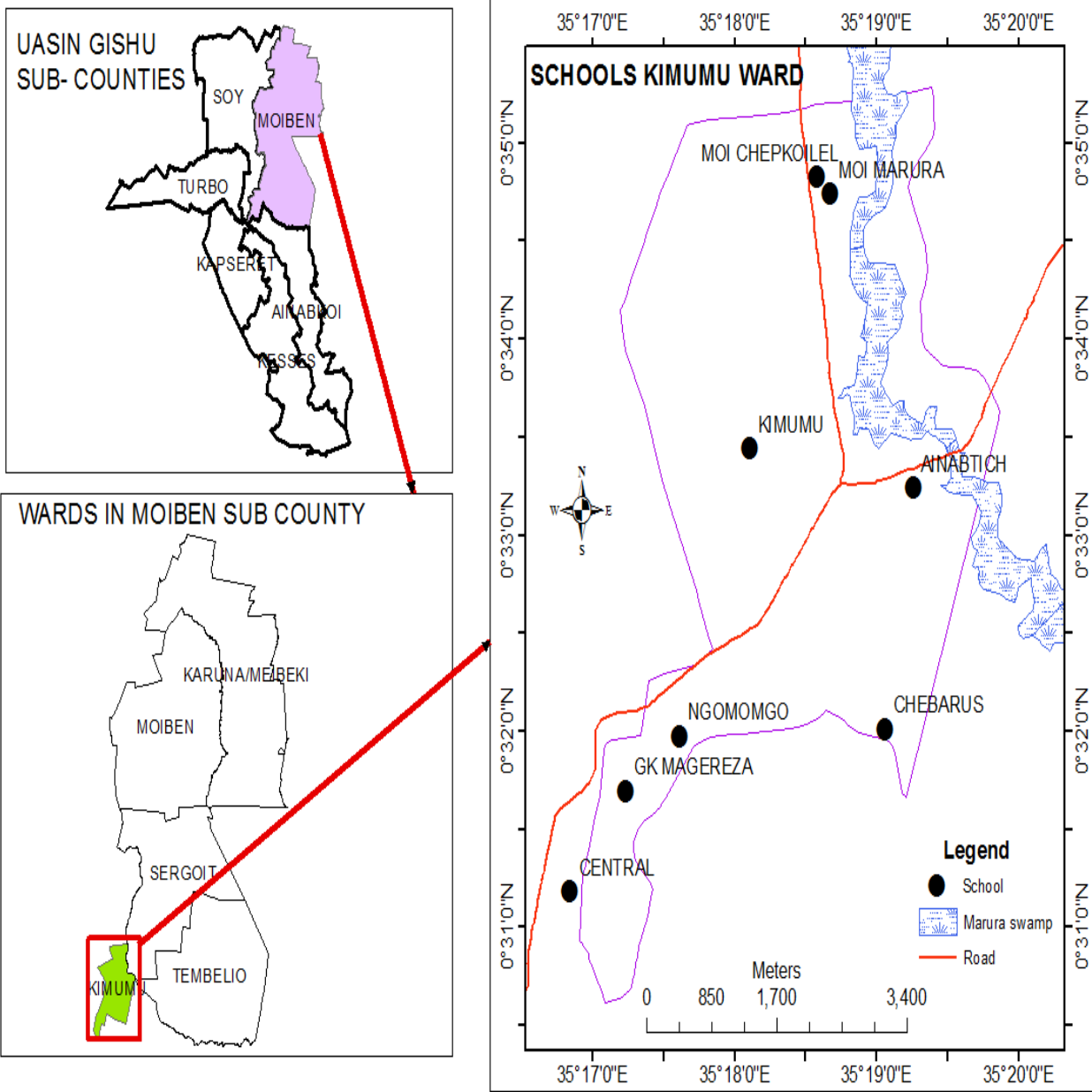


Figure 3.1: Location of the study Area (Source: Author, 2018)

3.2.1 Distribution of schools in the study area

Kimumu Ward consists of two locations i.e. Sigot and Kimumu and a total of eight public primary schools exists in the Ward namely: Moi University Chepkoilel also called University of Eldoret primary(UOE), Moi Marula, Kimumu Ainabtich, Chebarus, G.K Magereza, Central and newly established Ngomongo primary schools shown in Figure 3.1.

3.2.2 Demographic characteristics of Kimumu ward.

According to 2009 census a total of 42,346 people inhabited the Location and distributed in Kimumu and Sigot Locations as 15,083 and 27,263 persons respectively. The population density for the Location was 1,852 persons per square kilometre and distributed as 1,097 and 2,994 persons per square kilometre in Kimumu and Sigot Locations respectively. Further, the households available in the Location were 10,945. However, since 2009 there have been changes in the study area demographics, attributed to rapid urbanisation and rural urban migration. The projected populations as at 2018 was 55,684 persons in the Ward with 19,834 persons in Kimumu and 35,850 in Sigot Locations as can be seen in Table 3.1.

Table 3.1: Kimumu Ward Demographic Characteristics

	Housing and census population 2009				Projected
	Total population	No. of household	Area (km ²)	Population Density	2018 population
Kimumu location	15083	3559	13.8	1097	19834
Sigot location	27263	7386	9.1	2994	35850
Kimumu ward	42346	10945	22.9	1852	55684

3.2.3 Infrastructure in Kimumu Ward

The study area is served by various transport and communication networks including the A104 road connecting Kenya to Uganda and Sudan and serves Central primary school. Other major tarmacked roads are the Eldoret-Iten road which serves Ainabtich primary, Eldoret-Ziwa road that serve both Moi Chepkoilel and Moi Marula primary schools. There are also other collector roads which are either earth or marrum which serve Chebarus, Kimumu, GK Magereza and Ngomongo schools.

3.3 Data requirements

The study used the following primary data: school geographic location, pupils' homes locations, schools attended by the pupils, the distances between the school and pupils' home, factors parents consider when selecting schools for their children. Data on school characteristics such as total enrolment per school, number of teachers per class, number of desks per class, number of toilet/latrines, number of taps per school, number of pupils per class and type of building (whether permanent or semi-permanent) were also used.

Secondary data on the other hand included relationship between existing schools and population of the area, population characteristics, 2016 and 2017 KCPE academic performance of the schools.

3.4 Data collection and analysis

Before data was collected a pilot study was done in two primary private schools namely AIC Chebisas and Highlands Plateau. This study tested the content validity of the instruments by consulting a panel of postgraduate students in the Department of Environmental Monitoring, Planning and Management and in consultation with experienced staff and supervisors from the School to judge the standards of the instruments developed. All suggestions and modification offered were considered and helped improve the tools.

Cronbach's alpha correlation is a statistic that was used to estimate reliability of the instrument using SPSS statistical software. The tools were coded into SPSS and

reliability test was conducted a Cronbach alpha was found to have an internal consistency coefficient ($\alpha = .78$) confirming that the tool were reliable. In addition, professionalism, confidentiality and consent of the interviewee were observed during the entire research process.

In addition, the following sample size and sampling procedures were followed. The study employed simple random sampling in selecting the County to be studied. From which from the forty-seven Counties of Kenya Uasin Gishu County was selected. The second simple random sampling was done to select one Sub-County from which Moiben Sub-County was selected among the six Sub-Counties available in the study area. Since the study was interested to determine access to primary education in public schools in the urban areas, then Kimumu Ward was the only Ward with urban features and hence selected through purposive sampling to be the study area.

All the eight public schools were involved in the study whose total pupil's enrolments were 4,419. Yamane, (1967) formulae $\{n = N / [1 + N (e)^2]\}$ were used to calculate the sample sizes of the study from the projected study area population of 55,684. The sample size was calculated as 426 Pupils who connected the researcher to the 426 parent by a way of questionnaire. It should be noted that the student not only acted as a medium that linked the researcher to the parents (respondent) but also with consent marked their home Location from the Google Earth map.

In order to select the number of sample per school, proportional sampling technique was employed. This gave rise to the distribution of samples as shown in Table 3.2.

Table 3.2: Sample size per school

School	Student Population	Sample Size
Moi University Chepkoilel	1,188	114
Kimumu	454	43
MoiMarula	570	54
Ainabtich	572	55
G.K Mageresa	590	56
Chebarus	375	36
Central	570	59
Ngomongo	100	9
Total	4,419	426

At the school level the study employed probability sampling technique where all the subjects had equal opportunity to be sampled in every class. This is because this criterion ensures the law of Statistical Regularity

3.4.1 School attendance patterns

In order to determine the percentage of pupils enrolled to public primary schools other than those closest to their homes the following procedure was followed. Google Earth image of the study area was downloaded and geo-referenced using ArcMap. The image was then printed in colour on AO paper (Plate 3.1) to be used in the field for home

identification by the pupils. In the field each sampled pupil was asked to identify their home or any conspicuous feature very close to their domicile and it was marked with a dot and identity of the students inform of the unique number (assigned to each questionnaire), written beside the dot.



Plate 3.1: Pupils marking and identifying their homes from the printed A0 map

(Source: Author, 2017)

The marked image (Appendix, II) was scanned and geo-referenced. On screen digitizing was used to create a point map of all homes and schools using unique identifiers to link each home to the school attended. A Voronoi map was created to delineate catchments for each school i.e. all areas within a polygon represented the closet school for all homes. The point file containing pupils' homes was then superimposed on the Voronoi map and

by inspection all homes found within their closest school and those found in other polygons were identified and counted. The ones within were categorized as Yes while the other as No. That is attending closest and not attending closest schools respectively. These results were expressed as a percentage.

3.4.2 Factors influencing choice of schools

To determine factors that influence the choice of public primary school to attend in the area of study first-hand information was used. Parents of all sampled pupils were requested to fill in a questionnaires listing and ranking factors they considered before enrolling a child to a school (see Appendix I).

The nominal and ordinal data collected from the interview and questionnaires were coded/ classified to achieve compressed classes appropriate for analysis which was done by coding and entry of data using SPSS software. The first aspect entailed obtaining the frequency of the factors selected by the parents that influence their choice of a school. This was done by generating cross-tabulation of frequencies of the responses from the parents as filled in the returned questionnaire.

Since the frequencies were only indicative it was necessary to determine the significance of the factors that influence school choice. Logistic regression model (LRM) was therefore used to measure the significance of the factors that influence choice of public-school attendance and hence predict the probability of a parent choosing to send or not to his/her child to the closest school given a set of predictor variables.

For this model, the dependent dichotomous variable was whether a pupil attends a school closet to their home or not (1=Yes and 0=No) which was obtained from the Voronoi diagram in Objective 1. The independent variables were the factors that were considered by parents in selecting the schools to be attended by their children as summarized in Table 3.3.

Table 3.3: Factors parents consider in selecting the school to be attended by their children.

Variable Name	Abbreviations	Description	Unit
Network Distance to school	ND	Measured network distances along the road from pupils home to school	M
Academic performance	AP	Mean KCPE for 2016/2017	score
Pupil desk ratio	PDR	Counts of desks and the pupils using it	numeric
Safety	S	The school having fence, gate and security person	categorical
Pupils gender	G	Sex of the child	1-male 0-female
Pupils age	A	The number of years of the child	numeric
Class of the pupil	C	The grade to which the pupil is enrolled	numeric
Pupil teacher ratio	PTR	The number of teachers and pupils per school	Ratio
Pupil toilet ratio	PTR	The number of toilets in a school compared to the school population	Ratio
School total enrolment	SR	The total population of pupils from grade 1-3 and class 4-8	numeric
Water sources available	HO	Number of water points or boreholes that serves the pupil	categorical
Work place proximity	PW	The nearness to a parents home	dummy
Building type	BT	Whether is permanent, semi-permanent or mixed buildings	categorical
Availability of public transport	APT	If it is reliable or not	categorical

$$\text{logit}(p) = \ln[p/(1-p)] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n \dots \dots \dots \text{Equation 4}$$

Where

X1 = Network Distance to school

X2= Academic performance

.Xn= pupils gender

The coefficients of determinations $\beta_{1...n}$ represent the contributions of different variables in predicting a parents choice of a school to enrol a child.

3.4.3 Optimum distribution of schools

To address the third and final objective i.e. to determine if the study area complies with the requirement for a primary within 2 km of all homes and determine the optimal distribution of public primary schools in Kimumu Ward the following was done. A 2 km buffer was drawn around each school to represent the Planning Handbook guidelines for primary school siting. Areas that were not covered within any school buffer were deemed underserved by the schools.

In addition, the projected population of the study area was used to determine the adequacy of schools by applying a mathematical formula derived from the Physical Planning Handbook that recommends a catchment population of 4000 persons for one

school. These formulae were operationalized as follows: For every 4000 persons there exist a school. Therefore:

$$N_s = \dot{G} \div 4,000 \dots \dots \dots \text{Equation 5}$$

Where,

N_s – the number of schools

\dot{G} – the projected/current total population in the given area=55,684

4,000 – A constant that represent the population to be served by one school according to the Kenyan planning handbook.

The figure obtained by this formulae was compared to the number of existing schools to determine the shortage or surplus.

Finally, network distance (distance along a road) and Euclidian distances (straight line distances) from each pupil's home to school were measured from the map and recorded as shown in Table 3.4.

Table 3.4: Distances to pupils home

Pupil code	Euclidean distance(in Metres)	Network distance(in metres)
1	43	76
2	1319	2570
.....		
N	9563	11,112

These distances were averaged and comparison drawn between the distances travelled by children enrolled to their closest schools versus those not as defined by Voronoi. Also the percentages of pupils attending schools within the recommended distances of 2 km network distance were compared to those not.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the findings of this study that are linked to the three objectives of the study.

4.2 School catchment areas

The results in Figure 4.1, shows school delineated catchment areas Voronoi, pupils' homes and the school each pupil attends that are differentiated by pupils home represented by a dot that resembles the colour of symbol of a school they attend (school flag). The results display schools having unique catchment areas, that is, there are schools where majority of their pupils come from within the catchments. Such schools include: Ainabtich, Chebarus, Kimumu and Ngomongo represented by pupils homes on the map by black, purple, blue and sky-blue dotted colours respectively (Fig 4.1). The pupils the following schools: Moi Chepkoilel, Moi Marula, GK Magereza and Central primary have majority of their pupils' coming from areas that are outside the delineated Voronoi catchment areas of a school, hence not attending their closest school as represented in the map by yellow, pink, sky green and red coloured dots respectively refer (Fig 4.1)

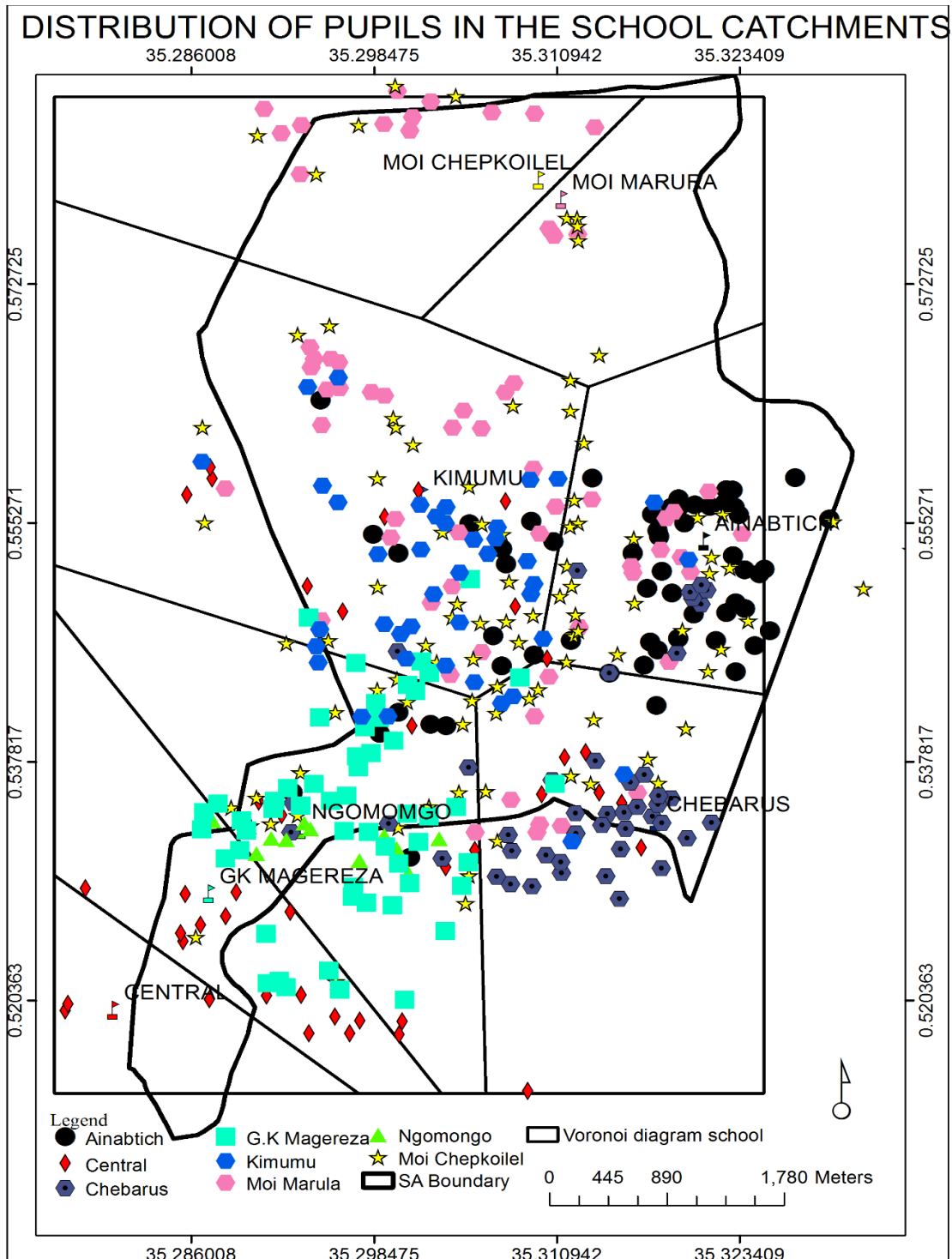


Figure 4.1: Distribution of pupils in the school catchment area (Source: Author, 2019)

In addition, there are pupils who reside in other wards adjacent to Kimumu Ward (see below Figure 4.2). It can be observed that the distribution of pupils homestead can be spotted in Kuinnet/Kapsuswa, Kiplombe, Huruma, Sergoit, Tembelio and Kapsoya Wards. All these pupils; homes for this case are located along the major roads of these adjacent Wards.

Based on the distribution of homesteads on Fig 4.2, pupils from Moi Chepkoilel have the widest dispersion (refer yellow dots on the map) of her pupils and hence draws students from almost every corner of the study area compared to schools such as Ngomongo where their pupils concentrate within the school catchment area (Fig 4.1 & 4.2)

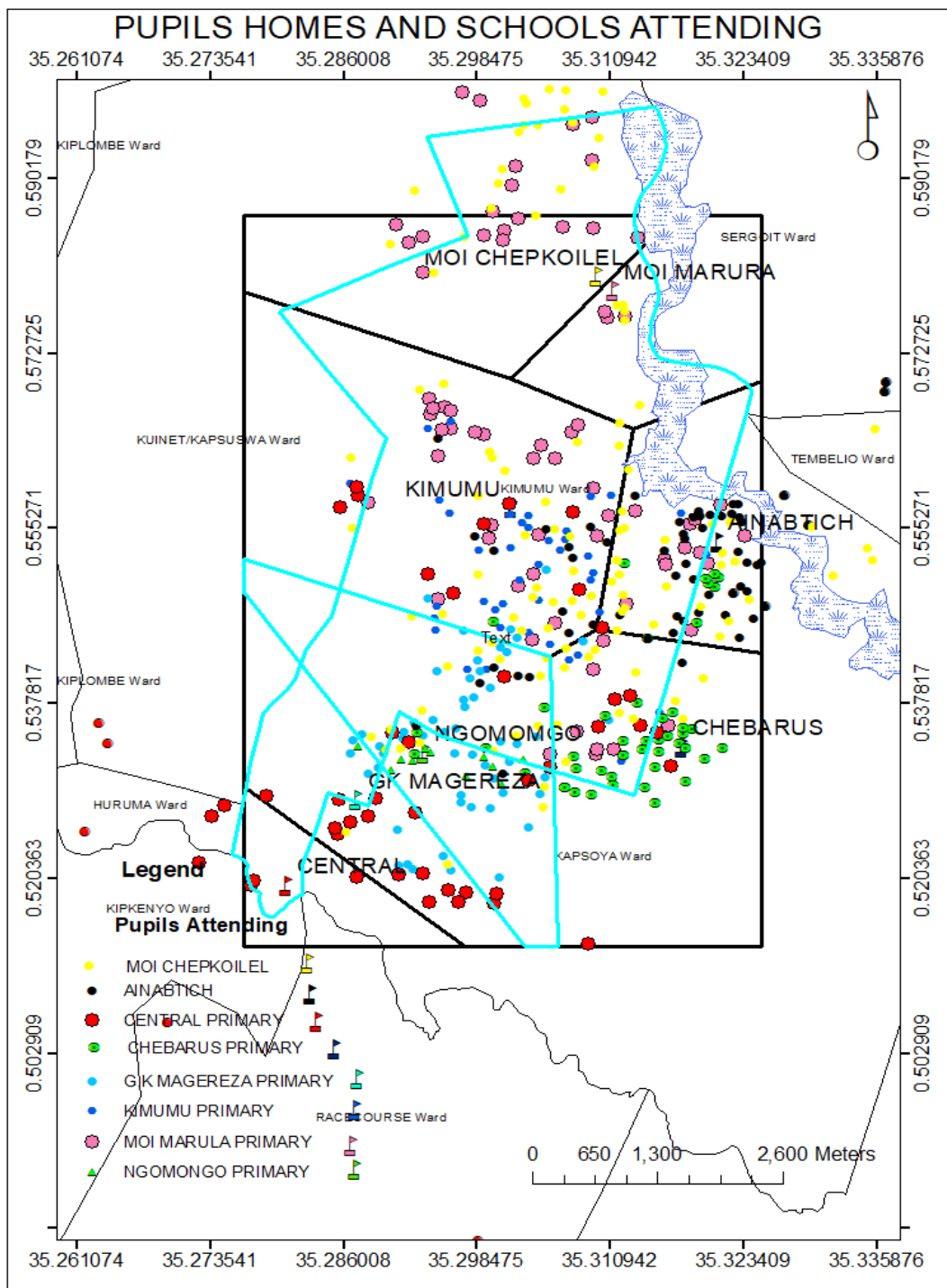


Figure 4.2: Distribution of pupils in the school catchment area (Source: Author, 2019)

4.2.1 Percentage of pupils not attending closest school as defined by Voronoi

While the maps on Fig 4.1 and 4.2 represents the spatial aspects of pupils homes and school attended. Frequencies were necessary to display the numbers and percentages of pupils attending schools close to their homes as defined by the Voronoi.

Voronoi polygon meant that pupils' whose homes were found within the defined Voronoi polygon were considered attending closest school and were recorded under the "YES" column in a table. Whereas those homes found outside were recorded under the "NO" column of the same table.

On calculating the percentages of "YES" and "NO" the findings, as presented in Table 4.1 show that on average 69% of the sample pupil's attend to public primary schools that are not close to their homes as defined by Voronoi diagram.

Table 4.1: Percentage and frequency of school attendance pattern

Attending Closest School	Frequency	Percent	Valid Percent
NO	294	69.01	69.00
YES	132	30.98	31.00
Total	426	100.0	100.0

Diversity of school attendance by pupils to the different schools were computed. Results obtained (see Table 4.2) concur with the observations from the distribution of schools in Fig 4.1 and 4.2 where four schools notably, Moi University Chepkoilel, Central, Moi Marula, and G.K Magereza had 98%, 95%, 94% and 77%, of their pupils not attending closest schools respectively (Table 4.3). On the contrary, schools such as Ainabtich, Chebarus, Kimumu and Ngomongo that have a mean value of 42%, 33%, 18% and 0% respectively indicating that majority of their pupils attend a school near to their areas of residence as illustrated in Table 4.2.

Table 4.2: Percent number of pupils not attending closest school per school

School	Frequencies	%		Frequency	Location of the school
		NACPS	%ACS		
Ainabtich	22	42	58	33	Residential area
Central	54	95	5	3	CBD
Chebarus	10	33	23	27	Residential area
G.K Magereza	42	77	33	14	Near CBD -prison
Kimumu	7	18	82	36	Residential
Moi Marula	49	94	6	7	Near university
Ngomongo	0	0	100	9	Residential
Moi University Chepkoilel	110	98	2	4	Near university
Total	294			132	

4.2.2 Percentage not attending close school within the recommended planning distance of 2 km.

The network distance calculated on screen from the pupils' home to school was used to calculate the percentage of pupils travelling two kilometres and less to school and those pupils, travelling more than 2 km to schools. This was aimed at to discover the comparison between the close school attendance as defined by the Voronoi's and the recommended distance.

The results from Table 4.3 shows that about 64% of the sampled pupils come from far which has a close associations to the results obtained from Table 4.1. With respect to schools four schools that is Central, Moi Marula, Gk Magereza and Moi Chepkoilel displays high percentages of those from far. In addition, Moi Chepkoilel continues to display that majority of her pupils residing furthest from school than the rest. Similar results are displayed by Voronoi see (Figure 4.1 & 4.2)

Table 4.3: Percentage of pupils attending school based on the 2 km benchmark

School	% of traveling > 2km	% of traveling ≤ 2 km	Grand Total
Ainabtich	73.33%	26.67%	100.00%
Central	23.40%	76.60%	100.00%
Chebarus	69.57%	30.43%	100.00%
Gk Prison	31.58%	68.42%	100.00%
Kimumu	61.36%	38.64%	100.00%
Moi Marula	14.93%	85.07%	100.00%
Ngomongo	100.00%	0.00%	100.00%
Moi Chepkoilel	6.61%	93.39%	100.00%
Mean	36.11%	63.89%	100.00%

4.3 Variable inclusion and selection for LRM

Variables inclusion and exclusion into the final regression model was determined univariate model as proposed by Bendel and Afifi (1977)). The exclusion criteria was for variable with a *P*-value greater than 0.20 will be excluded from the model see Table 4.4

Table 4.4: Univariate Linear Regression Model (LRM)

Independent Variable		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1 ^a	Academic performance	0.758	0.151	25.272	1	0	2.134
	Constant	-2.614	0.364	51.49	1	0	0.073
Step 1 ^a	Gender	0.098	0.216	0.206	1	0.65	1.103
	Constant	-1.097	0.347	10.018	1	0.002	0.334
Step 1 ^a	Age	0.615	0.153	16.139	1	0	1.849
	Constant	-2.211	0.342	41.739	1	0	0.11
Step 1 ^a	Class	0.165	0.052	10.03	1	0.002	1.179
	Constant	-1.861	0.317	34.38	1	0	0.156
Step 1 ^a	Teacher-Pupil ratio	-0.578	0.094	37.479	1	0	0.561
	Constant	12.79	2.172	34.685	1	0	358584.9
Step 1 ^a	Pupil-chair ratio	-0.503	0.104	23.481	1	0	0.605
	Constant	0.793	0.365	4.729	1	0.03	2.209
Step 1 ^a	Network Distance	-0.001	0	80	1	0	0.999
	Constant	1.582	0.261	36.718	1	0	4.866
Step 1 ^a	Total roll	-0.008	0.001	42.426	1	0	0.992
	Constant	3.73	0.673	30.734	1	0	41.684
Step 1 ^a	Public transport	-0.006	0.001	75.796	1	0	0.994
	Constant	1.268	0.266	22.742	1	0	3.552
Step 1 ^a	Proximity to	0.216	0.218	0.985	1	0.321	1.241

	workplace						
	Constant	-1.281	0.356	12.984	1	0	0.278
Step 1 ^a	Type of building	-0.401	0.225	3.187	1	0.074	0.67
	Constant	-0.39	0.326	1.429	1	0.232	0.677
Step 1 ^a	Water	0.994	0.236	17.703	1	0	2.701
	Constant	-2.558	0.411	38.699	1	0	0.077
Step 1 ^a	security	0.648	0.22	8.68	1	0.003	1.911
	Constant	-1.86	0.335	30.845	1	0	0.156

The workplace proximity ($P=.321$) and gender ($P=.650$) had P values greater than .20 and were to be excluded from the multivariate model. However, they were not excluded since this variables were of interest to the study.

4.3.1 Factors influencing public school attendance

The model results in Table 4-5 showed that academic performance, Pupil Desk ratio (space), network distance, and water ($P \leq .05$) were found to be significant factors that determines attendance or enrolment of a pupil to a school close to a pupil's home.

Table 4.5: Multivariate Logistic Regression Model

Independent Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Age	0.323	0.25	1.667	1	0.197	1.381
Gender	0.139	0.33	0.176	1	0.675	1.149
School Academic Performance	2.3 48	1.154	4.136	1	0.042	10.46
T-Pupil ratio	0.735	0.669	1.207	1	0.272	2.085
Size class	-0.026	0.02	1.668	1	0.197	0.974
P-Toilet ratio	-0.137	0.083	2.738	1	0.098	0.872
P-Desk ratio	2.036	0.61	11.126	1	0.001	7.658
N-Distance	-0.001	0	32.835	1	0	0.999
Total roll	-0.005	0.009	0.293	1	0.588	0.995
Public transport	-0.014	0.004	12.22	1	0	0.986
Proximity	0.509	0.338	2.271	1	0.132	1.664
Building-type	0.271	0.369	0.539	1	0.463	1.311
Water	0.291	0.355	0.671	1	0.413	1.338
Security	0.465	0.329	2	1	0.157	1.593
Constant	-17.694	10.93	2.62	1	0.105	0

4.3.2 Factors that predict choice of public-school attendance

Table 4.6 represents summary results of the logistic regression model with all the important statistics and model characteristics as represented below.

Table 4.6: Logistic regression analysis results for school choice factors

Dependent variable	Association/Predictive Efficiency	Independent Variable	Unstandardized Logistic regression Coefficient(β)	Standard Error of b	Statistical Significance	Standard Logistic Regression Coefficient
TNACS	Nagelkerke's R ² =0.645 -2 Log likelihood= 253.734 ^a	Academic performance	2.348	1.154	0.042	0.493
		P-Desk-R	2.036	0.61	0.001	0.595
		Network Distance	-0.001	0	0	-0.539
		Public transport	-0.014	0.004	0	-0.705
		intercept	-17.694	10.93	0.105	-

The findings on Table 4.6 shows four factors that were statistically significant in the prediction as to whether a parent enrolls a child to the closest school or not. Based on the unstandardized logistic regression coefficients academic performance with $\beta = 2.348$ appeared to be the strongest factor, closely followed by P-desk $\beta = 2.036$, public transport $\beta = -.014$, network distance $\beta = -.001$.

By standardizing the beta, availability of public means of transport (PT) appeared to have the strongest negative effect to not attending closest school ($\beta = -.70502$) followed by these other factors in that order Pupil Desk Beta ($\beta = .5946$), Network Distance ($\beta = -.5387$) and Academic performance ($\beta = .4929$) (see table 4.6). In other words, a 1 standard deviation increase in (PT) is associated with .070502 decrease in logit NAPSCH. A 1 standard deviation increase in PDR is associated with 0.594 increase in logit NAPSCH.

4.4 Optimal distribution of schools

This section presents results on how to visualise and computed optimal public primary school distribution in Kimumu Ward. It commences by presenting a map showing a 2 km buffer around the schools. Secondly, a derived mathematical formulae was used to calculate the ideal number of schools that ought to benefit the study area. Finally the results on compared network distances to standard distance for a child to travel to school was computed. The results therefore are as presented below;

4.4.1 School buffer

The generated 2 km buffer around each school (Fig 4.3) display that all the study area is covered by a primary school because of the overlapping buffer zoned. However, small area in the North Eastern part of the map is not covered by the buffer hence described as a school deficient zone.

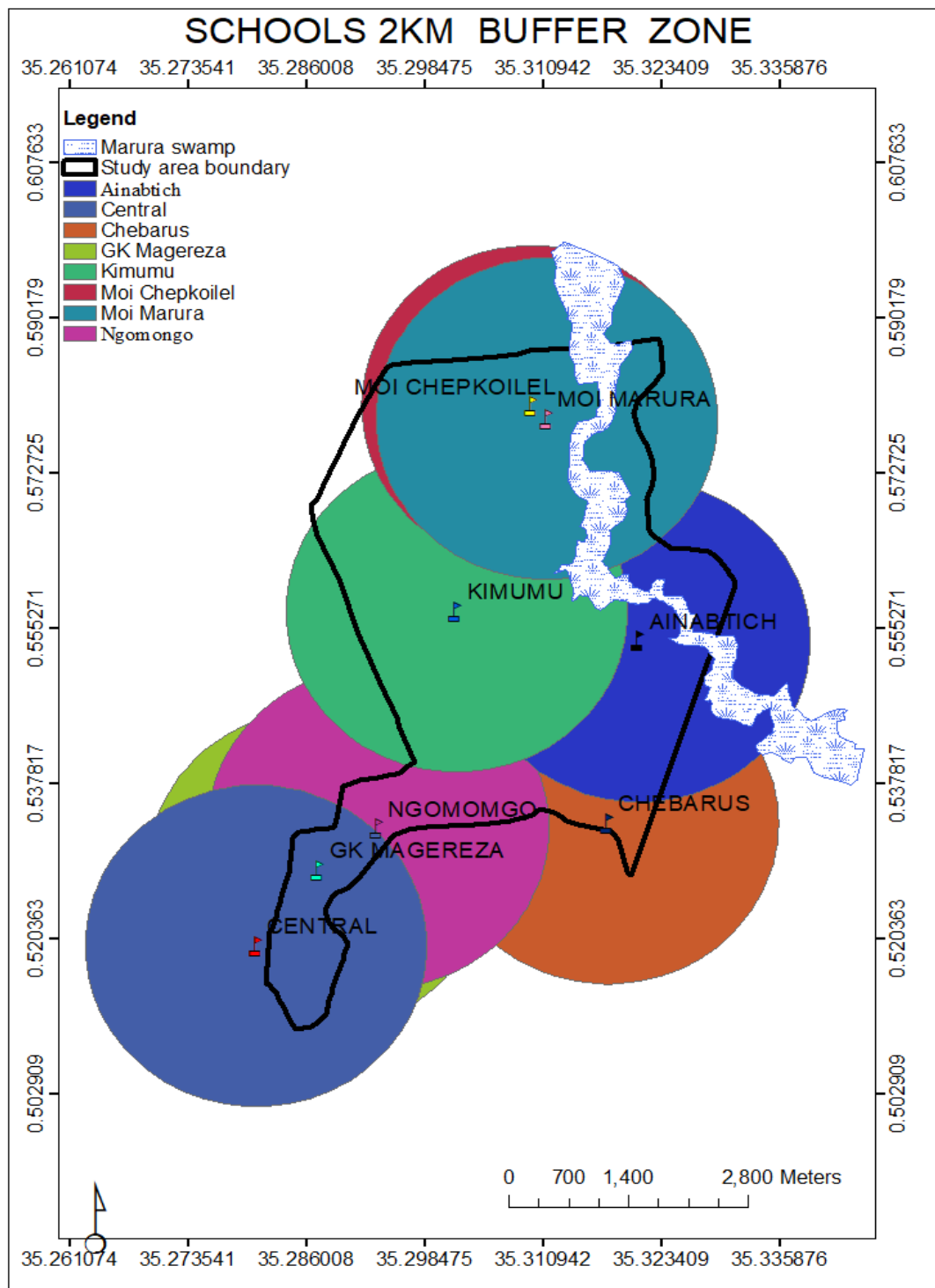


Figure 4.3: Map showing schools buffered at 2 km (Source: Author, 2019)

4.4.2 Mathematical analysis of school adequacy

The derived formulae from the physical planning handbook (see chapter three) was applied as follows. The number of schools in the study area is given by $N_s = 55684/4000 \approx 13.92$. The results shows that study area ought to be served by 14 public primary schools. However the existing number of schools are eights public schools.

4.4.3 Mean Euclidean and Network distances from pupil home to school

The measured straight line and network distances from pupils' home to school were compared. Results on (Figure 4.4) shows that Straight line distance is shorter than the network distances covered by pupils to attended school for all the cases. The minimum and maximum straight line distance a pupil's home was from the school attending were 43 metres and 9.56 km respectively and minimum and maximum network distances to a pupils home were 76 meters and 11.112 km recorded in Chebarus and Moi Chepkoilel primary school respectively.

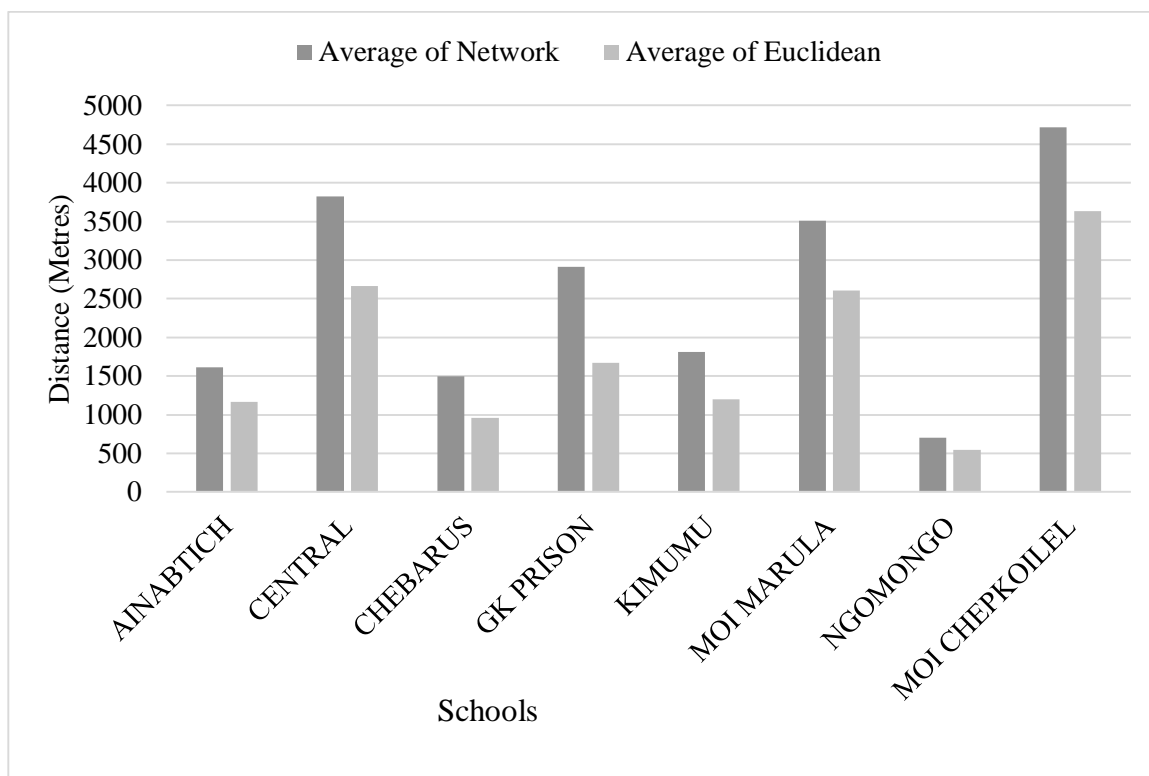


Figure 4.4: Average Network and Euclidean Distances from Pupils Home to School

4.4.4 Mode of transport by sample pupils to school

The results showed that 57% of students walk to school, followed by 43% of the sample who use motorized means of transport (that is *Matatus*, motorcycle, partial walk and motorcycle, Private car and Bicycle) from the most to the least used in that order. The results are presented in Table 4.7

Table 4.7: Mode of transport used by the pupil to travel from home to school and back

Mode of transport	Frequency	Percent	V B Cumulative Percent
Walking	245	57.5	57.5
Matatu	150	35.2	92.7
Bicycle	2	0.5	93.2
Motorcycle	16	3.8	96.9
Private Car	3	0.7	97.7
Partial Walk And Motorcycle	10	2.3	100
Total	426	100	

CHAPTER FIVE

DISCUSSIONS

5.1 Introduction

This chapter discusses the results obtained as presented in the previous chapter and compares them to other scholarly findings. This is done in the order of the objectives of this work.

5.2 Percentage of pupils not attending closest school as defined by Voronoi

The study depicts that most pupils do not attend their closest schools and the attendance patterns varies between schools. For example Ngomongo, Kimumu, Ainabtich and Chebarus have most of their children come from within the school catchment area .This could be a factor of their location in areas characteristically described as residential. Moi University Chepkoilel, Central, Moi Marula and G.K Magereza on the other hand have most of their children not attending their closest schools. These can be explained by the virtue of their locations that are located close to public institutions such as the University of Eldoret, G.K prisons and the Central Business District (CBD) of Eldoret town. This findings, agrees with those of Müller, Tscharaktschiew & Haase (2008) and Parsons *et al.* (2000) which shows that pupils are increasingly attending to schools not close to homes. Similar findings have also been reported in (Allen, 2007; Ferrari & Green,2013; Deruyter *et al.*, 2013) who found out that less than half of all school age children attend their nearest school in England.

Parents who choose to send their pupils to schools not located within their catchment areas must have lacked an intervening opportunity within their catchment and were able to afford the cost of transportation to the schools of their choice. This agrees with Ullman (1980) perspective that for spatial interaction to occur the following are the driving forces complementarity, transferability, and intervening opportunity. This could mean the parents negating distance decay theory where close schools would be conceived close schools to be most patronized. This can be possibly explained by housing prices in the urban areas that are uneven and which may act as a barrier that locks-in or out some families who wish their children to school at a particular school but cannot afford the prices as found out by (Cheshire & Sheppard (2004), Gibbons & Machin (2003) and Leech & Campos (2001). On the contrary, some findings in the developed countries indicate that most pupils attend their neighbourhood school and is assumed that parents choose schools through their housing choice (Snyder, de Brey, and Dillow, 2016).

Percentage not attending close school within the recommended planning distance of 2 km.

The findings of this study depicts that parents still send their children to school beyond the recommended two kilometre distance. The percentages obtained here are almost similar to the ones obtained from the Voronoi. Which actually stamps that most pupils do not attend their closest schools. This is despite the Voronoi diagrams identifying the existence of another public primary school close to their homes.

5.3 Factors parents consider when choosing schools

This sub-section tries to present an explanations to the findings that despite a school being in close proximity to pupils home it is seen that most of them do not attend their closest schools and in addition pupils still travel to school beyond the recommended distance.

To explore the relationship between factors influencing school choice and whether the child is enrolled to the closest school or not, a regression analysis was used. The 15 independent variables were regressed against the binary dependent variable (attending closest school or not (YES/NO)). The model Nagelkerke pseudo- $R^2=0.645$ which means the model was able to explain about 65% of the variance in the variables. That is the model does not explain 35% of the other factors that determines choice of school. However, the variation could be attributed to random sampling error. Confidently $R^2=0.645$ confirms that the model is good enough to be trusted as a predictive model (Menard, 1995).

From this analysis, four factors that were found to be statistically significant in influencing choice of a public primary school in the study. These are academic performance, pupil desk ratio (space), network distance, and availability of public transport

5.3.1 Academic performance and pupil-desk ratio (space)

Academic performance was the leading factor that parents consider when selecting public primary school. This can be explained by the benefits that are associated with good academic performance in the current Kenyan 8-4-4 system of education that translates to enrolment to better high school and consequently high chances of transiting to the higher institutions of learning. A school such as Moi University Chepkoilel primary that performs exemplarily has a wider catchment area and tripled enrolments compared to the other schools in the study area.

This finding is similar with the findings of other studies that observed that academic performance influence choice of a school (Burgess *et al.*, 2009; Cabrera & Najarian, 2015; Deangelis & Erickson, 2000; Hausman & Goldring, 2000; Ibrahim *et al.*, 2014; Maangi, 2014; Roda & Wells, 2013; Schneider, 2003). Further, Dustan and Ngo (2018) show that parents who consider academic achievement as important have a greater tendency of leaving their neighbourhood to access to better school.

However, based on the school performance and out of school catchment population, not all schools with great out of catchment enrolments excelled in their KCPE exams results but still some who performs lowly such as the case of Moi Marula displays a great percentage of out of catchment enrolments. Therefore, the expectations that schools' academic excellence are gaining pupils from out of catchment than the poor performing schools are not true, the realities are more complex.

These findings are an indication of the parent's priority and how these factors in the long run impacts on the quality of the performance. Pupil chair ratio determines the comfort of the child to learn, an indication of school capacity and consequently good academic achievement. To conclude bases on the strengths of influence of the factors Academic performance with ($\beta = 2.348$) appeared to be the strongest factor that positively contributed to a parent not enrolling to a public primary school close to their homes. Similar results are found in a study carried out in Kuala Lumpur using a regression analysis indicated that quality of teaching (with a beta value of 0.359) made a significant contribution to school choice

5.3.2 Distance to school and public means of transport

Pupils' proximity to school and availability of public means of transport were found to be an important factor that influenced school choice. This is because, distance determines the mode of transport used. In an urban setting like it is in the study area Town service transport systems tend to be the cheapest Regina & Oliver (2009) although have been described as inefficient by other researchers such as Aduwo (1990). Therefore parents living in areas that are serviced by town service then consider public transport as an important factor to sending a child to school. This is the case of Moi Marula, Moi Chepkoilel, Ainabtich, G.K Magereza and Central primary schools served by Chep *Matatu*, Kongtai and M.C.J.P *Matatu* Saccos respectively and for Central primary being in the CBD is served by all Saccos.

However, distance to school is not a stand lone factor since most parents do not enrol their children to the closest schools. It only matters where the closest school shows an outstanding performance in their KCPE results. Findings of Duze (2011) and Müller *et al.* (2008) corroborates this finding by pointing out that for those attending closest school proximity is an important factor while for schools with unique profiles this does not hold water. Other researchers have also pointed out the contribution of the non-academic factors such as proximity to school, transportation or social environment (Hausman & Goldring, 2000). Distance, availability of public transport goes hand in hand to influence choice of the school and summative hints on academic performance. This is in concurrence with Alsaudi (2015); He & Giuliano (2018) and Hsu and Yuan-fang (2013).

5.3.3 Proximity to the parents work places

This variable was not significant but since there are schools located within a University, a Government Prison and CBD of Eldoret town. Their special locations might be a reason why pupils attend catchment or out of catchment school for parent convenience. This schools are Moi Marula, Moi Chepkoilel, GK.Magereza and Central primary that are located close to University of Eldoret, Prison and Central Business District of Eldoret town respectively. Similar observations has been made by (Nelson, 2018a). in addition, it urban catchments areas have been reported to be the most permeable unlike rural areas where distance limits such movements as found by Parsons, *et al.* (2000). Finally, Müller *et al.* (2008) points out that those not attending their neighbourhood school do so to attend a school with different profile. Also, out of catchment attendances could be

explained by schools reaching their capacity when enrolling pupils in the own statistical area, forcing pupils in adjacent statistical areas to attend schools at greater distances as pointed out by (Deruyter *et al.*, 2013).

5.4 Adequacy of public primary schools

This subsection discusses the results on analysis of schools' adequacy in the study from Schools buffered zone and mathematically calculations done based on the population school comparison.

5.4.1 School buffer zones

The buffer of 2 km around all the school showed that the buffer for 2 km overlap each other in most part of the map which in accordance to planning guidelines indicates that all schools are within a radius of 2km except for a small section in North East part of the map. This area not buffered by a school signifies inadequacy however, a school (Koitabes primary) in Kiplombe Ward serves the area. Therefore it is right to conclude that primary schools are adequate in the area of study only if there are not obstacles like private land and developments and all the schools can be accessed from all the direction. However, the later may never be realistic and as stated earlier buffers are limited in many ways and without accurate information on the existing school going age population together with the housing units in the study area the question of adequate or inadequate may not be answered well.

5.4.2 Mathematical analysis of school adequacy

Results from section 4.4.2 shows that the area is underserved by 6 public schools. This does not mean there is an acute shortage, but the realities are cautioned by the number of streams in the schools. For example Moi Chepkoilel is a three streamed school, G.K Mageresa, Ainabtich, Central that are two streamed. Private primary schools that also serve the area hence based on the parents tastes and preferences demand for public primary schools are shared.

However, this study can be able to critique the distribution of the schools with respect to the exact locations. This we mean schools must and should always be in the most central location to the residential areas of the town. That is schools such as Moi University Chepkoilel primary, Moi Marula and Central primary are misplaced such that they first two are crowded in the same place with barriers to access on both of its side that is the university to the West covering a vast land and a stretchy swamp to the east acting as a barrier to access and definitely most students must walk long journeys to reach this schools. Secondly the central primary is located right in the CBD; hence most residential houses are expensive for the low-income families who are the majority users of the public facilities for this case school.

In addition, the planning handbook is limited in stating two kilometres as an appropriate distance to a school since factors such as the means of transport are not stated since walking to such distance is possible but also unrealistic for young children.

5.4.3 Distance to school and transport mode used

This sub-section discusses the mean distances travelled by the pupils to school and presents both Euclidean and network distances from pupil home to school and the variability between the distances travelled by pupils from different schools. It further explains the variations on the mode of transport used by the pupils.

5.4.4 Mean Euclidean and Network distances from pupil home to school

The findings indicate that the Euclidean distances is shorter for all schools compared to their corresponding network distances. This is valid because the network distance follows the roads and consider all physical barriers in the area for example a barrier such as Marura Swamp and developments such as fenced Shahid *et al.*, 2009.

The findings of this study indicate that there is significant difference between the distance travelled by children attending the closest school and those who do not. With those attending close school covering less or equal to the recommended distance by planning handbook of 2 km. Furthermore, the distance travelled by pupils not attending close schools from Moi Chepkoilel and Central primary schools are significantly different from the rest and exceeding more than 4km. This can be explained by urban form and attractiveness of the school to academic performance, accessibility and proximity to the parent's workplace as for the parents working at the university and Eldoret town.

Further, considering two-way journey to school (morning & evening) then, coverage of total of 7.5 km is done. But if it is a four-way such as Quadra-journey morning lunch and evening movements, a distance of 15.416 km is covered per child per day to and from school which is very stressing and tasking in the absence of eateries and automated transport modes to school, it is impracticably unachievable with the strict school schedule, age and the environmental variability in the area. Duze (2010) found similar results with more children travelling beyond 5 km to school in the case of a densely populated state in Nigeria.

This finding reveals that those not attending their closest school must overcome the constraints of long distance to the school of their choice. Hence, we can infer to the economic empowerment of the parents as brought out by Charles & Mott (2002), Fiske (2002), Handa (2002), Teske, Fitzpatrick., & Kaplan (2007) as the main means of overcoming these distance challenges. Nonetheless, this distance is relatively smaller as compared to that travelled by pupils in the rural areas and marginalised areas which are characterised by sparse populations that sometimes exceed 10 km to school (Adele, 2008; Al-Qudsi, 2003; Kristiensena and Pratiknob, 2006).

5.4.5 Mode of transport used by the sampled pupils to school

The finding show pupils majority walk to school and closely followed by use of *matatus* in many ways is different from expectations given that most of the pupils do not attend to their closest schools as alluded by Timperio *et al.* (2006) that school proximity is a major

determinant of children's active travel to school. Furthermore, the average distance travelled by pupils to most of the schools exceeds the recommended total school journey of four kilometres in a day. Which still though is much more, compared to a distance of 400 m (0.25 miles) about five-minute walk that is often used as an acceptable walking distance for the case of the developed nations (Wilson *et al.*, 2007).

These findings could be attributed to the low socio-economic factors of the parents not able to pay for fare as pointed out or unable to afford car as found out by (Davison *et al.*, 2008). But the contrary is reported by (Duze, 2010) who reports that despite the children ability to pay for car transport some may choose to walk for long distances to school. Other factors that may explain above results include, urban form and structure may have limited or enhanced the walkability of the pupils as the case of greater junctions density areas poses traffic and safety concerns of the pupils as supported by the findings of (Shokoohi *et al.*, 2012; Davison *et al.*, 2008; Ibrahim *et al.*, 2014; Kristiensena, 2006).

Parents perception of short distance to school could have necessitated walking to school as found out by Carlin (1997) and Ewing *et al.* (2004). In addition, Norah Nelson *et al.* (2008) found out that there exist an inverse relation between population density and mode of travel to school.

These findings are also contrary to those of Ibrahim *et al.* (2014) who found out that majority of the pupils use private vehicles with the percentage of for safety concerns and because the school distance is closer to their workplace. Shokoohi *et al.* (2012) mentioned that neighbourhood safety becomes a concern of parents which leads them to

use private vehicles to send their children to school. According to (Ewing *et al.*, 2004); the shorter distance between school and home encourages children to walk or cycle during a school trip. In addition, Maryati *et al.* (2012) stated travel distance to primary school should be normally within walking distance.

Furthermore, the reasons for walking as pointed out from interviews interactions during the study, most pupils pointed out discrimination by the “*Manambas*” who view children not as potential customers of the *Matatu* business hence most shun away from accepting to carry children to school. Mode choice to school may differ from one place to another because it influenced by parents’ perception towards factor such as distance and traffic safety (Ewing *et al.*, 2004)

Most pupils coming from far are a clear indication that parents of these pupils are able to bear the cost of long journey to school. This is supported by Parsons *et al.* (2000) who reported that a high proportion of middle-class exports have been consider short-distance moves to another nearby school while children living in ‘prospering’ middle-class areas who are moving to out-of-catchment schools are making longer journeys. In addition, Bernal, (2005), states that “middle class families have more resources as well as greater cultural capital and often do not send their children to the nearest school, but rather to one they consider better, no matter its location”. On the contrary, a study carried out by Parsons *et al.* (2000) showed that Out-of-catchment schools were chosen by 42% of children living in ‘struggling’ and ‘aspiring’ neighbourhoods compared with 35% for parents in more prosperous areas.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter concludes the study by highlighting key findings makes conclusions and makes recommendations that are expected to influence policy and potential future researches on the same subject.

6.2 Summary of Findings

The following is a summary of the main findings by this study:

- Most pupils (69% of sampled pupils) in Kimumu Ward are enrolled to schools not close to their homes as defined by the Voronoi delineated catchments.
- Similarly, most pupils (64%) travel to school beyond the 2 km contrary to the recommendations of Kenya Physical Planning Handbook.
- Academic performance, distance to school, pupil desk ratio (school capacity) and availability of public transport are major factors that a parent from enrolling a child to a close school.
- Using the Kenyan Planning standards (PPH, 2007), schools in Kimumu Ward are adequate (within on two kilometres radius for primary schools) but most pupils do not attend their closest schools. However, based on the population to public

primary schools available schools are inadequate. But this inadequacy has been compensated by the schools which are either double or tripled streamed.

- Considering performance most of the public schools perform averagely or below average. Very few schools are, therefore, attractive to parents hence they must shop around for the good school and with vacancy they crowd those few schools and travel long distance.
- Over 40% of the sampled pupils use motorized transport to school.
- Some schools are crowded or located in the same spot need to be relocated.

6.3 Conclusions

- A mere closeness or physical presence to a school does not guarantee patronage by the adjacent children. Investment in other aspects such as academic performance, pupil chair ratio, and transport are critical to making a school attractive.
- Pupils not attending closest schools and travelling beyond the recommended 2km has a potential to contribute to increase the per capita carbon foot print.
- The fact that schools recommended 2 km buffer zones overlap and students still travel beyond this distance to attend school is a clear indications that parents are exercising school choice and there are factors that make the public primary schools have different attractions to parents.

- Some schools are located in close proximity this means there are other factors not captured by the Planning Handbook that informed siting of schools.

6.4 Recommendations

This section has presented two sets of recommendations, first to decision makers/policy makers and the second is meant to furthering research.

6.4.1 Recommendation to decision and policy makers

- All Public schools' administration need be tasked to improve their academic performance through improving their KCPE results. It could be achieved through benchmarking in the performing schools.
- Government need to invest on the public primary school infrastructure this can be done by coming up with a policy document that defines school infrastructural endowments.
- All policy should be focussed at making public primary school attractive. Through infrastructural improvement of the schools, provision of pedestrian side-walks and offering quality education.
- Schools are not adequate and establishing new ones may be expensive hence proper planning in schools with enough land resources be done to establish a complex school that can accommodate more children.

- Decongestion of school's especially those very close to each other such as Moi Marula and Moi Chepkoilel primary schools.

6.4.2 Recommendations for further Research

- Further studies, should apply the economic distance to compare their influence to school choice
- Further studies should also investigate the Social Economic Status of the household and its relationship to distance attendance to close school or not.
- Same Studies should be conducted on the private and rural public schools to observe their trends
- There is need to investigate the relationship between school movements and the environmental pollutions as well as respiratory disease among the pupils commuting long distance to school.

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APPENDICES

APPENDIX I: HOUSEHOLD QUESTIONNAIRES

INTRODUCTION STATEMENT

My name is Rose Chepatei a student at the University of Eldoret, department of environmental planning and management. I am conducting a research on accessibility to public primary schools in Chepkoilel location. This study involves a survey on hundreds of households. I am requesting for your permission and that of your child to ask questions about your home location and factors you consider before enrolling your child to school. Some of the information am seeking might be personal, however, all the information shall be treated with absolute anonymity, this means we are not asking for your identity or that of your child instead numbers shall be used. The information shall only be used for this academic work. Please fill in the questions and return to the school through your child. Thank you.

SECTION A: QUESTIONNAIRE PART A TO BE FILLED BY THE PUPIL

No. of the questionnaire_	Name of school__	Gender__	Class__	Age__
Q1	Study the A0 map provided and identify the location of your home or the very closest conspicuous feature close to where you live and thereafter you will be guided by the researcher to mark and label your home using the unique number given to you.			

Q2	Give the name of your residence as locally known by many _____
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PART B : TO BE FILLED BY THE PARENTS/GUARDIAN SCHEDULE

No. of the questionnaire	Name of	Gender	Class	Age	
_____	_____ _____ _____	_____ _____ _____	_____ _____	_____	
Q1	Give the name of estate/place you live				
Q2	What is the approximate distance from your home to this school				
Q3	Which of these factors made you choose this school for your child? (Mark appropriately; YES or NO)				
				Mark (X)	
	Factor			Yes	No
	i)	Teacher to pupil ratio			
	ii)	Sanitation			
	iii)	Long distance to school			
	iv)	Short distance to school			
	v)	Proximity to your workplace			
	vi)	Type of building in the school			
	vii)	Availability of public transport			
	viii)	School security			
	ix)	School total enrolment /population			
	x)	Academic performance			
xi)	Class size				
xii)	Facilities (name them)				

	xiii) Others (Specify)		
Q4	Which mode of transport do your child use to get to school; (Underline appropriately) i) Walking ii) Matatu iii) Bicycle iv) Motorcycle v) School bus vi) Private car v) Specify if mixtures of the above are used		
Q5	How much do you spend on your child per month for: a) Transport to school? b) On lunch at school?..... but if S/He eats at home during lunch hour indicate null		
Q6	a. What challenges do you face while selecting a school for your children? i. ii. iii. b. What challenges does your children face while attending the school? i. ii. iii.		
Q7	Draw a direction sketch map to your home, label the roads used and any major landmark		

PART C: INFRASTRUCTURE ASSESSMENTS IN SCHOOL

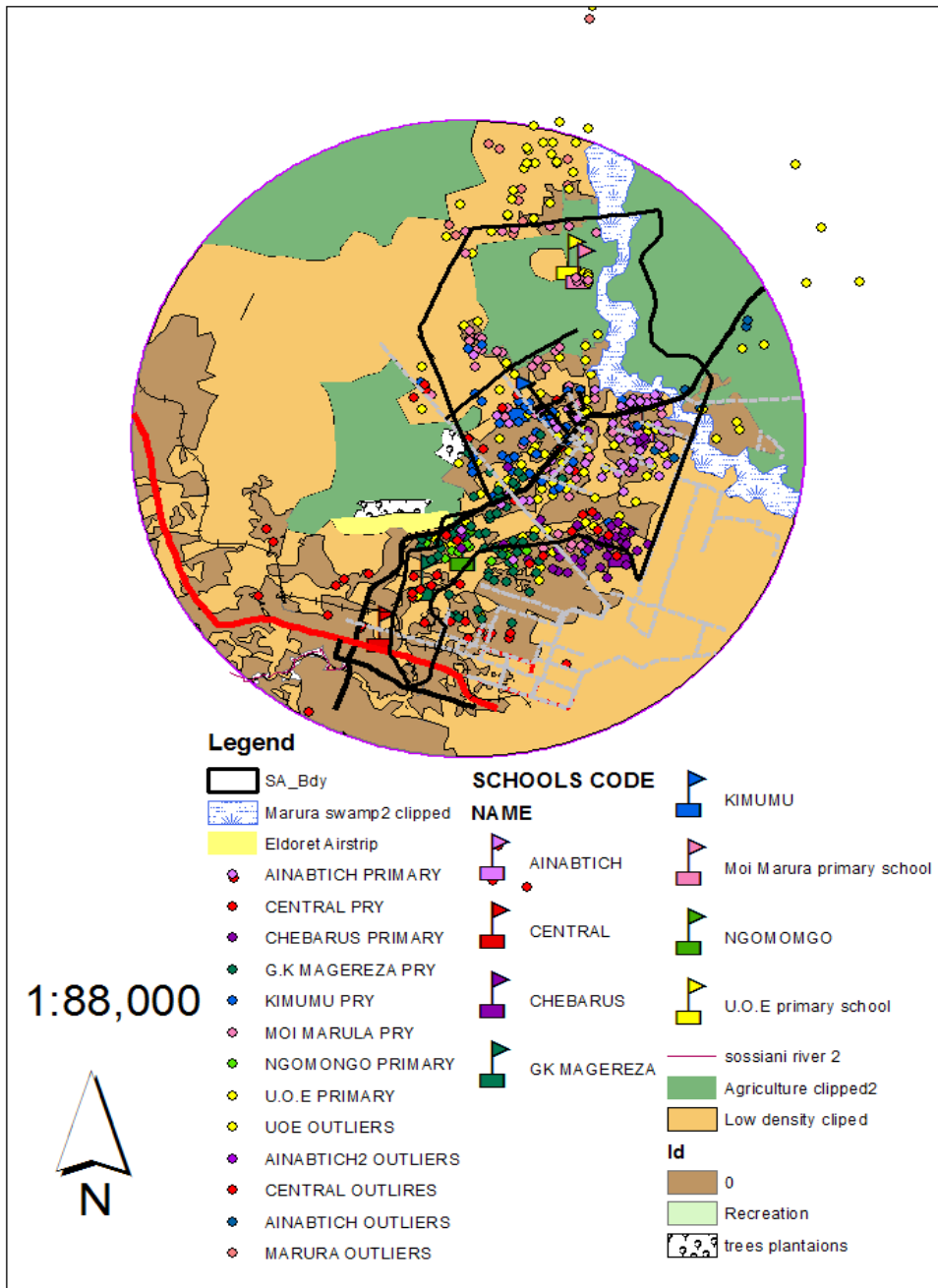
(i) How do you rate the following in the school your child attends?

Name of the school						
Coordinates						
Type of infrastructure	Indicate as 0=absent, 1=insufficient, 2=reasonable,3=good,4=very good and 5=excellent					
Sanitation						Remarks

total enrolment									
Enrolment per stream									
No. of teachers									
Number of latrines									
Number of classrooms available									
Number of taps									
Others									
School Name									
Sub-Location									

APPENDIX II: LAND USE IN THE STUDY AREA

LANDUSE AND PUPILS RESIDENCE



APPENDIX IV: SIMILARITY REPORT


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