

# TECHNICAL UNIVERSITY OF KENYA

# A GIS Application in Competency-Based Curriculum Schools Distribution Mapping and Proposing Future Secondary Schools Locations:

Case Study of Makadara Sub-County.

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A project submitted to the School of Surveying and Spatial Science for the Award of the Degree of Bachelor of Technology in Surveying

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# DECLARATION

I hereby declare that this project here is my original work and has not been presented
in any other university for examination or award of any other degree.

Signature......Date:....

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I confirm that the work reported in this project was carried out by the candidate, under my supervision. I have read and approved this project for examination.

Signature......Date.....

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Project Supervisor.

# **DEDICATION**

I dedicate this project to my family for their unwavering love and support. My grandmother (Marianne Nyakerario), your prayers and inspiration has been my source of strength. My mother (Zipporah Kerubo), thank you for being my rock and support in all aspects of my studies, and my father (James Nyandika), thank you for your continuous advice and love. Lastly, my siblings Diana, Paul, Varelian, and Raphael for your support and love forever.

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# ABSTRACT

Education is regarded as one of the most effective means of reducing poverty, providing people with opportunities to better their lives and raise their voices, improving their health and productivity, and encouraging participation in civil society activities. It has been observed that growing the number of students who complete high school contributes to economic growth, social and political stability, a decrease in crime, and improved social services. School enrollment is the gateway to the education system, and research into it and its accessibility to the population of people easily has a significant impact on education management. Students' enrollment is impacted by various factors such as the population of people, educational facilities, environmental conditions, institutional barriers, and physical access.

The primary goal of this study was to show how to use a Geographic Information System (GIS) to determine the relationship between CBC school access, school enrollment, and people's population. The study's methodology included collecting various datasets for schools, populations, and roads in Makadara Sub County, which is part of the larger Nairobi County in Kenya. This was accomplished by collecting school spatial and enrolment data, population data, and road spatial data. The proximity distances of schools to the population in the area utilizing data collected and analyzed using ArcGIS 10.8 software. Projections for the population of school-aged children in the area of study and in the catchment area of each school were made using 2019 population census data. The catchment area was determined by using the schools as sample data points to create Thiessen polygons. The proposal for locations of new secondary schools was determined by considering the population in the area, the locations of already established secondary schools, the school enrollment, and the road network in the area.

The key findings were maps of school distribution and population in the area, as well as enrollment versus school-to-road distances. The findings revealed a strong relationship between population proximity, school location, and school enrollment. The gap between actual and proposed locations of secondary schools decreased. Actual enrolment decreased as school distances from the nearest roads increased. As a result of the study's objective, the relationship between school distribution access, the population, and school enrollment was determined.

# **Table of Contents**

DECLARATION i
DEDICATIONii
ACKNOWLEDGEMENTiii
ABSTRACTiv
Table of Contents
List of Figures viii
List of Tablesix
Abbreviationsx
CHAPTER ONE1
INTRODUCTION1
1.1 General Introduction
1.2. Problem Statement
1.3. Objectives
1.3.1. Main Objectives
1.3.2 Specific objectives
1.4 Methodology
1.5 Justification and Relevance
1.6 Scope and Limitations
CHAPTER 2
LITERATURE REVIEW
2. 1 Importance of Education in Kenya5
2.2 Factors influencing access to education
2.3. Stakeholders in Education Provision
2.3.1 Ministry of education

2.3.2 Kenya Institute of Curriculum Development (KICD)	
2.3.3 Kenya National Examinations Council (KNEC)	
2.3.4 Teachers Service Commission (TSC)	7
2.3.5 County Government Education Board	7
2.3.6 School Community	7
2.4 Competency-Based Curriculum (CBC) in Kenya	7
2.4.1 The History of CBC	7
2.4.2 The Basis of the Competency-Based Curriculum	
2.4.3 Levels of CBC	
2.5 The accessibility concept	
2.6 Geographic Information System (G.I.S.)	
2.6.1 GIS Definition	
2.6.2 GIS Analysis Methods (proximity analysis)	
2.7 Review of previous Studies of School Mapping in Other Countrie	es 12
CHAPTER 3	
METHODOLOGY	
3.1 Area of Study	
3.2 Methodology Overview	
3.3 Data Sets and Tools	
3.3.1 Hardware	
3.3.2 Software	
3.4 Collection of Data and Preparation	
3.4.1 CBC School Enrolment data	
3.4.2 Population Data	
3.4.3 Scanning of the Topographical Map	

3.4.4 Geo-referencing of the Topographical Map	. 20
3.4.5 Topographical Map Clipping of Area of Study	. 21
3.4.6 Digitizing Features	. 21
3.5 Data Processing and Analysis	. 21
3.5.1 Personal Geo-database Creation	. 21
3.5.2 Proximity analysis	. 22
3.5.3 Creation of Thiessen Polygons	. 23
CHAPTER 4	. 24
RESULTS AND ANALYSIS	. 24
4.1 Primary schools	. 24
4.2 Secondary Schools	. 25
4.3 Schools enrolment and population	. 25
4.4 Proximity analysis	. 27
4.4 School Catchment Area Generated from Thiessen Polygons	. 28
4.6 Proposed Secondary schools	. 29
CHAPTER 5	. 30
CONCLUSION	. 30
5.1 Summary	. 30
5.2 Conclusions	. 30
5.3 Recommendations	. 31
References	. 32
APPENDIX 1: Nairobi Topographical map sheet number 148/4	. 34

# List of Figures

Figure 1An illustration of the levels of education under the CBC curriculum in Kenya
Figure 2 Creating Thiessen polygons from point features (ESRI)
Figure 3: Demonstration of Near Feature tool (ESRI)
Figure 4: Barriers to accessing education (Shyam (2007)13
Figure 5: Makadara sub-county (Area of Interest ) 15
Figure 6: Methodology flowchart16
Figure 7: Geo-referencing topographical image and Total RMS Error table
Figure 8: Personal geodatabase
Figure 9: Near analysis in process
Figure 10: Creation of Thiessen Polygons
Figure 11: The distribution of Primary schools in Makadara sub-county
Figure 12: Distribution of secondary schools in Makadara sub-county
Figure 13: CBC school's enrollment to population
Figure 14: Primary schools catchment areas in Makadara Sub-county
Figure 15: Proposed secondary schools

# List of Tables

Table 1: CBC Schools spatial data	17
Table 2: Roads Data (KRB)	18
Table 3: Wards population data (KNBS)	19
Table 4: Near analysis of roads and schools	27

# Abbreviations

- GIS- Geographic Information System
- CBC- Competency-Based Curriculum
- KRB- Kenya Roads Board
- KNBS- Kenya National Bureau of Statistics
- ESRI- Environmental Systems Research Institute

# CHAPTER ONE INTRODUCTION

#### **1.1 General Introduction**

Education is one of the typical elements of progress. People's understanding of the world and themselves is improved through education (Ozturk, 2008). It uplifts their standards of living and greatly positively affects both people and society. Advanced technology, productivity, and creativity are greatly influenced by education. It also boosts entrepreneurship. It is also essential to ensure social and economic progress and enhance income distribution. Around the world, societies with highly educated populations reap long-term benefits like better corporate production and wages. The primary functions of education in contemporary culture are empowerment and enlightenment. Analysts contend that there has never been a greater need in society for new knowledge and that education is the only way to bridge this gap (Ozturk, 2008). Despite being the best investment one can make in life, education offers the best chances for success in contemporary society. Education enables people to become conscious subjects of their growth and active, responsible participants in the methodical process of constructing a new world order in terms of knowledge, traits, skills, attitudes, and capacities.

GIS is a powerful tool for developing and planning spatial events because they are designed to capture, handle, analyze, manage, store, and display geographical data (Ali, 2020). To enhance educational planning and decision-making, school mapping entails the creation of demographic and geographic databases relating to education and socioeconomic data for learning institutions. The databases give information on the location of schools, the number of public and private schools currently operating at various levels, their capacities, and facilities (Ali, 2020). It is crucial to offer affordable schools in every community. The goal of the Makadara School Mapping Project is to gather data for educational institutions and to incorporate it into a GIS database that could be queried to give important information to educational planners and other people like professionals and any other person. This study aims to study the application of GIS in managing educational facilities, properly preparing for the construction of new CBC academic centers, and distributing resources that will significantly reduce literacy challenges and promote equality.

#### **1.2. Problem Statement**

The Government of Kenya encounters a wide range of issues when providing services to its citizens equally. One of the requirements for carrying out any effective academic activity is the availability of schools for students and suitable policy formulation, the importance of which cannot be overstated. The competency-Based Curriculum (CBC) was launched by the Kenya Institute of Curriculum Development (KICD) in 2017.

Equalizing educational opportunities for all children in Kenya and providing easy access to educational facilities have been among the most difficult challenges for educational planners and administrators. The issue of equality does not arise if all habitations/villages are provided with a school. However, in real life, we locate schools so that other habitations and areas also benefit. The location and accessibility of school buildings are urgent to meet the demand of new students and the new CBC program. As a result, this project will attempt to demonstrate how critical it is to integrate all of the data and use GIS to analyze the distribution of schools, identify disparities in the CBC school's location accessibility, and propose future areas for secondary schools based on suitability analysis.

#### 1.3. Objectives

#### **1.3.1.** Main Objectives

The main objective of this project is to show the use of GIS in mapping out the distribution of primary and secondary schools in Makadara Sub-county.

#### **1.3.2** Specific objectives

- i. To collect spatial data on the schools and roads in the Makadara sub-county.
- ii. To identify the existing disparities in the distribution of CBC schools, and determine their proximity and accessibility in Makadara sub-county
- iii. To carry out a suitability analysis to determine and propose the locations of new CBC secondary schools in the future.

#### **1.4 Methodology**

School mapping has been shown to provide a clear physical understanding that includes largescale surveys. This study will look at the impact of GIS on school mapping, including school enrollment, accessibility analysis, proximity analysis, and location suitability, among other things. Case study methodology will be used as the study's research strategy, and the Makadara sub-county area being the study's area. The research will use various data sources, including school mapping, evaluating the schools already in place in Makadara, proximity analysis, and analyzing location suitability. The range of the school's distance from the home, the state of the road system, the availability of social facilities, and urbanization and land use will form part of the research's variables.

The project will employ Primary data, GPS Coordinates of educational facilities in Makadara collected with mobile phone GPS. Data collected will be analyzed using maps, charts, and tables. Secondary data will include existing maps of the Makadara area showing school distribution and Roads data from the Kenya Roads Board (KRB).

The locations of all the schools in Makadara will be gathered using the GPS app MAPinr, which has a real-time accuracy range of 2 to 5 meters. The survey will be conducted utilizing GPS to gather the locations of these schools. Later, this data will be transferred to a computer and transformed into a point shapefile using ArcGIS software. The final map will be created using ArcGIS 10.8 software including the road network. The best strategy to decide where to locate the additional secondary schools to cover the gap is to do a suitability analysis.

#### **1.5 Justification and Relevance**

According to the Kenyan Constitution from 2010 education is identified as a guaranteed right to every Kenyan. According to the constitution, everyone has the right to education" and "every child has the right to free and compulsory education" (Article 53.1. b). Every child's right to an education is acknowledged and safeguarded under the Children's Act and the Basic Education Act (No. 14 of 2013). Secondly, the new education curriculum is here to stay as it had been gazette and gradually introduced and is steadily replacing the 8-4-4 education cycle. With the significant population growth and unsteady supply of government funds to build the schools at once, there has been a range of difficulties, from inadequate classrooms and furnishings to the more severe ones, as high enrollment in junior secondary schools is expected early next year. Mapping the locations of schools will help parents determine suitable schools to take their kids to, and the

government supplies resources. Additionally, mapping the locations of schools will also benefit the general public, foreign organizations, and Non-governmental organizations who might be interested in education-related activities.

#### **1.6 Scope and Limitations**

Case study methodology will be used as the study's research strategy, and the Makadara sub-county area being the study's location. Makadara's location is in Nairobi, Kenya, and its exact location is 1° 17' 0" South, 36° 53' 0" East. Makadara sub-county has 51 primary schools, and 15 secondary schools to which the study will be limited. The project will rely on ArcGIS software for suitability analysis and mobile GPS for data collection. The supply of educational facilities in Makadara by the public and private sectors will be examined in this study. Additionally, the study will evaluate the types and availability of the institutions, and road accessibility.

# CHAPTER 2 LITERATURE REVIEW

#### 2. 1 Importance of Education in Kenya

Investing in education is commonly regarded as being crucial to development. Human capital, and education, in particular, is likely the most important element in regional disparities in development (Chiappero-Martinetti & Sabadash, 2014). Investment in education continues to have a favorable impact on both private and aggregate levels of income, which are both indicators of economic growth and development in a nation. Although many other factors affect individual income levels, including political systems, economic stability, and labor market structures education level remains the most important one. As a result, investing in children's education leads to advanced private and public income; higher income enables individuals to have more freedom and purchasing power.

The development of human capacities, a crucial component, can be considerably aided by investments in education. Education benefits a person in reading, conversing, disputing, being able to make more informed decisions, being taken more seriously by others, and so on (Simamora, 2020). This could include improved decision-making, more political participation, beneficial spillover effects on people around the educated individual, instilling a love of reading in others, or contributing innovative ideas to a field. It is crucial to take into account this improved human capability as one of the significant advantages of investing in education and its crucial role at the center of development. Thus, education can be seen to play a key role in easing the tight constraints placed on developmental progress by poor health and in reducing the pervasive and difficult "disease burden" of many LDCs (Okediji, 2018). The existence of numerous educational externalities also suggests that governments and policymakers play a significant role in educational investment.

#### 2.2 Factors influencing access to education.

There have been significant changes in the education sector due to a factor that the industry is ignored in large quantities. The sector has had difficulties on a variety of fronts, including

administrative, socioeconomic, and physical. Data have been gathered over time by higher education institutions such as the Ministry of Education. It has been their trademark as a body in the delivery of high-quality education to lessen the difficulties encountered.

Various reasons exist as to why prospective students choose not to enroll or are compelled to drop out of school early (Abuya et al., 2013). High rates of poverty among slum residents in rural and urban areas, topographical obstacles, and regional differences cause a delay in population growth regarding the extension of educational facilities (Abuya et al., 2013). These elements create a disadvantage that suggests the lack of equal access to schooling opportunities in an environment where a propensity to pursue education exists at the earliest chance and when social and environmental obstacles obstruct achievement. Due to this drawback, fewer students will have access to educational opportunities and will be less able to profit from the education they do receive.

#### **2.3. Stakeholders in Education Provision**

Other stakeholders are covered below, in addition to the school's stakeholders (teachers and head teachers), students, parents, the local chief, Faith Based Organizations, Teacher associations and Unions, Boards of Management, and Local Administrators.

#### 2.3.1 Ministry of education

Monitoring, policy, and planning for the education sector fall under the overarching jurisdiction of the Ministry of Education. Significant policy efforts in basic education are spearheaded by the Ministry of Education. Creating and implementing policies; maintaining standards, and educating staff members on CBC.

#### **2.3.2 Kenya Institute of Curriculum Development (KICD)**

KICD was initially known as the Kenya Institute of Education (KIE) and is obligated to develop and approve the curriculum for almost all subjects taught in Kenya. KICD being a state corporation of Kenyan laws sets forth its mandate. In addition to creating regulations and other pertinent laws, KICD also conducts research, creates support materials for the various curricula, and designs curricula.

#### 2.3.3 Kenya National Examinations Council (KNEC)

KNEC is responsible for managing Kenya's national exams. The other duties include establishing and maintaining examination standards holding national examinations in Kenya at the primary, secondary, and tertiary levels, and giving certificates or diplomas to successful candidates; no one or organization should withhold the candidate's certificate or diploma. Education managers can participate in collaborative forums on CBC after receiving assessment training.

#### 2.3.4 Teachers Service Commission (TSC)

The Commission oversees all public elementary and secondary schools, as well as Instructors' Training Colleges, where teachers are employed (TTCs). Its roles include the implementation, supervision, and teacher competency development of a competency-based curriculum; review of the supply and demand of teachers for effective implementation; and advice to the national government on subjects about the teaching profession.

#### 2.3.5 County Government Education Board

The Cabinet Secretary (CS) is referred to be the one in charge of affairs regarding training and basic education. The County Education Board's responsibilities are: supervising, in consultation with the county government, the operation, and management of pre-primary education.

#### 2.3.6 School Community

The school community gives teachers, students, and parents a place to have meaningful interactions. Strong relationships between schools and the local community help the institutions succeed. The importance of the school community is for creating policies that are useful to students and are student-oriented.

### 2.4 Competency-Based Curriculum (CBC) in Kenya

#### 2.4.1 The History of CBC

To fulfill the need for education and help Kenya realize its 2030 vision, a task force presented a report that emphasized the following curriculum adjustments (Akala, 2021). First, the curriculum should be restructured within a competency framework that outlines the information, abilities,

values, and attitudes that should be included at each level, such as entrepreneurial talents. Two, by taking into account the study of regional knowledge and culture, local demands can be met. Three: Creating routes so that all students have an equal chance to recognize their talents and realize their full potential. A fourth recommendation was to incorporate ICT into the curriculum as a key component of the knowledge-based economy. CBC was created by the Kenya Institute of Curriculum Development (KICD) team and introduced by the Ministry of Education in 2017. The CBC is made to emphasize the importance of learning new things and using what you've learned in practical circumstances (Nyakangi, 2018).

#### 2.4.2 The Basis of the Competency-Based Curriculum

With the Competency-Based Curriculum, every Kenyan learner will receive an education that meets the highest standards in the world for both skills and knowledge. The curriculum's goal is to develop each learner's potential while advancing social, economic, technological, and industrial demands. In a changing society, the learner will adopt beneficial cultural habits. Learning will be motivated by a student's interests, talents, and character to make a constructive contribution to society. A curriculum that supports environmental protection, conservation, and animal care for long-term growth. Give all students, both those that are disabled and the ones with special needs, inclusive and equal access to high-quality, individualized education that is focused on helping them become responsible, moral, and religious citizens. It gives students the chance to grow and put their competencies—a combination of knowledge and skills—to use. Seven competencies make up the competency-based curriculum;

- Learning to learn
- Critical Thinking and Problem-Solving
- Collaboration and Communication
- Digital literacy
- ➤ Self-efficacy
- ➢ Citizenship
- Creativity and Imagination

# 2.4.3 Levels of CBC

This approach tracks each learner's development over a period of 2-6-3-3 years, evenly divided into the three main educational levels:

- Early childhood education (2 years in Pre-primary and 3 years in lower Primary).
- Middle education (3 years in Upper Primary and 3 years in Junior Secondary).
- Senior high school (3 years in tertiary).



Figure 1An illustration of the levels of education under the CBC curriculum in Kenya

### 2.5 The accessibility concept

Although the geographical aspect of accessibility to people's population is the study's main focus, the term has a considerably broader connotation when used in various development literature. The phrase is frequently used about having access to facilities for transportation, health, and education as well as to businesses, financial institutions, markets, and communication infrastructures, all of which can improve people's fundamental living conditions. It is also claimed that a lack of proper accessibility thwarts efforts to give citizens more influence socially, politically, and economically. The definition of accessibility is expanding to encompass elements like social inclusion and social exclusion in addition to geographic accessibility (Bantis & Haworth, 2020).

#### 2.6 Geographic Information System (G.I.S.)

#### 2.6.1 GIS Definition

This is a set of components; hardware, software, processes, and people that can gather, organize, analyze, and disseminate geographically related data. A geographic information system (GIS) is an information system that is computer-based and uses tabular attribute data that is spatially referenced to capture, store, manipulate, analyze, and display the data to help with complex research, planning, and management issues.

There are visualization and spatial analytical advantages that are provided by maps with database functions that are conventional such as query and statistical analysis. GIS is unique from other information systems because it can explain occurrences, forecast results, and plan strategies. This makes it helpful to a variety of public and private companies. The conventional GIS application fields, such as mapping of land cover and use, census mapping, urban mapping, environmental planning and management, disaster and hazard risk management, and numerous others, received a lot of attention for a very long period. Database systems are now used by GIS, which also makes it simple to overlay data in various projection systems, fully integrates raster data, and supports Internet mapping. GIS-based solutions have recently been created for use in a variety of disciplines, greatly assisting decision-making.

#### 2.6.2 GIS Analysis Methods (proximity analysis)

The analyses that apply to this study are based on an evaluation of how easily accessible the institutions are for students who live inside the sub-county's limits. The Proximity toolset includes instruments for calculating the distance between features in two feature classes or between one or more feature classes. These instruments can determine the separations between features or locate those that are closest to one another. To do the proximity analysis, Thiessen polygons are made, and the nearby feature is located. In Arc GIS, proximity analysis tools include:

- Creation of Thiessen polygons
- > Buffer
- Multiple ring buffers
- Generation of near features
- Calculation of point distance.

#### i. Thiessen polygon creation

Only a single point input feature is present in every Thiessen polygon. A Thiessen polygon's associated point is always closer to any position inside of it than it is to any other point input feature. When constructing Thiessen polygons to assess a school's accessibility, care is taken to ensure that each one has only a single-point input feature (school). This is then understood to mean that the centers of settlement and highways are all located within the Thiessen polygon, which is closer to its school than any other school in the region. The Thiessen polygon is seen as being close to the school, and from these zones, it is possible to conduct a critical analysis of the state of the surrounding roads and relate it to the local population and student enrollment. The method used to generate Thiessen polygon coverage from point characteristics is shown in Figure below;



Figure 2 Creating Thiessen polygons from point features (ESRI).

#### *ii)* Near Features

Calculates the distance, within the search radius, between each feature in the input features and the nearby feature in the near features. The closest features from the input features are found using the near features. Nearby features can be listed as one or more entries, each of which can be of the point, polyline, polygon, or multipoint type. The input table gains a new column called NEAR FC to store the routes of the source feature class that houses the nearest features when multiple entries of nearby features are supplied. The Arc GIS NEAR tool provides attribute fields with the distance, feature identification, angle, and coordinates of the closest point or line feature to a point feature class. The figure below shows how to extract near features from input features of points, lines, polygons, and mixed point, line, and polygon feature types.



Figure 3: Demonstration of Near Feature tool (ESRI).

#### 2.7 Review of previous Studies of School Mapping in Other Countries

Numerous studies suggest that hurdles to accessing education are caused by structural and economic factors. For instance, school enrollment is extremely low in some nations, such as India, Mali, and Burkina Faso, as a result of the high expense of education (including direct expenditures and opportunity costs), inadequate school infrastructure, a lack of teachers, and issues with safety and cleanliness (Birdsall et al, 2005). In studies conducted in other regions, such as several Latin American nations, it is evident that enrollment may be almost universal but completion and retention may be very low for a sum of reasons, which include poor health of students or their household members, absenteeism of teachers, and curricula that do not meet needs of the students. (UNESCO, 2005).

A study on geographic accessibility and its effects on school enrollment was conducted in Nepal by Shyam (2007). The study focused on how bettering household accessibility levels through road construction can affect enrollment of children in schools and how such provisions may differently affect different societal groups including boys and girls, younger and older children, and poor and non-poor households. It investigates whether the influence of increased accessibility is favorable to human development and more favorable to the underprivileged. He analyzes the social constraints on access to education in his study.



Figure 4: Barriers to accessing education (Shyam (2007).

# CHAPTER 3 METHODOLOGY

### 3.1 Area of Study

The study was carried out in Makadara Sub County in Nairobi City County; one of the 47 Counties in Kenya. Nairobi County borders Kiambu County to the North and West, Kajiado to the South, and Machakos to the East. Among the three neighboring counties, Kiambu County shares the longest boundary with Nairobi County. Nairobi is the most populated city in Kenya. More than 5.1 million people live in the capital as of 2022 and it occupies an area of 696.1 square kilometers (269 square miles). Nairobi City County is divided into five electoral sub-counties namely: Westlands, Dagoretti North, Dagoretti South, Langata, Kibra, Roysambu, Kasarani, Ruaraka, Embakasi South, Embakasi North, Embakasi Central, Embakasi East, Embakasi West, Makadara, Kamukunji, Starehe, and Mathare.

Makadara sub-county geographical coordinates are 1° 17' 0" South, 36° 53' 0" North. It covers some parts of Southern and Central Nairobi. Makadara sub-county has an approximate area of 13 km<sup>2</sup>. It is a residential area while a few parts form the industrial area of Nairobi County.



Figure 5: Makadara sub-county (Area of Interest )

# 3.2 Methodology Overview



Figure 6: Methodology flowchart.

# **3.3 Data Sets and Tools**

- > Topographical Map sheet number 148/4 from Survey of Kenya (Scale 1:50,000)
- > Primary school enrollment data from the Ministry of Education.
- > Roads data from Kenya Roads Board (KRB).

NAME OF SCHOOL	STATUS	ENROLMENT	LOCATION	LATITUDE	LONGITUDE
AGBON ACADEMY – PRI	PRIVATE	355	MARINGO	-1.295997	36.85729
CANON APOLO PRI SCH	PUBLIC	256	MARINGO	-1.295942	36.860123
JOSEPH APUDO PRI SCH	PUBLIC	470	MAKONGENI	-1.29584	36.849616
ST PAULS PRI SCH	PUBLIC	700	MARINGO	-1.295302	36.85843
ST. JOHNS KALOLENI PRI SCH – PRI	PUBLIC	538	MAKONGENI	-1.295248	36.847559
ALIMUS LEARNFIELD ACADEMY	PRIVATE	133	MAKADARA	-1.294876	36.87029
JOKEN PRI SCH	PRIVATE	80	MARINGO	-1.294663	36.857449
PAVID JUNIOR SCH – PRI	PRIVATE	48	MARINGO	-1.294113	36.85954
JOGOO ROAD PRI SCH	PUBLIC	352	MAKADARA	-1.293562	36.867146
THREE IN ONE CHILDREN CENTRE	PUBLIC	735	MARINGO	-1.292068	36.859721
PRI					
ST. MICHAELS PRI SCH	PUBLIC	1073	MAKADARA	-1.291951	36.867416
ST. PATRICKS PRI SCH	PUBLIC	519	MARINGO	-1.291877	36.86487
MARTIN LUTHER PRI SCH	PUBLIC	720	MAKADARA	-1.291823	36.874039
CHURCH ARMY ACADEMY - PRI	PRIVATE	221	MARINGO	-1.291732	36.852981
ST ANNES PRI SCH	PUBLIC	646	MARINGO	-1.291538	36.856984
CHURCH ARMY PRI SCH	PRIVATE	221	MARINGO	-1.291533	36.852514
BLESSINGS ACADEMY	PRIVATE	38	MARINGO	-1.29129	36.864036
NILE ROAD SPECIAL SCH - PRI	PUBLIC	83	MAKADARA	-1.290819	36.868406
WOODPECKER SCHOOL (PRI)	PRIVATE	76	UHURU	-1.290025	36.8473
MARY IMMACULATE EDUCATIONAL	PRIVATE	732	MARINGO	-1.289852	36.856372
CENTRE (PRI)					
DR. KRAFT PRI SCH	PUBLIC	651	MARINGO	-1.288998	36.86498
PCEA BAHATI MATYRS ACADEMY	PRIVATE	466	MARINGO	-1.288527	36.858912
(PRI)					
BAHATI PRI SCH	PUBLIC	639	MARINGO	-1.288527	36.861486
THOMAS BURKE PRI SCH	PRIVATE	364	MAKADARA	-1.288389	36.881093
MORRISON PRI SCH	PRIVATE	476	BAHATI	-1.2873	36.858486
RABAI ROAD PRI SCH	PUBLIC	743	MAKADARA	-1.286176	36.872801
DONKIM GLORIOUS JUNIOR SCH (PRI)	PRIVATE	135	BAHATI	-1.285821	36.862955
OFAFA JERICHO PRI SCH	PUBLIC	472	MAKADARA	-1.285491	36.868929
JERICHO BAPTIST CHURCH -PRI	PRIVATE	74	MAKADARA	-1.285491	36.868929
KIMATHI PRI SCH	PUBLIC	1213	BAHATI	-1.284345	36.863258
DR LIVINGSTONE PRIMARY	PUBLIC	648	KIATATHI	-1.284345	36.864049
TWIN BIRDS ACADEMY (PRI)	PRIVATE	152	BAHATI	-1.283712	36.862827
SOS TECHNICAL SCH PRI	PUBLIC	247	BURUBURU	-1.283668	36.877892
BIDII PRI SCH	PUBLIC	1308	MAKADARA	-1.283137	36.880379
HAPPYLAND PREP SCH	PRIVATE	531	MAKADARA	-1.282128	36.873
DOMINIQUE JUNIOR ACADEMY – PRI	PRIVATE	29	MAKADARA	-1.280761	36.878291
WANJA & KIM COMP SCH	PRIVATE	329	MAKADARA	-1.280688	36.880533
MAGODO CHILDRENS HOME - PRI	PRIVATE	74	MAKADARA	-1.279852	36.871995
SILVERGATE ACADEMY - PRI	PRIVATE	327	MAKADARA	-1.279817	36.873282
HARAMBEE PRI SCH - PRI	PUBLIC	1136	HARAMBEE	-1.279367	36.87534
SHEPHARDS JUNOIR SCH - PRI	PRIVATE	291	MAKADARA	-1.278202	36.879447

Table 1: CBC Schools spatial data

The road data was obtained from the Kenya Roads Board (KRB). The data obtained from KRB was in shape files.

ROAD ID	CONDITION	NO. OF	SURFACE	LENGTH (M)
	CLASS	LANES	CLASS	. ,
Premix	Good	2	Paved	415.398898
Premix	Fair	2	Paved	394.37385
Premix	Good	2	Paved	2816.297412
Premix	Fair	1	Paved	1863.936294
Premix	Good	2	Paved	362.351302
Premix	Fair	2	Paved	5232.261054
Premix	Poor	2	Paved	2378.077377
Premix	Good	2	Paved	297.977254
Premix	Fair	1	Paved	421.980205
Premix	Poor	1	Paved	488.958925
Premix	Good	2	Paved	345.073007
Premix	Fair	1	Paved	361.106595
Surface Dressing	Good	1	Paved	131.611609
Premix	Good	1	Paved	989.247707
Premix	Good	1	Paved	355.564313
Premix	Fair	1	Paved	2259.211327
Premix	Poor	1	Paved	158.816192
Premix	Good	1	Paved	978.058856
Premix	Poor	1	Paved	3152.427609
Premix	Fair	1	Paved	32.41435
Earth	Poor	1	Unpaved	4.500425
Surface Dressing	Good	1	Paved	2420.142423
Premix	Poor	1	Paved	1204.988166
Premix	Fair	1	Paved	1095.658569
Premix	Fair	1	Paved	642.219133
Premix	Poor	1	Paved	641.430945
Premix	Good	1	Paved	156.110923
Premix	Fair	1	Paved	793.845633
Surface Dressing	Good	1	Paved	1107.619655
Premix	Fair	1	Paved	1095.848325
Gravel	Poor	1	Unpaved	731.087024
Premix	Good	1	Paved	895.478155
Premix	Good	1	Paved	751.105513
Premix	Fair	1	Paved	1962.198714
Premix	Fair	1	Paved	727.287686
Premix	Good	2	Paved	417.213656
Earth	Fair	1	Unpaved	252.564864
Earth	Fair	1	Unpaved	182.693638
Concrete Block	Fair	1	Paved	242.126294
Concrete JT	Good	1	Paved	209.485233
Premix	Poor	1	Paved	29.906807
Earth	Poor	1	Unpaved	259.467254
Premix	Good	1	Paved	157.80115
Premix	Poor	1	Paved	72.731122
Premix	Poor	1	Paved	190.092879
Premix	Poor	1	Paved	890.392557

Table 2: Roads Data (KRB)

# 3.3.1 Hardware

- ➢ Epson scanner
- ▶ HP laptop with 4 RAM and speed of 2.5GHZ 1TB HDD.
- ➢ Hard drive disk of 500GB

# 3.3.2 Software

The software employed includes;

- ➢ ArcGIS 10.8
- Microsoft Office 2013 version.
- Microsoft Excel 2013 version.
- > Chrome.

# **3.4 Collection of Data and Preparation**

# 3.4.1 CBC School Enrolment data

The enrollment data were obtained from the Ministry of Education in excel format. The needed data was extracted and filled in for the appropriate schools with their latitudes and longitudes.

# **3.4.2 Population Data**

The population data of the four wards in the Makadara sub-county was obtained from the Kenya National Bureau of Statistics (KNBS) and tabulated in an excel sheet which was later projected in ArcGIS 10.8 for visualization. The data portrayed the household population of the wards.

WARDS	MAL	FEMAL	TOTA	HOUSEHOL	AREA(s	PERSONS/	LATITU	LONGITU
	Е	Е	L	DS	q. Km)	sq. Km)	DE	DE
HARAMBE	10,36	12,920	23,280	6,779	2	13,423	-1.28455	36.87615
E	0							
MAKONGE	15,76	14,229	29,993	10,835	1.2	24,278	-1.29874	36.84945
NI	2							
MARINGO	19,27	19,498	38,770	13,915	1.4	27,512	-1.29169	36.86498
	0							
VIWANDA	24,15	18,915	43,070	18,472	5	8,554	-1.31372	36.87411
NI	3							

Table 3: Wards population data (KNBS)

### 3.4.3 Scanning of the Topographical Map

The scanning was done with an Epson scanner with the image having a resolution of 300. The image was saved in the working folder as a JPEG.

# 3.4.4 Geo-referencing of the Topographical Map

The scanned JPEG topographical map was geo-referenced in ArcMap, one of ArcGIS's features as explained. The reference datum employed was Arc 1960 and a projected coordinate system, Universal Transverse Mercator (UTM) zone 37S. The unit of measure used was set in meters. Four points with coordinates in Easting and Northing were identified and utilized as control points namely; ABCD After Geo-referencing, the root mean square error was found to be 0.00101313 which is acceptable. The already geo-referenced image was rectified, exported, and saved to the working folder in TIFF format.



Figure 7: Geo-referencing topographical image and Total RMS Error table

#### 3.4.5 Topographical Map Clipping of Area of Study

The Makadara sub-county (area of interest) was extracted from the topographical map sheet 148/4 which covered the whole of Nairobi county. To execute this, the geo-referenced topographical map was added and the polygon enclosing the Makadara sub-county was utilized as the clipping overlay polygon.

#### **3.4.6 Digitizing Features**

The digitizing toolbar was accessed by clicking the customize option, toolbars, and then georeferencing. From the windows tab, the catalog was accessed which provided a way to connect to the working folder. By right-clicking the working folder from the catalog tab, then "new", the new shapefile prompt popped which allowed for the setting of the name, feature type, and coordinate system. The created shapefile layer appeared on the table of contents and the next step was turning the editor tool by highlighting the shapefile, going to edit features, and then starting editing.

#### **3.5 Data Processing and Analysis**

Data processing and analysis included the projection of school enrollment data in the area of study, CBC schools catchment areas determination, ascertainment of the nearest distance from school to the closest road, school proximity analysis, and determination of locations for new secondary schools. Enrollment and school proximity have a link. The roads were classified based on their condition. To evaluate the correlations between enrolment, population, and school proximity.

#### **3.5.1 Personal Geo-database Creation**

The Geodatabase was created having all layers of the collected datasets to help in processing and manipulation. In the Arc catalog, a new working folder was created in which a personal geodatabase was created containing feature classes, raster datasets, and tables. The personal geodatabase was created by the following procedure; organizing the data in the catalog by creating a folder connection to it in Arc Catalog. On the "Connect to folder" button on the Arc Catalog Standard right click the connected folder new then Personal geodatabase. The new dataset was created and new feature classes were imported as well as the relationship class.

In the personal geodatabase feature datasets are a collection of related feature classes that share a common coordinate system and were created to spatially related feature classes. This was done to organize related feature classes into a common dataset for building a topology, a network dataset, a terrain dataset, or a geometric network. Roads, wards, and Schools feature classes were then built in the new feature dataset. The feature classes used in the geodatabase were points, lines, and polygons. A line feature class represents road centerlines; a point feature class represents schools location while the polygons represented the spatial extent of wards in the area.



Figure 8: Personal geodatabase

#### **3.5.2 Proximity analysis**

A proximity analysis was performed to assess the distance from the school to the nearest road, as well as the road quality and class. The different road surfaces were classified as minor or major were used. From the Arc Toolbox, analysis tools, under proximity, the "generate near table" tool was accessed. The Makadara primary schools layer was used as the input feature while the minor roads were used as near features. The distance and units of measurement were set in Metres.



Figure 9: Near analysis in process

### 3.5.3 Creation of Thiessen Polygons

From the Arc Toolbox, the analysis tool, then the proximity tool, and then create Thiessen Polygons tool were obtained. The Makadara primary schools layer was used as input features and the Thiessen polygons were created. In every single Thiessen polygon, it contained only one Primary school.



Figure 10: Creation of Thiessen Polygons

# CHAPTER 4 RESULTS AND ANALYSIS

#### **4.1 Primary schools**

The collected locations of primary schools within the Makadara sub-county were projected in ArcGIS and a map was produced showing the distribution of the schools as shown below: The total number of CBC schools within the Makadara sub-county is 46.



Figure 11: The distribution of Primary schools in Makadara sub-county

#### 4.2 Secondary Schools

The map below shows the distribution of secondary schools in the Makadara sub-county mapped in ArcGIS software.



Figure 12: Distribution of secondary schools in Makadara sub-county

#### 4.3 Schools enrolment and population

The mapping of the primary schools enrolment to the various population densities of the area was done to show how enrolment varies within the four wards of the sub-county. According to the CBC schools analysis, for instance, Harambee, Maringo, and Makongeni wards registered high numbers of children joining schools compared to viwandani due to the high populations they have. Top-up on the high numbers of enrolment in the mentioned wards is the accessibility of the road network. Though most of the roads do not have good condition, the schools within the roads are still accessible as shown by the high number of students enrollment registered. For instance, a school in Viwandani registered zero enrolments. The road network available around the school shows that they are poor roads. So the school could not register students despite the high population in the ward. Also from the analysis, other schools registered high populations of children despite the roads are still in poor condition but the schools are accessible still, therefore, registering higher numbers of children. Due to the high population in the wards, some schools have very close geographical locations and therefore the rate at which they enroll the children is very competent.



Figure 13: CBC school's enrollment to population

### 4.4 Proximity analysis

Most of the primary schools have poor access to good roads since most of the roads connecting with the schools have poor surface conditions. Therefore, interfering with the means of accessing the schools. The near analysis done at a radius of 200m showed the nearest distance of the schools from the roads. The schools located at the various wards of the sub-county have low enrolment due to their location in the road network. This means these schools don't register a big number of pupils joining the school due to the poor road network which can adversely be affected by the environmental conditions.

NAME OF SCHOOL	STATUS	LOCATION	NEAR DISTANCE
AGBON ACADEMY – PRI	PRIVATE	MARINGO	48.31695
CANON APOLO PRI SCH	PUBLIC	MARINGO	44.211007
JOSEPH APUDO PRI SCH	PUBLIC	MAKONGENI	25.70015
SHEKINAH GLORY EDUCATION CENTRE - PRI	PRIVATE	MARINGO	3.490718
ST PAULS PRI SCH	PUBLIC	MARINGO	26.963696
ST. JOHNS KALOLENI PRI SCH –PRI	PUBLIC	MAKONGENI	28,394253
ALIMUS LEARNFIELD ACADEMY	PRIVATE	MAKADARA	23.813176
JOKEN PRI SCH	PRIVATE	MARINGO	1.30777
PAVID JUNIOR SCH – PRI	PRIVATE	MARINGO	16.244569
JOGOO ROAD PRI SCH	PUBLIC	MAKADARA	33.974993
NPC BURUBURU PRIMARY SCHOOL	PRIVATE	MAKADARA	25.191233
THREE IN ONE CHILDREN CENTRE PRI	PUBLIC	MARINGO	52.202862
ST. MICHAELS PRI SCH	PUBLIC	MAKADARA	36.958758
ST. PATRICKS PRI SCH	PUBLIC	MARINGO	36.727539
MARTIN LUTHER PRI SCH	PUBLIC	MAKADARA	32.916513
CHURCH ARMY ACADEMY – PRI	PRIVATE	MARINGO	43.664271
ST ANNES PRI SCH	PUBLIC	MARINGO	60.293927
CHURCH ARMY PRI SCH	PRIVATE	MARINGO	53.993611
BLESSINGS ACADEMY	PRIVATE	MARINGO	12.681435
NILE ROAD SPECIAL SCH – PRI	PUBLIC	MAKADARA	16.255652
WOODPECKER SCHOOL (PRI)	PRIVATE	UHURU	51.734237
MARY IMMACULATE EDU CENTRE (PRI)	PRIVATE	MARINGO	71.462881
DR. KRAFT PRI SCH	PUBLIC	MARINGO	37.512429
PCEA BAHATI MATYRS ACADEMY (PRI)	PRIVATE	MARINGO	21.99114
BAHATI PRI SCH	PUBLIC	MARINGO	41.286692
THOMAS BURKE PRI SCH	PRIVATE	MAKADARA	62.771014
MORRISON PRI SCH	PRIVATE	BAHATI	28.790043
RABAI ROAD PRI SCH	PUBLIC	MAKADARA	49.831369
BURU BURU COMMUNITY CENTRE PRI SCH	PRIVATE	MAKADARA	20.657882
DONKIM GLORIOUS JUNIOR SCH (PRI)	PRIVATE	BAHATI	3.733764
OFAFA JERICHO PRI SCH	PUBLIC	MAKADARA	7.224612
JERICHO BAPTIST CHURCH –PRI	PRIVATE	MAKADARA	7.224612
BURUBURU CHURCH OF GOD PRI SCH	PRIVATE	MAKADARA	34.765808
KIMATHI PRI SCH	PUBLIC	BAHATI	13.217388
DR LIVINGSTONE PRIMARY	PUBLIC	KIATATHI	50.944824
TWIN BIRDS ACADEMY (PRI)	PRIVATE	BAHATI	35.97879
SOS TECHNICAL SCH. – PRI	PUBLIC	BURUBURU	58.49354
BIDII PRI SCH	PUBLIC	MAKADARA	46.324635
HAPPYLAND PREP SCH	PRIVATE	MAKADARA	19.314899
TERYSAM MONTESSORI ACADEMY – PRI	PRIVATE	MAKADARA	19.320768
DOMINIQUE JUNIOR ACADEMY – PRI	PRIVATE	MAKADARA	16.862815
WANJA & KIM COMP SCH	PRIVATE	MAKADARA	9.98038
MAGODO CHILDRENS HOME – PRI	PRIVATE	MAKADARA	1.237152
SILVERGATE ACADEMY – PRI	PRIVATE	MAKADARA	3.374039
HARAMBEE PRI SCH – PRI	PUBLIC	HARAMBEE	25.678619
SHEPHARDS JUNOIR SCH – PRI	PRIVATE	MAKADARA	18.097958

Table 4: Near analysis of roads and schools

#### 4.4 School Catchment Area Generated from Thiessen Polygons

The Thiessen or proximal zones represent full areas where any location within the zone is closer to its associated input point (Primary school) than to any other primary school. From the proximity analysis, the Thiessen polygons were generated from the set of primary schools. Each polygon, therefore, defines the area of influence around the sample school, this means that the school inside the polygon is closer to that area than any other school and that it's the school serving most of the area. For instance, we have polygons of two schools in Viwandani and other several other schools in the other two bordering wards showing the extent of influence of the schools in several areas. From the analysis, it is clear that the population in the wards has access to various schools in the various wards other than the schools in their wards. Within the four wards, the analysis was done at a radius of 400m showing the area and extent to which the school can be accessed.



Figure 14: Primary schools catchment areas in Makadara Sub-county

#### 4.6 Proposed Secondary schools

The new locations of secondary schools were proposed based on the area of the various wards and the population by the distance between the existing schools and the accessibility of the road network distribution around the proposed location of the school. Some have also been proposed at positions where there are poor surface roads meaning that the proposed schools are still accessible to ensure even and efficient access to secondary school education in the area. These schools are also proposed based on the population of the area based on ward level. The most populated ward has several schools proposed due to the possibility of higher rates of children enrolling in those schools compared to the other schools.



Figure 15: Proposed secondary schools

# CHAPTER 5 CONCLUSION

#### 5.1 Summary

The main objective of this project was to show the use of GIS in mapping out the distribution of both primary and secondary schools in the Makadara sub-county, it was accomplished as follows:

- i. The spatial data of schools was collected using a GPS whereas else the data of the roads was obtained from the KRB in the format of shapefiles. The collection of spatial data on the schools, population, and roads in the Makadara sub-county was done successfully by respective bodies and using the specified techniques.
- Schools' proximity analysis to the road network in the Makadara sub-county was done using the ArcGIS software and results are presented in a table showing the near distance. Additionally, the accessibility analysis of schools was executed and the results were presented on a map showing the Thiessen polygons to show the area within which the schools are accessible.
- iii. The suitability analysis to determine suitable locations for new secondary schools was done and the suitable locations were presented on a map.

### **5.2 Conclusions**

From the project experience and the main objective, it is concluded that:

- i. From the CBC schools distribution map produced, there exist disparities in the distribution of the schools within the Makadara sub-county.
- ii. The Thiessen polygons show that some schools are serving a larger area than others because of the uneven distribution of schools within the sub-county. The school enrolment is dependent on the population in the area and good road network access. In, improving the road facility around the schools which have roads with poor surfaces can increase enrollment in similar schools.
- iii. Some secondary schools were proposed at various locations of the wards of the sub-county based on the population mainly and the road network. Some of them were proposed at locations where there are poor surface roads meaning that the proposed schools are still accessible.

### **5.3 Recommendations**

Within the discussed results and conclusions, it is recommended that;

- i. Road network accessibility can be enhanced to increase the school's accessibility. The poor roads can be contained during harsh climatic conditions like lack of rainfall by sprinkling water on the rough roads to settle down the dust. The roads with poor surfaces as well can be improved with time to boost the ease of accessibility of both the proposed schools and the schools existing in locations with roads that have poor surfaces. The road network is a key factor to evaluate the accessibility of schools and therefore reconnaissance of physical access is important before the establishment of the institutions
- ii. More studies can also be carried out to determine the other factors like climate change, banditry, and insecurity affecting the school's accessibility and the hindrances towards quality education as well as proposing ways and means to mitigate the same.
- iii. The implementation of the proposed schools if well done is an assurance that the schools will be almost evenly distributed within the area to ensure that efficient and quality education is delivered.

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# **APPENDIX 1:** Nairobi Topographical map sheet number 148/4