PROJECTIONS OF SCHOOL-AGE POPULATION AND IMPLICATIONS ON STAFFING AND EDUCATIONAL FACILITIES IN KAJIADO COUNTY, 2010-2030

BY

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DECLARATION

STUDENT

This research project is my own original work and to the best of my knowledge has not been submitted to this or any other University for an award of a degree.

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DEDICATION

I dedicate this work to my father Albert C. Kwambai and my mother Hellen Chang'wony for believing and supporting me during the course of my entire school life. Their support helped me develop a firm education foundation which has enabled me rise the academic ladder this far. I also dedicate this work to my lovely husband, Ernesty Komen for the cooperation as well as support he accorded me. Many thanks for your understanding.

I love you All!

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I salute you All.

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LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
ARS	Age Ratio Score
ARSF	Age Ratio Score for Female
ARSM	Age Ratio Score for Male
ASFR	Age Specific Fertility Rate
CBS	Central Bureau of Statistics
CHE	Commission for Higher Education
CIDPs	County Integrated Development Plans
ECDE	Early Childhood Development Education
HIV	Human Immunodeficiency Virus
JS	Joint Score
KCIDP	Kajiado County Integrated Development Plan
KDHS	Kenya Demographic and Health Survey
KNBS	Kenya National Bureau of Statistics
KPHC	Kenya Population and Housing Census
MoE	Ministry of Education
PES	Post Enumeration Survey
PTR	Pupil Teacher Ratio
PToR	Pupil Toilet Ratio
RUP	Rural-Urban Projection Program
SDGs	Sustainable Development Goals
SRS	Sex Ratio Score
TFR	Total Fertility Rate
UN	United Nations
UNESCO	United Nations Educational, Scientific, and Cultural Organization

ABSTRACT

The prime objective of this study was to generate projections of school-age population and analyze their implications on staffing and educational facilities in Kajiado County over the projection period, 2010 to 2030. The school-age population corresponded to the three educational levels namely: pre-primary - population age 3-5 years; primary - population age 6-13; and secondary – population age 14-17 years. On the other hand, the specific objectives were to obtain the projected number of teachers, classrooms and toilets required in Kajiado County over the same projection period.

To realize these objectives, the study projected the 2009 Kajiado County population from 2010 to 2030 using the cohort component method after conducting data quality assessment. From the projected county population, the first four age groups (0-4, 5-9, 10-14 and 15-19) were split into single years so as to obtain projections of school-age population. Thereafter, the study applied the recommended standards of Pupil Teacher Ratio (PTR), class size and Pupil Toilet Ratio (PToR) (separate for boys and girls) to obtain the projected number of teachers, classrooms and toilets respectively.

The study revealed that, school-age population in Kajiado County would rise from 290,321 in 2010 to 434,254 in 2030 representing an increase of 49.6 percent. The primary level accounted for the highest number of school-age population in the county, owing to the fact that it covers a wider age bracket. The study further projected a rising demand for teachers, classrooms and toilets separate for boys and girls at the three educational levels in the County.

Based on the study findings, the study recommends the national and county governments to ensure availability of adequate teachers, classrooms and toilets so as to meet the demands of rising school-age population in Kajiado County. The study also recommends for further research focusing on this area in other counties where such research has never been conducted because of demand of socio-economic projections for purposes of planning, advocacy, research, monitoring and evaluation.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Population projections may well be defined as the numerical result of specific fertility, mortality as well as net migration assumptions about future trends in a population (Isserman, 1984; Irwin, 1977; Pittenger, 1976; Shryock& Siegel, 1973; Keyfitz, 1972). Population projections can also be defined as conditional statements concerning the future (Smith, Tayman& Swanson, 2002). Projections are generally extrapolations of past/historical data and information into the future (Agrawal, 2013).

People desire to know, visualize and understand what the future would be like because, somehow, the knowledge about the future would help them plan for their family's basic needs; food, clothing and shelter. Population projections come in handy here, as they generally provide a picture of how the population would be in future if certain assumptions remained to be true (Smith et al., 2002). Levels of population growth as well as demographic changes affect decisions of planners (at decision-making level) in all sectors, for instance, education, labor force, health and many others (Smith et al., 2002). Population projections are therefore important and are an essential input in planning, research, advocacy, monitoring and evaluation, and for constructing other categories of projections as outlined below:

Population projections are invaluable for various planning purposes. Development programs and projects intended to be initiated by both the national and sub-national governments, aimed at satisfying key necessities of the people, cannot be rationally determined without the knowledge of expected population characteristics at various geographical locations and time periods (Kenya National Bureau of Statistics (KNBS), 2012d). Additionally, projections predict future changes in a population, giving a distinct point of reference to persons responsible for future planning (Smith et al., 2002); thus, scarce resources are distributed fairly based on projected data.

Population projections play a vital role in the field of research. Researchers often utilize projections for research purposes in an attempt to respond to questions such as “what will occur if?” (KNBS, 2012d). O'Neill, Scherbov, and Lutz (1999) documented that global change researchers frequently use projections as exogenous contributions to research themes like global warming, the supply of energy and consumption as well as food supply. Such themes need projections with a longer time frame like a century or even more besides an array of settings instead of a single most probable projection (O'Neill et al., 1999).

Population projections can also be used for advocacy mainly when there is a negative influence of certain phenomena on population (KNBS, 2012d). According to O’Neill et al. (1999), policy community together with advocacy groups prefer alternatives or options to a single most possible setup, including projections that can reflect the effect of a policy. For instance, advocacy groups concerned with effects of population growth on the environment may want to influence such growth through policies aimed at reducing population growth (O’Neill et al., 1999). Also, population projections remain an important tool for monitoring and evaluation of programs and projects throughout their life cycle; particularly useful during target setting, implementation and evaluation. In addition, projections of population act as a basis for constructing a variety of more categories of projections used for making informed decision (Smith et al., 2002). Population projections, for instance, may be used to generate labor force projections by applying labor force participation rate to the correct age, ethnic groups, race and even sex (Smith et al., 2002).

In education, population projections provide education planners with the expected number of pupils/students in future, if the education system does not change; they also inform on the future trend and pattern of education parameters, particularly the resources required in the education system (Agboola and Adeyemi, 2013). Projections in this field of education have been considered as the focal point of quantitative feature of educational planning (Agboola and Adeyemi, 2013). Projections of the school-age population are therefore important since they indicate the total number of children who should attend school (UNESCO, 2006).

It is important to note that education is a key component of human capital development that contributes to a country’s economic and social development (Samir et al., 2010). Inter-relationship between education and development have been demonstrated in many dimensions, such as health, culture, human rights, economic growth, democracy and many others (Sen, 1999; Collier & Hoeffler, 2000). In addition, research experiences and findings from various countries show that education fosters economic growth, improves human capital, employability and income distribution, reduces poverty, and promotes gender equality (KNBS, 2012c).

Education in Kenya is a key fundamental human right enshrined in her 2010 Constitution, Article 43(1) which states that "Every person has the right to education" (Republic of Kenya, 2010). Kenya is also committed to implement Sustainable Development Goals (SDGs) since these goals have been mainstreamed into the Kenya Vision 2030 pillars (Republic of Kenya, 2007; Kimani, 2016). SDG goal 4 states that "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (United Nations, 2016). In the social pillar of the Kenya Vision 2030, education is one of the seven main sectors which Kenya recognizes as a means of development and a route to enhanced well-being for her citizenry. Thus, Kenya envisages to provide globally competitive quality education for all.

Kajiado County Integrated Development Plan (KCIDP) which was implemented by the County Government of Kajiado (CGK) from 2013 to 2017 highlights some education indicators which include school-age populations, the number of teachers and classrooms available in the three educational levels; pre-primary, primary and secondary levels (CGK, 2013). These statistics are essential for educational planning in the county that need to be regularly updated and incorporated into future county plans; for example, County Integrated Development Plans (CIDPs).

According to the plan (KCIDP), pre-primary population as at 2013 stood at 52,091 for girls and boys, and the total enrolment was 42,565 implying that only 76.7 percent of the pre-primary school population was enrolled. The total number of teachers and Early Childhood Development and Education (ECDE) centers were 2211 and 925 respectively. At the primary level, there were 155,955 pupils, the net enrollment rate was 86.2 percent and the Pupil Teacher Ratio was 60:1; and the transition rate from primary to secondary was 54 percent (CGK, 2013). Finally, at the secondary level, the number of secondary schools was 104 comprising both public and private schools in 2013, students enrolled were 20,122 and the number of teachers was 2,614; secondary school enrollment was at 32 percent. To improve on these education indicators and enhance educational planning, projected school-age population at the three educational levels which is lacking in Kajiado County is required.

1.2 Problem Statement

Projections of population age structure give a basis for generating projections of population related characteristics (Smith, Tayman & Swanson, 2013). It is also essential to understand that, projections of total population and demographic characteristics of sex and age are beneficial for various purposes; however, there are instances in which school enrollment, labor force, health, households, employment etc. are required for public financial management (budgeting), analysis of policies, planning, and management of programs (Smith et al., 2013). These projections are closely related to population projections since population size including demographic composition strongly affect them (Smith et al., 2013).

Projections of school-age population are important since they indicate the total number of children who should attend school (UNESCO, 2006). Knowledge of future school-age populations is important for education planners to make informed decisions regarding educational facilities and staffing (Aghenta, 2001). Also, school-age population projections are considered as the focal point of quantitative feature in educational planning (Agboola and Adeyemi, 2013).

The Kenyan Government has since independence addressed many challenges facing the sector of education through establishment of committees, commissions as well as taskforces. Recommendations from these bodies have been utilized in formulation of policies; however, there is no proof that they have been responsive to changes in population particularly the school-age population, which is a key element required to plan for future needs in the education sector (Kamunya, 2012).

The 2009 Kenya Population and Housing Census (KPHC) analytical report/monograph on population projections provides school-age population projections at national and regional levels only (KNBS, 2012d). These projections provided correspond to the three educational levels: pre-primary - population age 3-5 years; primary - population age 6-13 years; and secondary - population age 14-17 years. However, it does not provide school-age population projections at the county level and as a result, there is little understanding on school-age population projections at this level. It therefore becomes necessary to project school-age population at the county level for planning, advocacy, research as well as for monitoring and evaluation. Thus, this study generated school-age population projections for Kajiado County based on the 2009 KPHC data so as to provide information/data to be used by education planners.

1.3 Research Questions

This study sought to provide answers to the following research questions:

i. What is the projected school-age population in Kajiado County by 2030?
ii. What is the projected number of teachers required in Kajiado County by 2030?
iii. What is the projected number of classrooms required in Kajiado County by 2030?
iv. What is the projected number of toilets required in Kajiado County by 2030?

1.4 Objectives of the Study

The study's general objective was to generate school-age population projections and analyze implications on staffing and educational facilities for Kajiado County by 2030.

Specifically, the study focused on the following objectives:

i. To obtain projected school-age population in Kajiado County by 2030.
ii. To obtain projected number of teachers required in Kajiado County by 2030.
iii. To obtain projected number of classrooms required in Kajiado County by 2030.
iv. To obtain projected number of toilets required in Kajiado County by 2030.

1.5 Justification of the Study

The study focused on education sector since education is a key component of human capital development that contributes to a country's socio-economic development (Samir et al., 2010). It is also one of the social sectors in the Kenya's development blue print; the Kenya Vision 2030 which targets to transform Kenya into a newly industrializing nation. Education also has a vital influence in reducing excessively high fertility rates thus acting as a moderator of population growth (Guisan, Aguayo & Exposito, 2001).

The focus of the study was to provide school-age population projections for educational planning in Kajiado County. This county was chosen because of the fact that, it is a county with high population growth rate of 5.5 percent (intercensal growth rate, 1999-2009) (KNBS, 2012a), hence high school-age populations. Availability of school-age projections would enable education planners make informed decisions in policy formulation and create a basis for fair distribution and well utilization of resources (Aghenta, 2001).

Knowledge of future school-going children provides education planners the opportunity to prepare adequately, so as to address the challenges arising from increased numbers of school-going children (Wekesa, 1989). Considering this, availability of future school-age populations would also assist the sector of education estimate the funds required while preparing their annual budget estimates and in setting their targets.

Projections of school-going children are required to plan for educational programs and formulate education policies and, particularly, to plan for required schools, teachers and classrooms (Siegel and Swanson, 2004). According to Swanson et al. (1998), local projections may be applied to decide whether there is a requirement to establish new public schools. It is therefore necessary to provide projections of special population groups including projections of school-age population so as to ease planning processes (KNBS, 2012d).

The government of Kenya on 27th August, 2010, promulgated the new Constitution which created 47 counties as units of devolved system of governance implemented since 2013. With this Constitution, planning was devolve to the county level. Consequently, planners at this level require data for planning, advocacy, research as well as monitoring and evaluation (KNBS, 2012d). Population projections are therefore critical since they provide the required data for use at the county level by both private and public sectors (Kodiko, 2014).

Kajiado County Integrated Development Plan (KCIDP) which covered the period 2013-2017 points out various challenges in the education sector as shown by education indicators: high illiteracy rate (35 percent compared to the national illiteracy rate of 28.6 percent); low enrolment rates; low transition rate from primary to secondary schools; and high school dropout rate (CGK, 2013). For Kajiado County to improve on these indicators, then adequate information on future school-age populations, the number of teachers, number of classrooms must be available to provide a quantitative framework for educational planning (Agboola and Adeyemi, 2013). Improvement of these indicators at the county level, contributes to the realization of national and global goals of achieving quality education; the Kenya Vision 2030 goals, ministry of education goal geared to provide education for all and the sustainable development goal 4.

The cohort component method used in this study enables one to appreciate the effect of each of the separate assumptions regarding the three components of population change (KNBS, 2012d). The method was also preferred because it accommodates various assumptions making it flexible to be used at all geographical levels and the projected population is available by age and sex (Siegel and Swanson, 2004). The study findings would lead to a better understanding of school-age population projections in Kajiado County. This study would further contribute to projections of school-age population literature for future reference.

1.6 Scope and Limitations of the Study

The coverage area of this research was limited to Kajiado County. The study focused on projecting school-age population in this County using the 2009 KPHC data. Under the Basic Education Act No. 14 of 2013, the structures and systems for promoting education plus training in Kenya are: (1) pre-primary education (2) primary education; (3) secondary education; and (4) middle level institutions of basic education (Republic of Kenya, 2013). This study covered pre-primary, primary and secondary structures and excluded middle level institutions since the age bracket is flexible and variable. This is because the Commission for Higher Education (CHE) permit middle level institutions to implement policies as well as practices that allow entry to learning without or with minimum barriers regarding age (CHE, 2008).

The study also focused on the number of teachers to represent staffing and number of classrooms and toilets to represent educational facilities because of time constraints. The limitations included projecting only one sector of the economy whereas there existed many sectors that influence development in Kajiado County. Another limitation was the use of single data source which is the 2009 Kenya Population and Housing Census (KPHC) data. Projecting using a number of data sources provides an opportunity for comparing projected results.

Census taking exercise is always prone to non-sampling errors of content and coverage as it is influenced with problems of logistics and administration (KNBS, 2012d). The study was not able to adequately adjust coverage errors due to lack of the 2009 KPHC Post Enumeration Survey (PES) report by Kenya National Bureau of Statistics (KNBS).

The assumptions regarding the components of population change used are also limitations of this study. On fertility, the study assumed that Total Fertility Rate (TFR) and Age Specific Fertility Rate (ASFR) would decline throughout the projection period, while on mortality the study assumed that expectation of life at birth (e_0) would continue to rise throughout the projection period. The study further assumed that the average net migration rate applied would remain constant throughout the projection period, 2010 to 2030. Additionally, results for Kajiado County may not be reflective of the educational situation in the other 46 counties because of differences in demographic and socio-economic parameters.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter evaluates literature related to population projections. It is organized into various sub-sections as follows: population projections concepts; methods of population projections; relevant studies on population projection methods and summary of literature review.

2.2 Population Projections Concepts

According to Siegel and Swanson (2004), a population projection is a mathematical result of specifically agreed assumptions in respect to future population trends. "It is a conditional calculation showing what the future population would be if a particular set of assumptions were to hold true" (Siegel and Swanson, 2004). Smith et al. (2002) argue that, population projections provide a picture of how the population would look like if certain assumptions remained to be factual. A given projection may by no means be verified wrong or right by future happenings/events, even if a projection may be judged by the facts of its assumptions relative to its usage.

Conversely, a population forecast is taken as a projection where the expert selects as the most appropriate to give a precise calculation regarding future population (Smith et al., 2002). Unlike population projections, forecasts are "unconditional statements" that express the expert's opinions as regards the ideal combination of methodological assumptions, sources of data and projection technologies (Smith et al., 2002). Siegel and Swanson (2004) points out that, a forecast is usually recorded as an unconditional and factual statement which the expert determines to be a possible outcome.

Byran (2004), identified three categories of population estimates based on the method of derivation and time reference; the three broad types are namely: inter-censal, post-censal and pre-censal estimates. The inter-censal estimates interpolates between two (2) censuses and takes into account their results (Byran, 2004). On the other hand, the post-censal estimates relate to a current or past date after a census and takes into account that census and probably previous censuses, but not future censuses while pre-censal/historical estimates relate to a date prior the availability of data from census. Estimates could vary depending on: the geographical areas of reference, population groups they distinguish, and whether they refer to a usual residence or persons physically present, i.e. night time or daytime population.

In general, demographers mostly use the word projections to refer to calculations of a future population (Smith et al., 2002). The reasons why the term is mostly preferred as noted by Smith et al. (2002), is because: First, the term projection is more comprehensive compared to a forecast or an estimate. Second, projections may be used for other purposes apart from predicting future population (e.g. can be used for planning purpose – mainly in the distribution of resources by both national and local planners). Lastly, demographers frequently regard their future population calculations as just illustrative and not predictive; in this sense, projection closely fits with their intention instead of a forecast.

2.3 Methods of Population Projections

There are two methods of population projections used by demographers to estimate future populations, namely: mathematical methods and component method. Mehta (2004) wrote that certain methods are extremely rigorous and sophisticated whereas others are very simple and less sophisticated. Each method has weaknesses and strengths which need to be appraised in relation to data requirements, face validity, production cost, a simplicity of application and timeliness among others (Smith et al., 2002). This study also highlighted the ratio method of population projections.

2.3.1 Mathematical Methods of Population Projections

These are methods in which the growth of a population is assumed to be described by some fairly simple mathematical formulae; are much simple, require less data (data required is from only two points in time) and relatively quick (Smith et al., 2002). In these methods, census data are fitted into mathematical curves expecting that the curves will accurately describe how the population has changed or will change. Many mathematical functions may be employed to project total population. The common functions are linear, geometric, exponential and logistic.

Linear Function

The simplest way to project population of a given area is to make an assumption that, the annual average change that occurred during the recent past (period) will occur again in the future (Siegel and Swanson, 2004). That is, the population of a given area in future will change by a similar number over a certain period as in the base period. This function simply uses a straight line given by:

$P_t = P_0 + ct$, where;

P_t = population t years later

P_0 = initial population

c = average annual population change

Geometric Function

This function assumes that population growth continues at a constant annual rate as documented by Siegel and Swanson (2004). The authors (Siegel and Swanson) described the geometric function as noted by Agrawal (2013) and expressed the formula as:

$P_t = P_0 (1+r)^t$, where;

P_t = population t years later

P_0 = initial population.

r = population growth rate

This equation indicates that the same annual rate is being made repeatedly after every 12 months. However, in real life, population growth is continuous rather than an annual change.

Exponential Function

Siegel and Swanson (2004) point out that the exponential and geometric functions are closely related, but the former assumes that change occurs continuously and not at discrete intervals. This function views that human population tends to grow exponentially under constant fertility, mortality and closed migration (Siegel and Swanson, 2004). Its equation is:

$P_t = P_0 (e^{rt})$, where;

P_t = population t years later

P_0 = initial population

r = annual growth rate

e = base of the natural logarithm

Logistic Function

The logistic function is the best-known growth function in the field of demography (Siegel and Swanson, 2004). "It is designed to yield an S-shaped pattern representing an initial period of slow growth rates, followed by a period of increasing growth rates, and finally a period of declining growth rates that approach zero as a population approaches its upper limit" (Siegel and Swanson, 2004). The limitation of this function is that it cannot describe a decreasing population. The equation for this function is given as:

$P_t = 1/(1+e^{-t})$ where;

P_t = population t years later;

e = base of the natural logarithm and

t= time

Generally, every function has its own weaknesses, but the main limitations to mathematical methods include: first, they do not take into account the current trends and levels of population change components; second, they involve implied assumptions regarding population change continuity and most of these methods tend to over-estimate future population sizes because of decreasing fertility levels which are not accounted for by simply extrapolating past events. They are also used to project total population only.

2.3.2 Cohort-Component Method

In demography, calculation of population projections using this method has a long-standing tradition (Whelpton, 1928). Cannan (1895) pioneered this method and Bowley (1924) later applied it. This method can as well accommodate various assumptions making it flexible to be used at all geographical levels: the world, nations, provinces/states, counties plus sub-county areas (George, Smith, Swanson & Tayman, 2004). It is preferred to mathematical methods because it separately projects fertility, mortality and migration components (George et al., 2004). However, this method is time-consuming as it requires calculations of various age-sex specific mortality, fertility and migration projections (George et al., 2004).

This method has two main advantages: First, it enables one to appreciate the effects of each of the separate assumptions about the three components of population change (George et al., 2004). Secondly, the projected population is available by gender and age rather than the total population only as obtained by mathematical methods. However, cohort-component method is complicated and requires more data (George et al., 2004). Siegel and Swanson (2004) provide a basic principle to be followed when using this method so as each birth cohort's integrity is preserved as they progress throughout their lifetime: "the number of years in the projection interval should be equal to the number of years in the age-groups or a multiple thereof."

The cohort-component method basically follows each cohort of persons during its lifetime according to its exposure to fertility, mortality and migration. Beginning with a base population disaggregated by gender and age, persons at each particular age are exposed to the probabilities of dying as determined by projected patterns plus levels of mortality by gender and age. After estimating the total deaths, they are subtracted from the surviving population; the population remaining alive grows older. To estimate total births in each year, projected fertility rates are then applied to women aged 15 to 49 years. Similarly, each birth cohort is followed throughout time by exposing it to the correct mortality rates. At the end, net migrants are accounted for by incorporating them at each specific age. The projected population is obtained by repeating the entire process throughout the projection period.

This method may be considered as the basic method of demographic equation represented as:
$P_t = P_0 + (B - D) + (IM - OM)$; whereby P_t = future population after time t; P_0 = Initial/Base Population; B = No. of births; D= No. of deaths; IM = No. of in-migrants; OM = No. of out-migrants (No. stands for number).

2.3.3 Ratio Methods

These methods are used particularly when a part or area comprising the population whose projections are required is within the larger/bigger area with available projections (Siegel and Swanson, 2004). They are mostly reliable at lower geographical levels where the essential information regarding mortality, fertility including migration are hardly available (KNBS, 2012d). The common methods are the constant-share, the shift-share, and the share-of-growth methods (Siegel and Swanson, 2004).

In the constant-share method, “the smaller area’s share of the larger area’s population is held constant at a level observed during the base period” (Siegel and Swanson, 2004). It is expressed as: $P_{st} = (P_{sb}/P_{Lb})\ (P_{Lt})$ where P_{st} = smaller area population projection in future time t; P_{sb} = smaller area base population; P_{Lb} = larger/parent area base population; P_{Lt} = parent area population projection in future time t. Only one date historical data is required for this method; therefore, suitable for regions/areas whose geographical borders keep changing. The main disadvantage of this method is, it assumes that, the entire smaller areas have the same growth as the larger area (Smith et al., 2002).

The shift-share method accounts for changes in population shares (Siegel and Swanson, 2004). Its equation is given as: $P_{st} = (P_{Lt})\ [(P_{sl}/\ P_{Ll}) + (m/n)((P_{sl}/P_{Ll}) - (P_{sb}/\ P_{Lb}))]$ whereby P_{st} = population of smaller area in the target year: s = smaller area; P_{Lt}= population of larger area in the target year: L = the parent area; P_{sl} and P_{Ll} = smaller area and larger area populations in the launch year respectively; m = number of years between the launch year and the target year; n = number of years between base year and launch year; P_{sb} and P_{Lb} = smaller area and larger area populations in the base year respectively b= base year; l= launch year; t= target year. The problem with this method is that sizeable population losses can occur in areas which witnessed very slow growth or decline in the base period particularly long projection periods; it may be solved “by incorporating constraints on projected population shares or on the projected rates of change in those shares” (Siegel and Swanson, 2004).

Share-of-growth model does not deal with population size but shares of population change (Siegel and Swanson, 2004). “In this method, it is assumed that the smaller area’s share of population change in the parent area will be the same over the projection horizon as it was during the base period” (Siegel and Swanson, 2004). The equation is given by: $P_{st} = P_{Ll} + [((P_{sl} - P_{sb})/(P_{Ll} - P_{Lb}))/(P_{Lt} - P_{Ll})$ where the terms are defined as in the previous method. A problem may arise when smaller area’s growth rate and that of the parent area has negative signs. To solve this problem, the share is set to zero and letting it remain constant (Siegel and Swanson, 2004).

2.4 Relevant Studies on Population Projection Methods

The Kenya National Bureau of Statistics used the cohort-component method to generate population projections at national level (Kenya) and sub-national level (the eight regions or former provinces) based on the 2009 KPHC; on the other hand, constant-share ratio method was used by KNBS to generate population projections at the county level (KNBS, 2012d). Using the base population, the ratio of county population to that of provincial population was calculated and assumptions on the future values of ratios were made, then the projected county population were obtained by applying that ratio to the projected provincial population in that year (KNBS, 2012d).

In preparing population projections based on the 1999 KPHC, the Kenya Central Bureau of Statistics applied cohort component method to project Kenya's population (CBS, 2002). This method simulates the effects of fertility, mortality as well as migration. This method traces each population cohort throughout its lifetime according to its exposure to mortality, fertility and migration. International migration was assumed to be insignificant while generation population projections at the national level (CBS, 2002). On the other hand, the Bureau projected provincial together with district populations using mathematical method. The method was chosen as it implicitly incorporates the regional variations in fertility, mortality and migration since they make some district population grow faster compared to others. The method was also preferred for its robustness and simplicity in application as it makes an assumption that, the rate of change for national proportions would remain constant at least during the short-run projections and would apply at the province as well as district levels (CBS, 2002)

Ohio Research Office (2013) employed the cohort component method to generate population projections for Ohio State including its 88 counties for the period 2010-2040. Population change components namely: deaths, births, and migration were computed differently so as to reflect changes in mortality, fertility and migration for individual cohort (Ohio Research office, 2013). Assumptions as regards to projections of mortality, fertility as well as migration trends at the two levels were independently set. The number of projected births was obtained by multiplying women of reproductive age population in the base year by the projected Age-Specific Fertility Rates (ASFRs); then the sum of these ASFRs multiplied by five generated total fertility rate (Ohio Research office, 2013). Based on recent population and death information, age-specific survival rates were calculated (national census survival rates were used); these were then used to generate projected deaths (Ohio Research office, 2013). For migration, net migration rates were projected based on past/historical information for net migration and recent gross migration trend using migration data obtained from Internal Revenue Service (Ohio Research office, 2013).

Swanson et al. (2010) used Hamilton-Perry method to prepare population projections of Clark County. The method has fewer data requirements as compared to the cohort-component method; data requirements are minimal, from two recently conducted censuses only (Smith et al., 2002). The disadvantage of this technique is, it may produce very high population projections (which are unreasonable) for areas experiencing rapid growth and very low projections (which are unreasonable) in areas facing population losses (Smith et al., 2002). Changes in the geographical boundary is a problem for sub-county areas, thus it is another limitation for this method. To overcome these limitations, the following measures are observed: "control of Hamilton-Perry projections to independent projections produced by some other method; calibrate Hamilton-Perry projections to post-censal population estimates; set limits on population change; and account for all boundary changes" (Swanson et al., 2010).

India's National Commission on Population (2006) generated projections for India's population and its states for the period 2001 to 2026 using the cohort-component method. The commission used different methods to project the three components of population change; Gompertz model was used to project future levels of TFR, UN (United Nations) model life tables was adopted to project future levels of e_0 (expectation of life at birth). Based on historical data of census, interstate migrants was assumed to remain constant and international migration was insignificant factor of population change (National Commission on Population, 2006).

Lesotho Bureau of Statistics (LBS) (2010) employed the cohort–component method to prepare the national plus sub-national population projections. To achieve this, the Bureau critically analyzed past trends of mortality, fertility including migration and established corresponding future levels as well as trends; Rural-Urban Projection (RUP) program/software (for projecting the population) developed by United States Bureau of Census was utilized (LBS, 2010).

Smith and Tayman (2003) used Hamilton-Perry method to construct population projections for United States at the national as well as at state levels including for counties located in Florida. The main advantage of this method is that data requirements are less compared to complete cohort component method; hence it is much easier, quicker and cheaper to apply (Smith & Tayman, 2003). However, this method often produces large forecast errors and upward bias (strong) for fast growing areas since constant growth rates are applied (Smith & Tayman, 2003); This method therefore requires an independent set of population projections.

Office for National Statistics of England (2016) employed the use of cohort-component method to prepare the 2014 based sub-national population projections for England. These projections were calculated based on set assumptions as regards to future fertility, mortality in addition to migration levels constructed from recent estimates (Office for National Statistics of England, 2016).

Cameron and Poot (2010) applied the stochastic method to prepare population projections for sub-regions of Waikato region located in New Zealand, (i.e. Hamilton City, Thames-Coromandel Franklin, South Waikato and Otorohanga Districts) as an alternate of the cohort-component method. Cameron and Poot (2010) points out that this method explores and permits numerous sets of mortality, fertility and net migration than cohort-component method; it also accounts for probabilities of each joint scenario occurring. In addition, stochastic method accounts for both temporal and spatial variations (Cameron and Poot, 2010).

Bwila (2004) used the matrix method to obtain Kenya's population projections to stability. Bwila's study looked specifically at estimating Kenya's stable age structure and as well comparing the population size, rate of natural growth and the net reproductive rate of the stable population with the present reported and associated demographic indicators. From his study he found that, Kenya's population would stabilize in the year 2090.

Kamunya (2012) in his project analyzed projections of primary school-age population in Kenya particularly for counties in central region. In his study, he applied the cohort component method to generate projections for national and regional populations. He later projected school-age populations for primary educational level using the ratio method for all the counties. The study noted that, the primary school-age population in Central region could rise from 813,000 pupils in 2010 to 1.08 million pupils in the year 2030.

Kodiko (2014) reviewed sub-national methods for constructing population projections with an aim of establishing the best method for generating population projections at sub-county level. The methods reviewed were: population model share, growth model share, shortcut model and growth difference model. Kodiko (2014) applied these models in his study to project school-age populations in the counties of Nyanza region. Using the four models, the study revealed that school-age populations would rise in each county. Finally, his study pointed out that shortcut model was the best method to employ while generating school age projections at the sub-county level.

Bilala (2016) generated sectoral population projections for Isiolo County where she utilized the cohort-component method while projecting Kenya's population (national), population of Eastern Region (sub-national) as well as the population of Isiolo County. She then provided population projections for school-age, labor force and youth for Isiolo County. The study recommended that further research focusing on similar study be conducted in other counties of Kenya so as to compare the results (Bilala, 2016).

Kamunya (2012), Kodiko (2014) and Bilala (2016) are some of the projects included which focused on population projections for counties.

2.5 Summary of Literature Review

There are many methods which can be applied to generate population projections as observed from the literature reviewed. The cohort-component method was noted to have been widely used to generate population projections since it separately projects mortality, fertility as well as migration (KNBS, 2012d). Alternatively, the ratio method was used where the components of population change were not readily/easily available. This study used the cohort component method to generate population projections in Kajiado County between 2010 and 2030.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter provides approaches applied in generating population projections. The chapter covers data sources, quality assessment of the 2009 Kenya Population and Housing Census (KPHC) data, components of population projections and types of population projections with methods used in the study.

3.2 Data Sources

The secondary source of data utilized in this study was obtained from 2009 Kenya Population and Housing Census (KNBS, 2010). The KPHC is carried out after every ten years as recommended by the United Nations. Kajiado County population (obtained by adding the then three districts i.e. Kajiado Central, Kajiado North and Loitokitok) was 687,312 comprising of 342,166 females and 345,146 males. The study also utilized data obtained from the 2014 Kenya Demographic and Health Survey (KDHS) in addition to other Kenyan censuses from 1969 to 1999 by KNBS. Further, the study used data from Kenyan censuses monographs/analytical reports on population dynamics, migration, education, population projections, mortality, fertility and nuptiality.

3.3 Quality Assessment of the 2009 KPHC Data

Population and housing census data enables demographers to estimate future population size and its characteristics using population projection methods. Data containing errors produce incorrect projections leading to wrong decisions. The key objective of conducting census assessment is to assure data users/consumers of high quality data and as well let them understand errors that census results may contain (United Nations, 2015). United Nations (2015) noted that it is accepted worldwide that census taking is not flawless and as a result errors do and may arise almost in every census phase and operations; thus assessment of census data is acknowledged as an essential need by many countries, Kenya included. This study assessed the quality of the 2009 KPHC data for both coverage and content errors (KNBS, 2012d).

Globally, problems associated with logistics and administration influence collection of economic, social and demographic data which may affect the quality of census data (KNBS, 2012d). This may give rise to two forms of non-sampling errors: coverage and content errors.

3.3.1 Coverage Errors

This type of errors occur mainly when enumeration units are omitted or duplicated during census enumeration; for instance, persons and households (United Nations, 2010). A number of sources of coverage errors have been identified (United Nations, 2010). Incorrect or incomplete maps or household listings of enumeration areas, enumerator's failure to cover their entire enumeration areas, omission of individuals unwilling to be counted, duplicate enumeration, erroneous handling of certain groups of individuals like foreigners and loss of completed census forms are among the various sources of coverage errors identified. These errors can either lead to under-coverage (under-counting) or over-coverage (over-counting). As a result, the 2009 KPHC data was checked for any inconsistencies from such errors.

This study used sex ratios to check for coverage errors. Sex ratio is a methodological tool obtained by dividing males' population in a particular cohort by females' population in the same cohort then multiply the result by 100 (Arriaga, 1994). When the values of this ratio greatly depart from 100, then the errors in the data are possibly large. The sex ratio at birth is higher for males compared to sex ratio for females in all populations. But, this ratio continually reduces up to the oldest ages because male's mortality is higher compared to female's mortality (Arriaga, 1994).

3.3.2 Content errors

Incorrect recording or reporting of households, individual characteristics and housing units give rise to content errors in any census (United Nations, 2010). Individual characteristics like age may wrongly be recorded or reported resulting to age misreporting which originates from two sources; one is the respondent who gives an estimate of her or his age because the true age is unknown or intentionally misreports (United Nations, 2010). The other is the interviewer who approximates the age of a respondent who fails to report or does not know her or his age (United Nations, 2010). It should be noted that age profile is one of the most important information obtained from census, though frequently misreported (KNBS, 2012d). It is therefore important to check for digit preference, age misreporting and age-sex misreporting to ensure that the statistics on population age and sex is accurately recorded. These actions that give rise to content errors are discussed below.

Digit Preference: This error usually happens in age reporting by single years which can be analyzed using indices developed by Whipple, Myers, Bachii, Carrier and Ramachandran (Arriaga, 1994). The study briefly discussed some of these indices.

Whipple's index applies when age is recorded in single years. It detects age preference for ages with terminal numbers or digits 0 and 5 or both, within the age bracket of 23 and 62 years. It is computed as the ratio of individuals aged 25, 30, 35, 40, 45, 50, 55 and 60 as a percentage of $1/10^{th}$ or $1/5^{th}$ of the number of individuals in the age interval 23 to 62 years old arbitrary chosen (Siegel and Swanson, 2004). This index range between 100 and 500 such that if age is accurately reported, the index will have a value of 100 or otherwise 500 (Siegel and Swanson, 2004). Between these extremes, Whipple's scale indicates the quality of data as; (1) highly accurate if the index is below 105 (2) fairly accurate if the index ranges from 105-109.9 (3) appropriate if the index is between 110-124.9 (4) rough if the index is between 125 and 174.9 and (5) very rough if the index is 175+.

Myers index is used to evaluate digit preference in all the terminal digits 0, 1, 2… 9 (KNBS, 2012d). Each of the 10 terminal digits takes a share of 10 percent out of a 100. When there is no digit preference, each terminal digit will have a score of 10%. Any deviation from 10% indicates either digit avoidance or digit preference. A positive deviation shows digit preference whilst a negative deviation indicates digit avoidance.

Bachii index is similar to Myers index only that the magnitude of Myers index is nearly double the index developed by Bachi (Arriaga, 1994). According to Arriaga (1994), the Bachi index give a magnitude/extent of the deficit or excess of persons in ages ending in any of the 10 terminal digits; such deficits or excesses are expressed in terms of percentages. So that, the greater the value of the index, the larger the preference for some terminal digits. In censuses, excellent age reporting would be indicated by values that are close to zero (0) (Arriaga, 1994).

In this study, Myers index was used instead of Whipple's index, since this index computes preference/avoidance in all the terminal digits/numbers from 0 to 9 while the latter index checks for preference/avoidance for terminal digits/numbers 0 and 5 only. The Bachii and Myers indices are similar.

Age Misreporting: To detect for age misreporting the study used age ratio technique. "Age ratios are calculated by dividing the population of a specific 5-year age group by the average population of the two adjacent 5-year age groups, times 100" (United Nations, 1952). When age ratios are similar all through the age distribution, then there is no age misreporting in that population. The values of these age ratios should be close to 100; the greater the departure from 100 the larger their fluctuations, the more the probability of errors in the data with the exception of populations experiencing international migration (Arriaga, 1994).

Age-sex misreporting: This study used Age-sex accuracy index to detect for age-sex misreporting. The United Nations (1952) suggested a joint accuracy index to summarize the values of age and sex ratios. "The sex-ratio score (SRS) index is described as the mean difference between sex ratios for successive age groups, averaged irrespective of sign whereas the age-ratio score (ARS) index is defined as the mean deviation of the age ratios from 100 percent, also irrespective of the sign" (Arriaga, 1994). Age-ratio scores for males (ARSM) and for females (ARSF) are calculated separately. The relationship between sex and age ratio scores defined as the age-sex accuracy/the joint score (JS) = 3xSRS + ARSM + ARSF (united Nations, 1952). On the basis of empirical studies, a population age-sex structure is considered accurate, inaccurate and highly inaccurate if JS is below 20, between 20 and 40, and over 40, respectively (Popoff and Judson, 2004).

3.4 Smoothed Population

To generate adjusted population due to age-sex misreporting, smoothing techniques was used to adjust irregularities reported or recorded in the population data. "These techniques mostly entail the use of a formula on data from the original source which usually gives accepted results" (KNBS, 2012d). The study calculated the joint score for Kajiado County populations and based on the magnitude of this JS, smoothing was done accordingly (i.e. either light or strong smoothing). The smoothed populations were used to generate base populations (KNBS, 2012d).

3.5 Components of Population Projections

Since population change is as a result of variations in the three demographic processes, it becomes necessary to project each component separately.

3.5.1 Fertility projections

The term fertility is defined as the occurrence of a live birth or births (Smith et al., 2002). Births contribute the most to the population growth of a country compared to migration and mortality (KNBS, 2012d). It is essential to note that future population growth mainly depends on future fertility trends, since relatively slight changes in fertility behaviour may produce a large difference in total population when projected over several decades (Lutz, 2006).

Total fertility rate (TFR) is the average number of children a woman would give birth to during her lifetime given that her fertility behavior followed a prevailing set of age-specific fertility rates (Smith et al., 2002). Fertility projections entailed two steps; the level of total fertility rates (TFRs) was first projected then the pattern of age-specific fertility rates (ASFRs) was estimated (Arriaga, 1994). To project the level of TFR, the study first assigned a target level for 2030 then determined its trend between 2010 and 2030. Results from the 2003, 2008/09 and 2014 Kenya Demographic and Health Surveys (KDHSs) showed that TFR in Kenya has been declining. Based on this historical data, this study assumed that TFR would continue to decline throughout the projection period, 2010-2030.

3.5.2 Mortality Projections

Mortality projections entailed two steps as in the case of fertility projections; first the general level of mortality was projected, this is measured by life expectancy at birth (e_0) then the pattern of mortality by age, for all the projected life expectancies was estimated (Arriaga, 1994). Expectation of life is the average lifetime of a baby/child born this day if present age-specific mortality rates remained constant in the future (KNBS, 2012d). The 2014 KDHS recorded an improvement in childhood mortality, based on this; the study assumed that e_0 would continue to rise throughout the projection period. In a population where the HIV prevalence is more than 1 percent, the United Nations recommends that HIV/AIDS should be incorporated in mortality projections (Murdock et al., 1995). Thus, this study incorporated HIV/AIDS since the prevalence rate for Kajiado County was 4.4 percent which is more than 1 percent (Ministry of Health, 2014).

3.5.3 Migration Projections

Migration can broadly be defined as permanent or temporary change of residence (Lee, 1966). When analyzing migration component of population change, two major problems are encountered: First, the measurement of population moves and second, the lack of migration data, these problems affect international and internal migration making projections of migration more uncertain than projections of fertility and mortality (Arriaga, 1994). In addition, natural disasters, government policies, social and cultural conflicts usually have a greater impact on migration rates compared to fertility or mortality rates (Siegel and Swanson, 2004). Subsequently, migration in general is most difficult component to project compared to fertility or mortality particularly for small areas (Siegel and Swanson, 2004).

Projecting migrations can be carried out using two approaches; gross migration and net migration (Siegel and Swanson, 2004). From a computational and theoretical view, using gross migration approach is considered “cleaner”, but, need many requirements in terms of data and also very complicated to use compared to approaches of net migration (Siegel and Swanson, 2004). For this reason, net migration was used in this study using data from monographs/analytical reports on migration (for Kenya). From analytical reports on migration for Kenya (for 1969 to 2009 censuses), the study noted that there has been continual increase of net migration in Kajiado County. Following this, the study made an assumption that net migration would continue to rise in Kajiado County over the projection period.

Internal migration was a significant factor of population change in Kajiado County since net migration rate was more than 1 percent (KNBS, 2012d); hence should be factored while generating county population projections. The study applied the average net migration figures for 1989, 1999 and 2009 (in the last three censuses) to represent internal migration in the county (KNBS, 2012d). This average was assumed to remain constant over the entire projection period, 2010 to 2030. The average figure was multiplied by the projected population and added to it so as to get the final Kajiado County population projections with migrants.

3.6 Types of Population Projections for the Study

The types of population projections and the method used for generating each are outlined below:

3.6.1. Sub-National Population Projections

Sub-national (Kajiado County) population projections was generated by applying cohort-component method. This method was applied because it separately projects fertility, mortality as well as migration. The method basically follows each cohort of persons during its lifetime according to its exposure to fertility, mortality and migration.

Step 1: Beginning with a base population disaggregated by gender and age, the persons at each particular age was exposed to the probabilities of dying as determined by projected patterns plus levels of mortality by age and sex. After estimating the deaths, they were then subtracted from the surviving population to approximate the numbers still alive during the start of the subsequent interval.

Step 2: To estimate total births in each year, projected fertility rates was applied to women of reproductive age. Then, each birth cohort was followed throughout time by exposing it to the correct mortality rates and the number who survived to the next interval was computed.

Step 3: At the end, net migrants were accounted for by incorporating them at each specific age. The projected population was obtained by repeating the entire process for every year within the projection period.

3.6.2. School-age Population Projections

School-age population projections was obtained from the projected population for Kajiado County. The 2009 enumerated population for Kajiado County distributions by age and sex was used to generate respective proportionate shares of school-age population projections over the projection period. The study then calculated school-age enrolment by multiplying the projected school-age population by the Ministry of Education target for each education level. The enrolment targets for pre-primary, primary and secondary levels are 81.4 percent, 103.5 percent and 64 percent respectively according to the Ministry of Education (MoEST, 2015).

3.6.3. Staffing and Educational facilities Projections

The study further projected the number of teachers (staffing), number of classrooms and number of toilets (educational facilities) required in the county, using the recommended Ministry of Education standards of pupil/student teacher ratio and pupil/student toilet ratios separate for boys and girls.

CHAPTER FOUR

PROJECTIONS OF SCHOOL-AGE POPULATION AND IMPLICATIONS ON STAFFING AND EDUCATIONAL FACILITIES

4.1 Introduction

The chapter highlights in detail the research findings in relation to the research objectives on projections of school-age population and implications on staffing and educational facilities for Kajiado County as well as their interpretations. The analysis starts with quality assessment of the 2009 Kenya Population and Housing Census (KPHC) data, followed by projections of population change components and the findings of population projections for Kajiado County. Finally, projected number of teachers, number of classrooms and number of toilets for Kajiado County as key education indicators are presented.

4.2 Quality Assessment of the 2009 KPHC Data

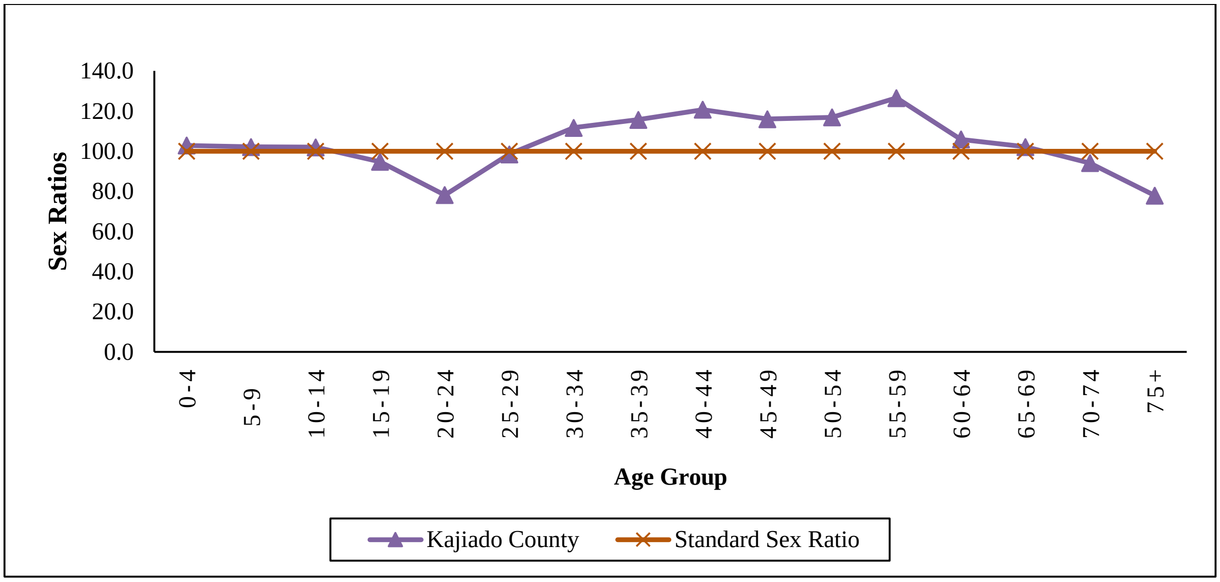
The quality of the 2009 KPHC data was assessed before using the data to generate population projections. Non-sampling errors of coverage and content were therefore evaluated.

4.2.1 Coverage Errors

The sex ratios for Kajiado County population as presented in figure 4 follow a pattern with fluctuations resulting from errors in the data. A closer look of figure 4 indicates that, some of these sex ratios greatly depart from 100. According to Arriaga (1994), the greater the rapid departure of sex ratio from values adjacent to 100, the higher the probability of errors in the data.

The study revealed that, maximum sex ratio for Kajiado County was 126.5 for age group 55-59 whilst the minimum sex ratio was 77.9 for the open ended age group 75+. These ratios indicates that there was double counting represented by 126.5 and under-coverage denoted by 77.9. These results are in tandem with the findings by KNBS (2012d). From these results of sex ratios, the study concludes that there were coverage errors in Kajiado County data.

Figure 4.1: Sex Ratios by Age for Kajiado County, 2009



Source: Study Data

4.2.2 Content Errors

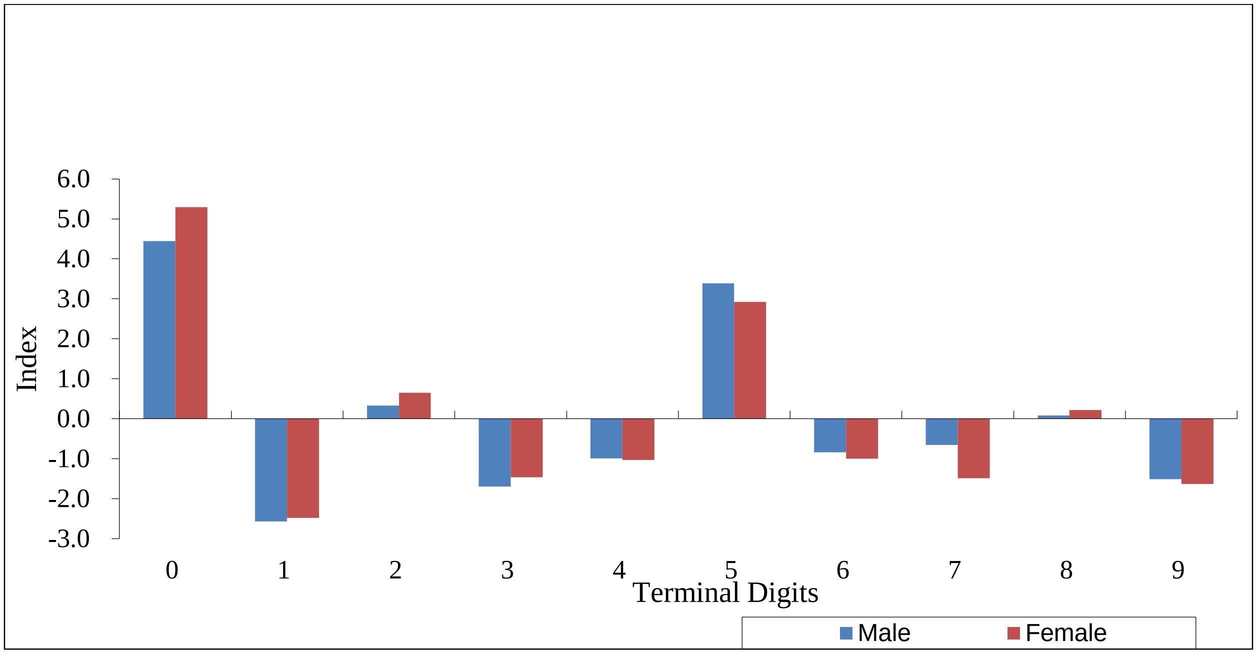
The study used Myers index, age ratio technique in addition to age-sex accuracy/United Nations Joint Score (JS) to check for content errors in the population to particularly detect digit preference, age misreporting and age-sex misreporting respectively.

Myers Index was used to detect digit preference or avoidance in Kajiado County using the 2009 KPHC data and the results are presented in figure 4.2 below. Positive indices indicate digit preference while negative indices indicate digit avoidance. When the value of the index is higher, it implies higher preference of the terminal digit (Arriaga, 1994).

It was evident from figure 4.2 that, ages ending with 0 and 5 were greatly preferred with zero taking the highest preference. The value of the index for zero was 5.3 for females and 4.4 for males whilst the index for terminal digit 5 was 2.9 for females and 3.4 for males. Digit preference was also noted at terminal digit 2 with an index of 0.7 for females and 0.3 for males. There was minimal age heaping for ages with terminal digit 8, since the indices for both sexes were fluctuating around zero; the index was 0.1 and 0.2 for males and females respectively. Females had more preference than males in most age groups. The finding are similar with the results documented by Bilala (2016), she noted that a larger population in Isiolo County preferred reporting their ages with terminal digit 0 and 5.

Most of the people avoided reporting their ages ending with digit 1 having an index of -2.5 for females and -2.6 for males. This was followed by terminal digit 3, 9, 7, 4 and 6 with indices -1.7 and -1.5; -1.5 and -1.6; -0.7 and -1.5; -1.0 and -1.0; -0.8 and -1.0 respectively for males and females. Accurate age reporting is indicated when the sum of all the deviations from ten percent are negligible, giving a resultant index of nearly zero (Myers, 1940). From the findings of Myers index, the study revealed that, all the ages in Kajiado County (except ages ending with terminal digit 8) were not reported accurately: this was because when all the deviations were added irrespective of sign, an index of 17.3 for both sexes was obtained.

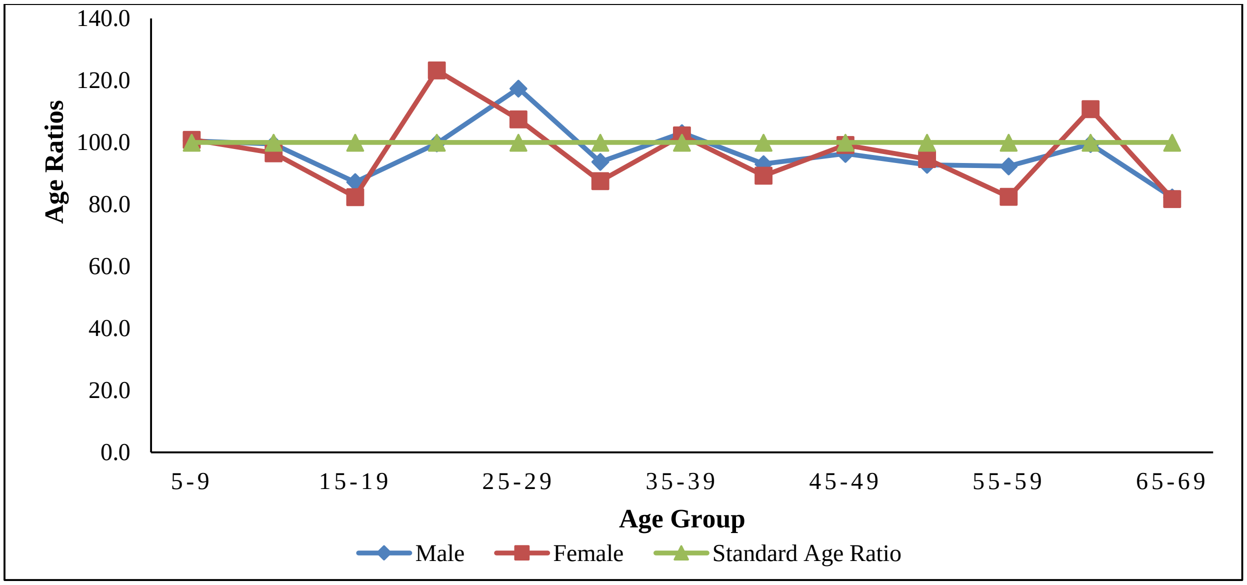
Figure 4.2: Digit Preference by Sex, Kajiado County, 2009



Source: Study Data

Age ratio technique was applied to detect age misreporting and figure 4.3 indicates the results of age ratios by sex for Kajiado County. From figure 4.3, it is clear that, age ratios were not similar throughout the age distribution implying that there was age misreporting (Arriaga, 1994). It can also be deduced that more females misreported their age than the males, in that, larger fluctuations were evident at age groups: 15-19; 20-24; 30-34; 40-44; 55-59 and 65-69 for females while at age groups: 15-19; 25-29 and 65-69 for males. These fluctuations were attributed to the quality of age reporting in the population as also noted by Bilala (2016) in her study.

Figure 4.3: Age Ratios by Age and Sex, Kajiado County, 2009



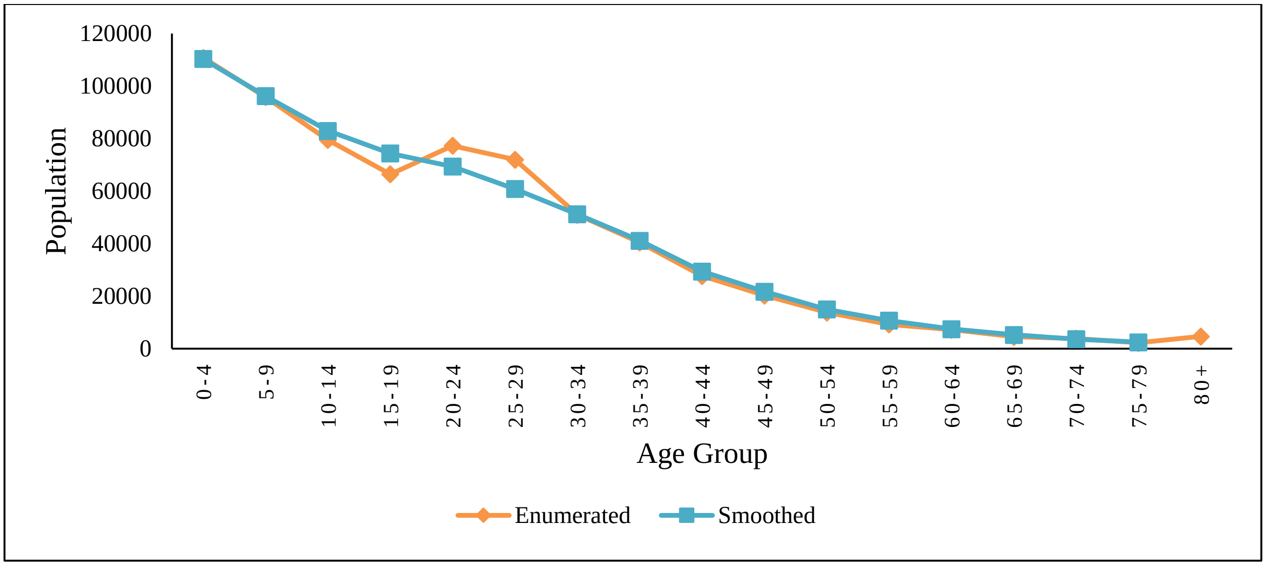
Source: Study Data

Age-sex accuracy index was applied to detect age-sex misreporting in the population. The Joint Score (JS) for Kajiado County using the 2009 KPHC data was 41.1 as revealed by the study. This index indicated that the population age-sex structure was highly inaccurate since it was above 40 (United Nations, 1952). This age-sex misreporting can be attributed to low literacy rate within the county which is 65.2 percent as compared to 71.4 percent for the national (CGK, 2013). The population age-sex structure was therefore smoothed.

4.2.3 Smoothed Population

The 2009 KPHC enumerated population for Kajiado County was found to be highly inaccurate since the age-sex accuracy index/Joint Score (JS) was above 40. This necessitated smoothing procedures to be used so as to adjust for irregularities registered in the population. As per the United Nations recommendations strong smoothing procedure was applied to adjust for age-sex misreporting (United Nations, 1952). The comparison between enumerated verses smoothed population for Kajiado County is presented in figure 4.4.

Figure 4.4: Enumerated versus Smoothed Population, Kajiado County, 2009



Source: Study Data

The pattern in figure 4.4 indicates that there were inconsistencies when enumerated together with the smoothed populations were compared particularly for age groups 5-9, 10-14, 15-19, 20-24 and 25-29. This means that there was age misreporting among these age groups.

The base population used to generate population projections was obtained by moving the smoothed population referring to 24th/25th August, 2009 to that for the midyear 2010. As a result, the start year of projections was 2010 whilst the end year is 2030. The step that followed was to calculate projections for population components; fertility, mortality taking into account the HIV prevalence as well as migration.

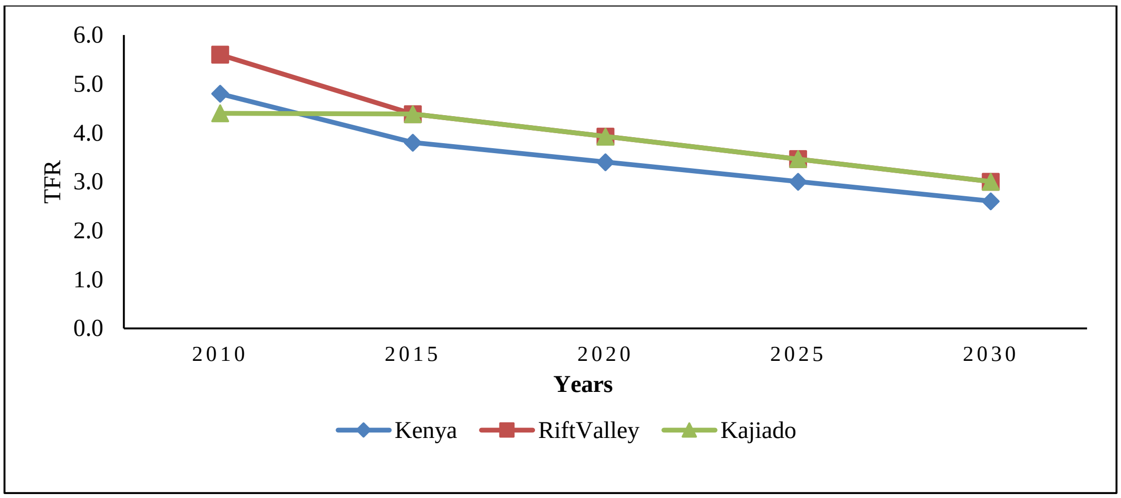
4.3 Components of Population Projections

The three population components are fertility, mortality as well as migration. These components were projected separately since changes in population is as a result of variations in these three components.

4.3.1 Fertility Projections

The 2009 KPHC, the 2014 Kenya Demographic and Health Survey (KDHS) estimates and the targets in the National Population Policy report were used as key inputs to observe fertility trends for Kenya, Rift Valley region as well as Kajiado County. Using the 2010 KPHC, 2014 KDHS estimates for TFR and the national population policy TFR targets for 2030, the study interpolated to get projected TFRs for 2015, 2020 and 2025. The study assumed that TFR for Kenya, Rift Valley and Kajiado County would continue declining to the end of projection year. The TFR for Kenya was assumed to decline from 4.8 in 2010 to 3.8 in 2015 to 3.4 in 2020 to 3.0 in 2025 and finally reach 2.6 in 2030 (NCPD, 2013; KNBS & ICF Macro, 2015). For Rift Valley region, TFR was projected to decline from 5.6 in 2010 to 3.0 in 2030. The TFR for Kajiado County was assumed to decline from 4.4 in 2015 to 3.9 in 2020 to 3.5 in 2025, and finally to 3.0 in 2030 (TFR in 2010 was same as in 2015). Figure 4.5 below shows the assumed decline in TFR for Kenya, Rift Valley and Kajiado County.

Figure 4.5: TFRs for Kenya, Rift Valley and Kajiado County, 2010-2030



Source: Study Data

The study also projected the age specific fertility rates (ASFRs) applying the 2014 KDHS estimates in addition to the already calculated TFRs. From this, the study assumed that the projected ASFRs for women of reproductive age (WRA) for Kajiado County would decline over the projection period, 2010 to 2030. For instance, in age group 15-19, the ASFR would decline from 0.0952 in 2015, 0.0884 in 2020, 0.0758 in 2025 and 0.0649 in 2030. Table 4.1 below illustrates the decline in the projected age specific fertility rates for WRA in Kajiado County from 2010 to 2030.

Table 4.1: Projected ASFRs for Kajiado County, 2010-2030

Age Group	2010	2015	2020	2025	2030
15-19	0.0952	0.0952	0.0844	0.0758	0.0649
20-24	0.2063	0.2063	0.1829	0.1641	0.1407
25-29	0.2012	0.2012	0.1784	0.1601	0.1372
30-34	0.1644	0.1644	0.1457	0.1307	0.1121
35-39	0.1208	0.1208	0.1070	0.0961	0.0823
40-44	0.0653	0.0653	0.0579	0.0520	0.0445
45-49	0.0267	0.0267	0.0237	0.0212	0.0182
TFR	4.4	4.4	3.9	3.5	3

Source: Study Data

The results shown in table 4.1 clearly indicates that ASFR for WRA in Kajiado County would decline over the projection period and as they move to the older age group. These results compares well with the findings of the 2014 KDHS, where ASFR for WRA in Kajiado County in 2014 declined from 0.2111 to 0.2058 to 0.1681 to 0.1235 to 0.0668 to 0.0273 for age groups 20-24, 25-29, 30-34, 35-39, 40-44, 45-49 respectively (KNBS & ICF Macro, 2015). ASFR for women in the age group 15-19 was lower over the projection period for this study and the findings of the 2014 KDHS.

4.3.2 Mortality Projections

The 2009 KPHC, the 2014 Kenya KDHS estimates and the targets in the National Population Policy report were used as key inputs to observe mortality trends for Kenya, Rift Valley region and Kajiado County. Using the 2009 KPHC analytical report on mortality (KNBS, 2012f), 2014 KDHS estimates for under-5 mortality (KNBS & ICF Macro, 2015) and the 2030 national population policy mortality targets (NCPD, 2013), the study interpolated to get projected under-5 mortality for 2015, 2020 and 2025. The study assumed that under-5 mortality for Kenya, Rift Valley and Kajiado County would continue to decline from 2010 to 2030. Under-5 mortality rates for Kenya were projected to decline from 79 in 2010 to 52 in 2015 to 51 in 2020 to 49 in 2025 and to 48 in 2030. Also, the under-5 mortality rates for Rift Valley region were projected to decrease from 67 in 2010 to 45 in 2015 to 44 in 2020 and to 42 in 2025 and 2030. Table 4.2 shows under-5 mortality for Kenya, Rift Valley and Kajiado County over the projection period.

Table 4.2: Under-5 Mortality Rates for Kenya, Rift Valley and Kajiado County, 2010-2030

Year	Kenya	Rift Valley	Kajiado County
2010	79	67	53
2015	52	45	36
2020	51	44	35
2025	49	42	34
2030	48	42	33

Source: Study Data

Under-5 mortality rates for Kajiado County were projected to decrease from 53 in 2010 to 36 in 2015 to 35 in 2020 to 34 in 2025 and to 33 in 2030 for both sexes as shown in table 4.2. For the county, under-5 mortality rate for males was projected to be higher compared to those for females. Under-5 mortality rate for males was projected to decline from 60 in 2010 to 41 in 2015 to 40 in 2020 to 38 in 2015 and to 37 in 2030. Similarly, the under-5 mortality rate for the female population in the county was projected to decrease from 53 in 2010 to 31 in 2015 to 30 in 2020 and 2025 and finally to 29 in 2030. These findings are in tandem with the findings of the 2014 KDHS which indicate a decline trend in under-5 mortality (KNBS & ICF Macro, 2015). Table 4.3 below illustrates under-5 mortality rates by sex for Kajiado County from 2010 to 2030.

Table 4.3: Under-5 Mortality Rates by Sex, Kajiado County, 2010-2030

Year	2010	2015	2020	2025	2030
Male	60	41	40	38	37
Female	46	31	30	30	29
Total	53	36	35	34	33

Source: Study Data

Adult Mortality

The study used the projected under-5 mortality rates together with the calculated survivorship probabilities and HIV prevalence to generate life tables separately for females and males for entire projection years. Based on generated life tables, this study used the probability of surviving from age x to x+n, (nLx) and age specific fertility rates to generate population projections.

4.3.3 Migration Projections

The study made reference to the Kenyan censuses analytical reports on migration and found out that there has been low volumes of international migration of less than one percent over the census years (KNBS, 2012b). On the other hand, the study found out that internal migration contributed to population growth in Kajiado County in that net migration rate was more than one percent. The censuses conducted in 1989, 1999, and 2009 showed that net migration rates were 10.9 percent, 6.8 percent, and 4.9 percent respectively (CBS, 1996; CBS, 2004 and KNBS, 2012b). The study applied the average figure of 7.5 percent of these three rates which was assumed to remain constant to the projected population. The result was then added to the projected population to get the final projections for Kajiado County with migrants. The study noted that the number of migrants would increase from 55,486 in the year 2010 to 92,735 in the year 2030 representing an increase of 67 percent.

4.4 Population Projections

The study generated population projections for Kajiado County using the cohort component method and then projected components of population change. Population projections for Kajiado County were utilized to generate school-age population projections for the county over the study period. The study also projected the number of teachers, classrooms and toilets required in the county over the projection period.

4.4.1 Kajiado County Population Projections

The study found out that Kajiado County population would increase from the start of projection year, 2010 up to the end of projection year, 2030. These projections are presented in table 4.4

Table 4.4: Projected Population by Sex for Kajiado County, 2010-2030

	2010	2015	2020	2025	2030
Male	371,551	424,298	488,096	549,454	616,748
Female	368,260	423,585	489,081	550,586	619,721
Total	**739,811**	**911,474***	**1,050,466***	**1,182,544***	**1,329,204***

Source: Study Data

****Projected population with migrants***

Starting with a population of 739,811 in 2010, Kajiado County population was projected to reach 911,474 by 2015; 1,050,466 by 2020; 1,182,544 by 2025 and 1,329,204 by 2030. These projections are slightly higher than Kajiado County projections published by KNBS (KNBS, 2012d). This could partly be explained by decline in childhood mortality in the last 15 years (KNBS & ICF Macro, 2015). This population comprises migrants projected to reach 63,591 by 2015; 73,288 by 2020; 82,503 by 2025 and 92,735 by 2030. The study revealed that, the county's population would increase by 78 percent from 2010 to 2030. The findings are similar with those found by Bilala (2016) in her study, which showed that population projections for Isiolo County were bound to increase from 2010 to 2030. ***Annex 1*** presents detailed population projections for Kajiado County by age and gender from 2010 to 2030.

Having generated projections for Kajiado County population, the study then generated projected school-age populations for Kajiado County over the period of study, 2010 to 2030.

4.4.2 Projected School-age Population, Kajiado County, 2010-2030

School-age population projections were obtained from the projected Kajiado County population by splitting the first four age groups (that is 0-4; 5-9; 10-14 and 15-19) into single years. To achieve this, the study used the 2009 KPHC enumerated Kajiado County population distribution by sex and age to generate respective proportionate shares of school-age population projections over the projection period. The study presented results organized according to the three educational levels namely: pre-primary, primary and secondary levels. The official ages at these levels are 3 - 5 years, 6 - 13 years and 14 - 17 years respectively as per the Ministry of Education (MoE) policy for Kenya. The study found that population at the three levels would continue to rise throughout the study period. The findings concurs with Kodiko (2014) findings which indicated that school-age population in Nyanza County were on an incremental trend between 2010 and 2030. The projected results are tabulated in table 4.5.

Table 4.5: Projected School-age Population, Kajiado County, 2010-2030

Educational Level	**Age Bracket**	**Sex**	**2010**	**2015**	**2020**	**2025**	**2030**
Pre-Primary	3-5	Male	36,015	39,562	45363	48732	51842
		Female	35,081	38,115	43305	45826	48614
		Total	**71,097**	**77,677**	**88,668**	**94,559**	**100,457**
Primary	6-13	Male	77,326	87767	98123	107495	118539
		Female	77,885	87162	96243	103181	113224
		Total	**155,211**	**174,929**	**194,366**	**210,676**	**231,763**
Secondary	14-17	Male	32,067	36257	41844	46572	52803
		Female	31,946	35418	39945	44155	49234
		Total	**64,013**	**71,675**	**81,789**	**90,727**	**102,037**

Source: Study Data

The study showed that, pre-primary, primary and secondary school-age population in Kajiado County would increase by 41.3 percent, 49.3 percent and 59.4 percent respectively. Numerically, pre-primary population was projected to rise from 71,097 in 2010 to 100,457 in 2030; primary from 155,211 in 2010 to 231,763 in 2030 and secondary from 64,013 in 2010 to 102,037 in 2030. The study further revealed that, primary school-age population constituted the highest number of school going children in the county, followed by pre-primary school-age and lastly by secondary population. Further, the primary school-age population was projected to account for 53.4 percent of the total school-age population over the projection period.

Available information from the Ministry of Education indicates that, the enrolment targets for pre-primary, primary and secondary levels are 81.4 percent, 103.5 percent and 64 percent respectively (MoEST, 2015). The study therefore, applied these targets to the respective projected school-age population to get projected school-age enrolment in the three educational levels. Table 4.6 shows projected school age enrolment which was obtained by multiplying the projected school-age population by the enrolment targets. The study assumed that the targets would remain constant throughout the projection period, 2010 to 2030.

Table 4.6: Projected School-age Enrolment, Kajiado County, 2010-2030

Educational Level	Age Bracket	Sex	2010	2015	2020	2025	2030
Pre-Primary	3-5	Male	29,316	32,203	36,925	39,668	42,200
		Female	36,309	39,449	44,821	47,430	50,316
		Total	**65,626**	**71,653**	**81,746**	**87,098**	**92,515**
Primary	6-13	Male	80,033	90,838	101,557	111,257	122,688
		Female	80,611	90,213	99,611	106,792	117,187
		Total	**160,644**	**181,051**	**201,169**	**218,050**	**239,875**
Secondary	14-17	Male	20,523	23,204	26,780	29,806	33,794
		Female	20,446	22,667	25,565	28,259	31,510
		Total	**40,969**	**45,872**	**52,345**	**58,065**	**65,304**

Source: Study Data

From table 4.6 above, the study noted that school-age enrolment in Kajiado County would increase over the projection period. Increase in enrolment would be associated with free primary education (FPE) besides free day secondary education (FDSE) programmes introduced in 2003 and 2008 respectively. Enrolment in pre-primary level was projected to increase from 65,626 in 2010 to 92,515 in 2030, representing a 41 percent increase. The total number of pupils projected to be enrolled in primary level would increase from 160,644 in 2010 to 239,875 in 2030 whilst those to be enrolled in secondary level would increase from 40,969 in 2010 to 65,304 in 2030. Total school-age enrolment was projected to increase by 49 percent from 2010 to 2030. The findings are in line with the results found by Kamunya (2012) which pointed out that school-age enrolment (particularly for primary level) in counties of Central region would increase from 2010 to 2030.

4.4.3 Projected Number of Teachers

The number of teachers for every educational level is a vital education tool since it is used to generate pupil teacher ratios (PTRs) together with the projected enrolment population. As per the Ministry of Education, Science and Technology (MoEST) (2014), PTR is the average number of students/pupils per teacher at a particular educational level in a certain school year. The recommended PTR for pre-primary, primary and secondary levels are 1:30, 1:45 and 1:35 respectively according to the Ministry of Education (MoEST, 2015). These ratios were assumed to remain constant from 2010 to 2030. The results depicted in table 4.7 below were obtained by applying these ratios to the respective projected school-age enrolment.

Table 4.7: Projected Number of Teachers, Kajiado County, 2010-2030

Educational Level	Age Bracket	2010	2015	2020	2025	2030
Pre-Primary	3-5	2,188	2,388	2,725	2,903	3,084
Primary	6-13	3,570	4,023	4,470	4,846	5,331
Secondary	14-17	1,171	1,311	1,496	1,659	1,866

Source: Study Data

The above analysis elucidates that, the demand for teachers at all levels of education was bound to increase over the projection period. The results are similar with the findings of Kamunya (2012); in his study he noted that the demand for teachers in Kiambu County would rise till 2030. At pre-primary level, the number of teachers required in Kajiado County would increase from 2,188 in 2010; 2,725 in 2020; 2,903 in 2025 and 3,084 in 2030. Teachers for pre-primary were 2,594 in 2014 as per the basic education statistical booklet (MoEST, 2014); this implies that additional 131, 309 and 490 number of teachers would be required in 2020, 2025 and 2030 respectively.

Since the primary level covers a wider age bracket, the number of teachers required at this level would be more compared to those of pre-primary and secondary levels. The study projected the number of teachers at this level to increase from 3,570 in 2010 to 4,470 in 2020 to 4,846 in 2025 and to 5,331 in 2030 indicating an overall projected increase of 49 percent from 2010 to 2030. Further, the study noted that there would be a shortfall of 1,856; 2,232 and 2,717 in 2020, 2025 and 2030 respectively since the number of teachers at this level were 2,614 in 2013 (CGK, 2013).

The study also projected an increasing demand for teachers at the secondary level. The number of teachers were projected to increase from 1,171 in 2010 to 1,496 in 2020 to 1,659 in 2025 and to 1,866 in 2030 indicating a 59 percent increase. In 2014, the number of secondary school teachers were 1,521 (MoEST, 2015); the study compared this with the projected number of teachers and revealed that, the county would be required to employ 138 and 345 additional teachers in 2025 and 2030 respectively.

4.4.4 Projected Number of Classrooms

Class size is another important education indicator which is defined as the number of students/ pupils in a classroom. The smaller the class size the better for effective learning and teaching to take place at any educational level. According to the Ministry of Education Kenya, the target class size for pre-primary, primary and secondary levels are 30, 50 and 45 respectively. The study applied these respective class sizes to the projected school-age enrolment to obtain projected number of classrooms required in the county over the projection period. The study assumed that class sizes would remain constant over the projection period. Table 4.8 below highlights the number of classrooms required in Kajiado County between 2010 and 2030.

Table 4.8: Projected Number of Classrooms, Kajiado County, 2010-2030

Educational Level	Age Bracket	2010	2015	2020	2025	2030
Pre-Primary	3-5	2,188	2,388	2,725	2,903	3,084
Primary	6-13	3,213	3,621	4,023	4,361	4,798
Secondary	14-17	910	1,019	1,163	1,290	1,451

Source: Study Data

Table 4.8 indicates that the demand for classrooms in the county would continue to rise over the entire projection period. These findings are in line with the findings of Kamunya (2012) and Kodiko (2014); both indicated that as the number of school-going children increase, the number of classrooms also increase. In Kajiado County, there were 811; 4,404 and 861 classrooms in pre-primary, primary and secondary level respectively (MoEST, 2014). Comparing these with the projected number of classrooms, the study revealed that the county would require 1,914; 2,092 and 2,273 additional classrooms for pre-primary level in 2020, 2025 and 2030 respectively. For primary level, the county would require to construct 394 more classrooms to accommodate primary school pupils in 2030. The study also revealed that, additional number of classrooms required for secondary level in 2020, 2025 and 2030 would be 302; 429 and 590 respectively. Following these findings, the county government need to collaborate with the national government together with development partners and set aside sufficient resources so as to achieve this.

4.4.5 Projected Number of Toilets

Pupil toilet ratio (PToR) is a vital education indicator which is defined as the average number of students/pupils per toilet at a particular educational level in a certain school year (MoEST, 2014). To project the required number of toilets in Kajiado County, the study applied the respective PToR to the projected school-age enrolment. According to MoE, the recommended PToR for boys and girls are 30:1 and 25:1 respectively at all education levels. The study assumed that the ratios would remain constant over the projection period 2010-2030. Table 4.9 displays the analysis for the required number of toilets separately for males and females in Kajiado County over the study period, 2010 to 2030.

Table 4.9: Projected Number of Toilets by Sex, Kajiado County, 2010-2030

Educational Level	Age Bracket	Sex	2010	2015	2020	2025	2030
Pre-Primary	3-5	Male	838	920	1,055	1,133	1,206
		Female	1,452	1,578	1,793	1,897	2,013
		Total	**2,290**	**2,498**	**2,848**	**3,031**	**3,218**
Primary	6-13	Male	2,287	2,595	2,902	3,179	3,505
		Female	3,224	3,609	3,984	4,272	4,687
		Total	**5,511**	**6,204**	**6,886**	**7,450**	**8,193**
Secondary	14-17	Male	586	663	765	852	966
		Female	818	907	1,023	1,130	1,260
		Total	**1,404**	**1,570**	**1,788**	**1,982**	**2,226**

Source: Study Data

Table 4.9 clearly shows that the demand for toilets in the county would continue to increase over the projection period, 2010-2030. The same findings were obtained by Kamunya (2012), in his study, he noted that the demand for toilets would continue to be on the increase in the counties of Central region. At pre-primary level, the number of toilets for males were projected to rise from 838 in 2010 to 1,206 in 2030 indicating a growth of 43.9 percent while for females were projected to increase from 1,578 in 2010 to 2,013 in 2030 representing a 38.6 percent increase. The study found out that, the overall increase in the number of toilets for males and females at this level would be 40.5 percent from 2010 to 2030.

Likewise, at primary level, the study projected the number of toilets to rise from 2,287 for males in 2010 to 3,505 in 2030 showing an increase of 53.3 percent and for females would shoot up to 4,687 by 2030 from 3,224 in 2010 indicating an increase of 45.4 percent. The study projected an overall increase in the demand for toilets of 48.1 percent between 2010 and 2030. The number of toilets in 2014 were 2,491 for males and 2,724 for females at this level in the County (MoEST, 2014). The study revealed that, for Kajiado County to match the recommended PToR by the Ministry of Education, then 411; 688 and 1,041 additional toilets for males and 1,260; 1,548 and 1,963 more toilets for females need to be constructed in 2020, 2025 and 2030 respectively.

Similarly, at secondary level, the number of toilets were set to rise like in the case of pre-primary and primary; the number of toilets for males were projected to rise from 586 in 2010 to 966 in 2030 representing a 64.7 increase and for females were projected to rise to 1,260 in 2030 from 818 in 2010 indicating a growth of 54.1 percent. From available information, there existed 659 toilets for males and 1,029 for females in 2014 (MoEST, 2014). This implied that more toilets need to be constructed in the county to meet the recommended PToR; hence, 106; 193 and 307 for males in 2020, 2025 and 2030 respectively while 101 and 231 would be required for females in 2025 and 2030 respectively. It is essential to note that, schools at national and county levels should remain within the recommended PToR so as to maintain the highest standards of hygiene and sanitation in schools.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter gives summary, conclusion and recommendations based on research findings. The main objective of this research was to generate school-age population projections for Kajiado County from 2010 to 2030 and as well project key education parameters: the number of teachers, number of classrooms and number of toilets required in the county over the projection period.

5.2 Summary

The 2009 census data for Kajiado County was evaluated and was found to have coverage errors and content errors in form of digit preference and age misreporting. Quality assessment was carried out and data smoothed using strong smoothing techniques since the joint score was above 40 (United Nations, 1952). Since the census was conducted on 24/25 August, 2009 the smoothed data was updated to midyear population and taken to be the base year population. Thus the start year for population projections was 2010 and end year was 2030. The assumptions on fertility, mortality and net migration were used to project the population for the next 20 years using the cohort component method.

The general objective of this study, was to obtain projected school-age population in Kajiado County at the three educational levels (pre-primary, primary and secondary) from 2010 to 2030. The study found that, the projected school-age population would rise entirely in the three levels over the projection period. Primary school-age population was found to account for the highest number of school-age population in the county (53.4 percent), followed by pre-primary (23.9 percent) and lastly by secondary school-age population (22.7). Population increase at all the levels would be associated with the implementation of Kenya’s 2010 Constitution, particularly Article 43(1) which points out that every individual has the right to education. In addition to government’s implementation of free primary and day secondary education programmes introduced in 2003 and 2008 correspondingly.

This study further projected key education indicators namely: number of teachers, classrooms and toilets separately for females and males at the three levels. The study revealed that the demand for teachers, classrooms and toilets would continue to rise over the projection period.

The study noted that, the number of teachers for pre-primary, primary and secondary levels would increase from 2,388 to 3,084;3,570 to 5,331; and 1,171 to 1,866 in 2010 to 2030 respectively. The number of classrooms were set to increase from 2,188 in 2010 to 3,084 in 2030 for pre-primary level while from 3,213 in 2010 to 4,798 in 2030 for primary level and from 910 in 2010 to 1,451 in 2030 for secondary level. The number of toilets for males at pre-primary, primary and secondary levels were projected to increase from 838 to 1,206; 2,287 to 3,505 and 586 to 966 in 2010 and 2030 respectively. Similarly, the number of toilets for females were projected to rise from 1,452 to 2,013; 3,224 to 4,687 and 818 to 1,260 in 2010 to 2030 respectively for pre-primary, primary and secondary levels.

5.3 Conclusion

The study noted that school-age population in Kajiado County would continuously rise with the primary level population accounting for the highest increase over the projection period, 2010 to 2030. The study also observed that, the demand for teachers, classrooms and toilets would increase throughout the projection period.

5.4 Recommendations

Based on the research findings, the study provides recommendations for national and county policy makers, program planners as well as education service providers. The findings of this study would benefit stakeholders implementing various programs/projects touching base on school-age population in Kajiado County to make sound decisions. Particularly on required number of teachers, classrooms and toilets and this would culminate to quality education.

5.4.1 Recommendation for Policy and Programme

The study noted that school-age population in Kajiado County would continue to rise throughout the projection period under the projected fertility, mortality as well as net migration rates. Due to this increasing number of school-age population, the two levels of government should formulate and implement policies that address completion/expansion and operationalization of existing educational facilities in addition to proper utilization of available resources so as to provide conducive learning environment.

There exist direct linkages between school-age population and education parameters for instance number of teachers, number of classrooms and number of toilets. This is so because, as the number of school-age population increase, the number of these parameters required also increase as observed by the study. The study therefore, recommends the national and county government to ensure availability of adequate classrooms, toilets and teachers at the three educational levels (pre-primary, primary and secondary levels).

The national and county government in collaboration with other education planners at both levels of government, need to take stock of education necessities/requirements and mobilize adequate resources to meet the demands of the rising school-age population. Hence, it is vital that the county commits to build a strong culture of periodic reporting on education to assist in planning.

5.4.2 Recommendations for Further Research

On the basis of this research findings, there is need for further research. Because of demand of socio-economic projections like the school-age projections in this study, there is need to do research focusing on this area in other counties where such research has never been conducted. This is mainly because these projections are required for various uses: planning, budgeting, monitoring and evaluation. It is also important to provide such projections since planning has been devolved to the counties (Republic of Kenya, 2010).

REFERENCES

Agboola, B. M. and Adeyemi, J.K. (2013). Projecting Enrollments for Effective Academic Staff Planning in Nigerian Universities. *Educational Planning, 21*(1), 5-17.

Aghenta, J. A. (2001). Determinants of Educational Costs in Ebele J. Maduewesi (eds.) *Financing of Education in Nigeria Ibadan: The Nigerian Academy of Education, Year Book*, 3-4(1)17-27.

Agrawal, V. (2013). Raipur as a New Capital: Impact on Population. *International Journal of Engineering Research and Science & Technology*, *2*(1).

Arriaga, E. E. (1994). *Population Analysis With Microcomputers:Presentation of Techniques,Volume I.*

Bilala, D. D. (2016). *Sectoral Population Projections for Isiolo County, Kenya.*Unpublished Master's Project, University of Nairobi, Population Studies and Research Institute, Nairobi, Kenya.

Bowley, A. L. (1924). Births and Population in Great Britain. *The Economic Journal*, *34*(134), 188-192.

Bwila, I. M. (2004). *Population Projections in Kenya: An Application of the Stable Population Model.* Unpublished Master's Project, University of Nairobi, Population Studies and Research Institute, Nairobi, Kenya.

Byran, T. (2004b). Population Estimates. In J. S. Siegel and D. A. Swanson (Eds.), *The Mathematical and Materials of Demography* (2nd ed., pp. 523-560). San Diego, California: Elsivier Academic Press.

Cameron M. P. and Poot J. (2010). *A Stochastic Sub-National Population Projections Methodology with an Application to the Waikato Region of New Zealand.* (Population Studies Centre Discussion Paper No.70). Hamilton, New Zealand: University of Waikato, Population Studies Centre.

Cannan, E. (1895). The Probability of a Cessation of the Growth of Population in England and Wales During the Next Century. *The Economic Journal*, *5*(20), 506-515.

Central Bureau of Statistics (CBS), Ministry of Health (MOH) and ORC Macro. (2004). Kenya Demographic and Health Survey 2003. Calverton, Maryland: CBS, MOH and ORC Macro.

Central Bureau of Statistics. (2004). *Kenya 1999 Population and Housing Census: Analytical Report on Migration and Urbanization, Vol. VI.* Nairobi, Kenya: Government Printer.

Central Bureau of Statistics. (2002). *The 1999 Kenya Population and Housing Census: Analytical Report on Population Projections, Vol. VII.* Nairobi, Kenya: Government Printer.

Central Bureau of Statistics. (1996). *Kenya Population and Housing Census 1989: Analytical Report on Migration and Urbanization, Vol. VI.* Nairobi, Kenya: Government Printer.

Collier, P. and Hoeffler, A. (2000). *Greed and Grievance in Civil War: Policy Research Paper 2355.* Washington, DC: The World Bank.

Commission for Higher Education. (2008). *Handbook on Processes for Quality Assurance in Higher Education in Kenya*. Nairobi, Kenya: Government Printer.

County Government of Kajiado. (2013). *KajiadoCounty Integrated Development Plan 2013-2017.* Unpublished Plan, Nairobi, Kenya.

George, M. V., Smith S. K., Swanson D. A., and Tayman J. (2004). Population Projections Chapter 21 in Jacob Siegel and David Swanson (eds.), The Methods and Materials of Demography. San Diego: Elsevier Academics Press.

Guisan, M., C., Aguayo, E. and Exposito, P. (2001). Economic Growth and Cycles: Cross-Country Models of Education, Industry and Fertility & International comparisons. *Applied Econometrics and International Development, 1*(1), 9-37.

Isserman, A. (1984). Projection, Forecast and Plan: On the Future of Population Forecasting. *Journal of the American Planning Association, 50,* 208-221.

Irwin, R. (1977). The Accuracy of Population Projections for Subcounty Areas. *Journal of the American Institute of Planners, 43,* 247-258.

Kamunya, F. M. (2012). *Primary School-age Population projections for Counties in Central Province, Kenya.*Unpublished Master's Project, University of Nairobi, Population Studies and Research Institute, Nairobi, Kenya.

Kenya National Bureau of Statistics, (2012a). *The 2009 Kenya population and Housing Census: Analytical Report on Population Dynamics, Vol. III.* Nairobi, Kenya: Government Printer.

Kenya National Bureau of Statistics. (2012b). *2009 Kenya Population and Housing Census: Analytical Report on Migration, Vol. VII.* Nairobi, Kenya: Government Printer.

Kenya National Bureau of Statistics, (2012c). *The 2009 Kenya Population and Housing Census: Analytical Report on Education, Vol. IX.* Nairobi, Kenya: Government Printer.

Kenya National Bureau of Statistics, (2012d). *The 2009 Kenya Population and Housing Census: Analytical Report on Population Projections, Vol. XIV.*Nairobi, Kenya: Government Printer.

Kenya National Bureau of Statistics, (2012e). *The 2009 Kenya population and Housing Census: Analytical Report on Fertility and Nuptiality, Vol. V*. Nairobi, Kenya: Government Printer.

Kenya National Bureau of Statistics, (2012f). *The 2009 Kenya population and Housing Census: Analytical Report on Mortality, Vol. VI.* Nairobi, Kenya: Government Printer.

Kenya National Bureau of Statistics, (2010). *The 2009 Kenya Population and Housing Census: Population Distribution by Age, Sex and Administrative Units, Vol 1C*. Nairobi, Kenya: Government Printer.

Kenya National Bureau of Statistics and ICF Macro, (2015). *Kenya Demographic and Health Survey, 2014.*Calverton, Maryland: Kenya National Bureau of Statistics and ICF Macro.

Kenya National Bureau of Statistics and ICF Macro, (2010). *Kenya Demographic and Health Survey, 2008-09.* Calverton, Maryland: Kenya National Bureau of Statistics and ICF Macro.

Keyfitz, N. (1972). On Future Population. *Journal of the American Statistical Association*, *67*, 347-362.

Kimani, B. (2016). *Overview of the SDGs in Kenya*. Paper Presented at the County Capacity Forum at Hill Park Hotel, Diani on 20 June 2016.

Kodiko, H. O. (2014). *Sub-National Projection Methods: Application of the Counties in the Former Nyanza Province, Kenya.*Unpublished Master's Project, University of Nairobi, Population Studies and Research Institute, Nairobi, Kenya.

Lee, E. S. (1966). A Theory of Migration. *Journal of Demography, 3*(1), 47-57.

Lesotho Bureau of Statistics. (2010). *National and Sub-National Population Projections.* Maseru, Lesotho: Bureau of Statistics, Ministry of Finance and Development Planning.

Lutz, W. (2006). Fertility Rates and Future Population Trends: Will Europe’s Birth Rate Recover or Continue to Decline? *International Journal of Andrology, 29*, 25-33.

Mehta, A. C. (2004). *Projections of Population, Enrolment and Teachers.* New Delhi, India.

Ministry of Education, Science and Technology. (2014). *Basic Education Statistical Booklet*. Nairobi, Kenya: Government Printer.

Ministry of Education, Science and Technology. (2015). National Education Sector Plan: *Basic Education Programme Rationale and Approach 2013-2018*. Nairobi, Kenya: Government Printer.

Ministry of Devolution and Planning. (2017). *Concept Note on Second Medium Term Plan, 2013-2017*. Nairobi, Kenya: Unpublished Report.

Ministry of Health. (2014). *Kenya HIV County Profiles*. Nairobi, Kenya: Government Printer.

Murdock, S.H., Hwang, S. and Hamm, R. R. (1995). Component methods. In Rives N. W., Serow, W. J., Lee, A. S., Goldsmith, H. F. and Voss P. R. (Eds.),*Basic methods for preparing small-area estimates* (pp. 10–53). Madison: Applied Population Laboratory, University of Wisconsin.

National Commission on Population, (2006). *population Projcetions for India 2001-2026: Report of the Technical Group on Population Projections Constituted by the National Commission on Population.* New Delhi, India: Office of the Registrer and Census Commissioner.

National Council for Population and Development, (2013). *Kenya Population Situation Analysis*. Nairobi, Kenya: Government Printer.

Office for National Statistics of England, (2016). Methodology Used to Produce the 2014-based Subnational Population Projections for England. Retrieved from https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/topicspecificmethodology

Ohio Research Office, (2013). *Population Projections Methodology*. Columbus, Ohio: Ohio Development Agency Services.

O'Neill, B.C., Balk, D., Brickman M. and Ezra, M. (2001). A Guide to Global Population Projections. Demographic Research, 4, 203-288.

O'Neill, B.C., Scherbov, S., and Lutz, W. L. 1999. The long-term effect of the timing of fertility decline on population size. *Population and Development Review 25*(4) 749-756.

Pittenger, D. (1976). *Projecting State and Local Populations.* Cambridge, MA: Ballinger.

Popoff, C. and Judson, D. H. (2004). Some Methods of Estimation for Statistically Underdeveloped Areas. In J. S. Siegel and D. A. Swanson (Eds.), *The Methods and Materials of Demography* (2nd ed., pp 603-641). San Diego, California: Elsevier Academic Press.

Rayer, S. and Smith, S.K. (2014). Population Projections by Age for Florida and its Counties: Assesing Accuracy and the Impact of Adjustments, 5 (33), 747-770

Republic of Kenya, (2013). *The Basic Education Act, 2013: No. 14 of 2013.* Nairobi, Kenya: National Council for Law Reporting.

Republic of Kenya. (2010). *Laws of Kenya: The Constitution of Kenya, 2010.* Nairobi, Kenya: National Council for Law Reporting.

Republic of Kenya, (2007). *Kenya Vision 2030: The Popular Version.* Nairobi, Kenya: Government Printer.

Samir,K. C., Barakat, B., Goujon, A., Skirbekk, V., Sanderson, W., & Lutz, W. (2010). Projection of Populations by Level of Educational Attainment, Age and Sex for 120 Countries for 2005-2050. *Journal of Demographic Research*, *22*(15), 383-472.

Sen, A. (1999). Development as Freedom. Oxford: Oxford University Press.

Shryock H. and Siegel J. (1973). *The Methods and Materials of Demography*. Washington, DC: U.S. Government Printing Office.

Siegel S. J. and Swanson A.D. (2004). *The Methods and Materials of Demography, Second Edition.* San Diego, California. USA: Elsevier Academic Press.

Smith S. K., Tayman J., and Swanson D. A. (2013). A Practitioner's Guide to State and Local Population Projections. *Demographic Methods and Population Analysis*,37.

Smith S. K. and Tayman J. (2003). An Evaluation of Population Projections by Age. *Journal of Demography, 40* (4), 741-757.

Smith S. K., Tayman J. and Swanson D. A. (2002). *State and Local Population Projections: Methodology and Analysis.* New york, United States of America: Kluwer Academic Publishers.

Swanson D. A., Schlottmann A. and Schmidt B.(2010). Forecasting the Population of Census Tracts by Age and Sex: An Example of the Hamilton-Perry Method in Action. *Business Demography for Population Research and Policy Review*, *29*, 47-63.

Swanson, D. A., Hough, G. C., Rodriguez, J.A. and Clemans C. (1998). "K-12 Enrollment Forecasting: Merging Methods and Judgment." ERS Spectrum 16: 24–31.

UNESCO. (2006). *Teachers and Educational Quality: Monitoring Global Needs for 2015.* Montreal, Canada: UNESCO Institute for Statistics.

United Nations. (2016). *The Sustainable Development Goals Report, 2016.* New York, NY: United Nations.

United Nations. (2015). *Principles and Recommendations for Population and Housing Census, Revision 3.* New York, NY: United Nations.

United Nations. (2010). *Handbook on Population and Housing Census Editing, Revision 1, Series F No. 82/Rev 1.* New York, NY: United Nations.

United Nations, (1952). "Accuracy Tests for Census Age Distributions Tabulated in Five-year and Ten-year Groups," in Population Bulletin, no. 2, ST/SOA/Ser.N/2, pp. 59-79. New York, NY: United Nations.

Wekesa, J. M. (1989). *Kenya's Population Projections and Some of Their Implications to Educational Planning.*Unpublished Master's Project, University of Nairobi, Population Studies and Research Institute, Nairobi, Kenya.

Whelpton, P. (1928). Population of the United States, 1925 to 1975. *American Journal of Sociology, 34*, 253-270.

Appendix 1: Population Projections for Kajiado County, 2010 - 2030

Age Group	2010			2015			2020			2025			2030		
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
0-4	60,918	59,407	120,325	66,699	64,011	130,710	77,116	73,804	150,920	83,143	78,611	161,754	89,024	84,147	173,171
5-9	52,388	51,834	104,222	57,938	57,286	115,224	65,294	63,128	128,422	69,610	65,877	135,487	73,026	68,514	141,540
10-14	44,439	45,448	89,887	51,874	51,546	103,420	57,506	57,036	114,541	64,807	62,855	127,662	74,985	72,551	147,535
15-19	39,408	41,127	80,535	44,093	45,245	89,337	51,560	51,361	102,921	57,158	56,832	113,990	64,376	62,622	126,998
20-24	36,317	38,824	75,141	38,934	40,772	79,706	43,674	44,926	88,600	51,071	51,000	102,071	56,564	56,416	112,980
25-29	32,077	33,783	65,860	35,692	38,286	73,979	38,394	40,299	78,694	43,069	44,405	87,474	50,304	50,380	100,683
30-34	27,819	27,618	55,437	31,270	33,191	64,462	34,950	37,709	72,659	37,596	39,688	77,284	42,109	43,694	85,803
35-39	22,861	21,725	44,586	26,867	27,076	53,943	30,359	32,614	62,973	33,932	37,046	70,977	36,435	38,948	75,383
40-44	16,991	14,866	31,857	21,904	21,265	43,170	25,880	26,553	52,433	29,244	31,975	61,219	32,627	36,272	68,899
45-49	12,796	10,756	23,552	16,149	14,523	30,672	20,922	20,805	41,727	24,719	25,969	50,687	27,888	31,220	59,109
50-54	8,796	7,461	16,257	12,028	10,469	22,497	15,245	14,150	29,395	19,749	20,261	40,010	23,305	25,238	48,543
55-59	6,268	5,360	11,628	8,121	7,210	15,331	11,139	10,121	21,261	14,118	13,669	27,787	18,278	19,517	37,795
60-64	4,291	3,838	8,129	5,606	5,107	10,713	7,267	6,864	14,132	9,968	9,623	19,591	12,641	12,940	25,581
65-69	2,967	2,788	5,755	3,621	3,559	7,180	4,707	4,718	9,424	6,102	6,325	12,427	8,397	8,803	17,200
70-74	1,956	1,988	3,944	2,257	2,455	4,712	2,706	3,098	5,803	3,517	4,085	7,602	4,600	5,408	10,008
75-79	1,259	1,437	2,696	1,245	1,583	2,828	1,378	1,895	3,273	1,652	2,367	4,019	2,189	3,053	5,242
Total	**371,551**	**368,260**	**739,811**	**424,298**	**423,585**	**911,474***	**488,096**	**489,081**	**1,050,466***	**549,454**	**550,586**	**1,182,544***	**616,748**	**619,721**	**1,329,204***

Source: Study Data

** Projected Population with Migrants*