TECHNICAL EFFICIENCY OF PUBLIC HEALTH CENTRES IN KAKAMEGA

COUNTY

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DECLARATION

This research report is my original work and has not been presented for award of a degree in any other University.

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ACKNOWLDEGEMENT

DEDICATION

This research work is dedicated to my family Mercy, Darry and Eddy Junior and to their grandmother *Mama* Ayeta.

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LIST OF ABBREVIATIONS

AE- Allocative Efficiency

ANC- Ante-natal Care

CRS- Constant Returns to Scale

DEA- Data Envelopment Analysis

DMU – Decision Making Unit

DRS- Decreasing Return to Scale

FP- Family Planning

IRS- Increasing Returns to Scale

KNBS- Kenya National Bureau of Statistics

MoH- Ministry of Health

MoMS- Ministry of Medical Services

NGO- Non-Governmental Organization

RA- Ratio Analysis

SFA- Stochastic Frontier Analysis

SSA- Sub-Saharan Africa

TE- Technical Efficiency

TGE- Total Government Expenditure

USA- United States of America

VRS- Variable Returns to Scale

WHO- World Health Organization

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ABSTRACT

Since independence Kenya has adopted several reforms and policies in health sector. One of the aims of these policies and reforms is improving efficiency, resource allocation and use. The new Kenyan constitution has extensively devolved health care services provision to the counties with the goal of achieving efficiency and proper use of resources. This study estimates technical efficiency and factors that influences it among public health centres in Kakamega County for the years 2013 and 2014.

We used number of outpatient visits, number of children fully immunized, number of family planning visits and number of at least four antenatal care visits as output variables and medical personnel and number of beds/cots as input variables. Our sample comprised of thirty six public health centres. Data envelopment analysis (DEA) was used in estimating efficiency scores. The efficiency scores were then regressed against selected variables to determine their effects on efficiency. Various diagnostic tests were performed before estimation.

From the results the average variable return to scale technical efficiency is 87% with the least efficient health centre score of 15.3% and the most efficient health centre score of 100%. Antenatal care visits influenced efficiency positively while medical personnel and beds/cots influenced efficiency negatively. The study recommends redistribution of medical personnel as well as extra beds/cots to other health facilities in the county based on assessed needs.

1.0 CHAPTER ONE: INTRODUCTION

1.1 Background

At independence in 1963 Kenya declared war on poverty, ignorance and disease. To win the war against disease, the government abolished user fee in public health facilities in 1965. The aim of this was to improve utilization of health services (WHO, 2006). In addition, provision of health care services at primary level was decentralized to local authorities in an attempt of achieving equity and efficiency in provision of health care services. However the local authorities were faced with a myriad of challenges. These challenges included lack of resources, wastage of available resources and general lack of capacity (Collins et al., 1996). Hence the central government in 1970 took over the running of dispensaries and health centres. This has been the case until 2010 when the new constitution devolved health care provision below level five to county governments.

In 1970s and 80s Kenya experienced rapid population growth which was not in tandem with manpower development and economic growth. This growth coupled with poor economic performance led to health crisis of 1990s (Collins et al., 1996). Free health care was not sustainable hence the government under the influence of donors introduced structural reforms. In health care provision notable reforms included cost sharing that aimed at achieving efficiency, quality, access, equity and revenue generation (Chuma et al., 2009, Kioko, 2000, Collins et al., 1996, World Bank, 1987). Another aim of cost sharing was to encourage consumption of low cost health promotion and preventive services rather than the costly hospital referral services (World Bank, 1987). However cost sharing led to inequity in usage of health care services particularly among the poor who could not afford (Mills, 1998)

To improve resource allocation, use and efficiency, the Kenyan government came up *Kenya Health Policy Framework* in 1994 that minimally decentralized health service

provision to the districts (Republic of Kenya, 1994). The policy did not achieve much success due to lack of capacity building at district level and poor coordination and supervision at national level. Efficiency of health facilities dropped instead of improving (Kioko, 2000).

At the turn of the century Kenyan health care indicators have relatively improved largely due to improved economy, increased funding both by government, private sector and donors. For instance total overall health expenditure increased from 163 billion shillings in 2009/2010 to 234 billion shillings in 2012/2013 (MoH, 2015). This expenditure translated to 6.8% of gross domestic product an increase of 1.4% from 2009/2010 figures. In 2013/2014 period the private sector was the major financier of health care at 40%, followed by public sector at 34% then donors and Non-governmental Organizations (NGOs) at 26% (MoH, 2014a). The Out of Pocket Payment (OPP) is the popular means of health care payment in Kenya. Medical bills settlement through OOP rose to 62.1 billion shillings in 2013 from 43.9 billion shillings in 2007(MoH, 2014a). This expenditure is mainly on ambulatory services provided by health centres and dispensaries.

Although the government has increased funds allocation towards health care provision in absolute figures, the funds as a proportion of the Total Government Expenditure (TGE) has been decreasing. In the financial year 2010/2011 for instance, the government allocated 45.7 billion shillings (6.3% of TGE) on health care while in the financial year 2011/2012, 49.7 billion shillings were allocated (5.8% of TGE) (MoH, 2014b). This is below the Abuja declaration in which governments in Sub-Saharan Africa (SSA) pledged to allocate 15% of the TGE on health care provision. The implication of this is fewer resources are allocated to health care provision and the situation is magnified by widespread inefficiency (World Bank, 2013).

1.2 Kenya Health Profile

Kenya Demographic Health Survey (KDHS) 2014 revealed a drop in infant mortality rate from 52 deaths per 1000 live births in 2009 survey to 39 deaths per 1000 live births in 2014 (KNBS and ICF Micro, 2015). The survey further revealed a drop in total fertility rate (TFR) from 4.6 children per woman of reproductive age in 2009 to 3.9 children per woman of reproductive age in 2014 the lowest rate ever recorded in Kenya's history. However there exist remarkable disparities among counties in that some counties like Kirinyaga recorded a low TFR of 2.3 children per woman of reproductive age while other counties like Wajir recorded TFR as high as 7.8 children per woman of reproductive age. The overall decline in TFR is in tandem with increased contraceptive use among women of reproductive age in general. The number of pregnant women who attended at least four Antenatal Care (ANC) visits as recommended by World Health Organization (WHO) stood at 58%.

Kenyan health infrastructure is largely mixed with government operating 51% of the health facilities, 29% operated by private sector and 21% by NGOs (MoMS, 2012). The public health care system is organized in hierarchical manner comprising of six strata. At the apex, level six is national teaching and referral hospitals followed at level five by county referral hospitals. At level four are county and sub-county hospitals, health centres and dispensaries are at level three and two respectively. The government and faith based organization takes the commanding lead in the running of health centres and dispensaries (MoMS, 2012). The dispensaries and health centres comprise 74% of health care infrastructure and have a good rural penetration.

In 2013 Kenya had 8682 doctors, 1045 dentists, 2202 pharmacists, 26841 enrolled nurses, 39780 registered nurses and 13216 registered clinical officers (MoH, 2014c). Though this represents a general increase in health care personnel, the numbers are still low as per the WHO recommendations. This gives an average ratio of 20.7 doctors and

159.3 nurses per 100,000 persons a ratio lower than the WHO recommended ratio of 21.7 doctors and 228 nurses per 100,000 persons. In addition distribution of health care personnel in Kenya is skewed in favour of urban centres putting rural and especially marginalized areas health care needs in jeopardy.

1.3 Problem Statement

The enactment of the new constitution in 2010 led to extensive devolution of health care service provision to the counties with the aim of improving efficiency, equity and quality in service delivery. In addition devolution was aimed at ensuring that resources are allocated efficiently in that the most needy health issues are given priority within a county. It was envisaged that decisions will be made timely and health care provision will be closely monitored ensuring proper utilization of health care resources. To achieve this Kenya Health Policy 2014-2030 was formulated which laid emphasis on resource allocation based on technical and allocative efficiency (MoH, 2014c). In order to assess if the objectives of devolution are being met insights into how the health facilities are performing need to be obtained.

In Africa, studies focusing on efficiency of public health systems and programmes reports inefficiency (Kirigia, et al 2004, Akizili et al 2008, Masiye, et al, 2006, Kioko, 2000). Yet the health service provision in African countries falls short of the demand and health indicators remains low. Efficient use of resources can bridge the gap between supply and demand and in the process improve health indicators. Needless to say in the presence of inefficiency the goals of equity, access, responsiveness and quality in provision of health care will remain a mirage. Increasing resources allocation alone without eliminating wastages will have little impact on health outcomes. Therefore this study will not only estimate efficiency of public health centres but also factors responsible for (in) efficiency.

Mwari (2013) studied technical efficiency and factors responsible for (in) efficiency in Kenyan health centres. The study focused on only forty seven health centres, one in every county and considered data for only one year. Since the counties are not homogeneous (differ in population structure, level of development, culture, religion among others) and small sample size used generalization of the findings to the entire county was not appropriate. This study focuses on all public health centres in Kakamega County for the year 2013 and 2014.

1.4 Objectives of the Study.

1.4.1 Broad Objective

The broad objective of the study is to assess the level of technical efficiency of health centres in Kakamega County for 2013 and 2014 years and factors influencing efficiency in these facilities

1.4.2 Specific Objectives

1. To assess technical efficiency of public health centers in Kakamega County for the years 2013 and 2014

2. To determine factors influencing (in)efficiency of public health centers in Kakamega County.

3. To suggest policy recommendations based on study findings.

1.5 Justification of the Study

The results of this study will yield valuable information that the County Health Management Board (CHMB) and relevant stakeholders in Kakamega County will use in the allocation of scarce health resources for maximum value and returns. In addition the information from this study will be used as a reference for monitoring and assessing progress in achieving TE and AE of health centres in Kakamega County as proposed in Kenya Health

Policy 2014-2030. The policy calls for evidence based resource allocation that ensures that both TE and AE in health care provision are achieved.

The information provided by the study will be of value to planners and policy makers in that the causes of inefficiency will be known and necessary measures put in place for their elimination. The resources saved can be used to provide more or other health care services. In the long run health care that is efficient, responsive, equity and of acceptable quality will be provided.

2.0 CHAPTER TWO: LITERATURE REVIEW

Introduction

This chapter explores both theoretical and empirical literatures on efficiency of health care facilities and programmes. Both internal and external environmental factors influence production process hence overall efficiency. Some of these factors include population structure and density, infrastructure network, concentration of health facilities in a locality, local regulations, health care utilization, disease prevalence, socio-economic factors among others.

2.1 Theoretical Literature Review

Productivity describes the relationship between the input resources and the deliverable outputs or outcomes in production process (Coelli, et al., 2005) whereas efficiency is the ratio of actual production unit outputs or outcomes to maximum achievable outputs or outcomes possible at a given system resources or inputs endowment.

Beattie, et al., (1995) proposed Euler's theorem of production as the model which explains production process. The model relates to inputs say labour and capital (K, L) to an output which is independent variable say Y. According to the theory, if Y= (K, L) relates to a production function and factors of production are paid according to their marginal productivities, then the total factor payment is equal to the degree of homogeneity of the production function multiplied by the output. Marginal productivity payment in value units exhausts total value of product. The output is measured in physical units or values.

The output in health care industry is the health care product (either immediate or final) which will have a direct influence to an individual's health stock. Euler's theorem postulates that under Constant Return to Scale (CRS) the total product should be distributed among factors of production equally according to their marginal productivity. However, health care

production is characterized by market failure due to externalities and government controls. For instance in 2004 the Kenyan government set the cost of maternal and child health services at Ksh. 20 and Ksh. 10 in public health centres and dispensaries respectively. Moreover health care activity results to residues, externalities that are not related directly to the intended health care outputs.

Farrell, (1957) defined efficiency as the firm's ability to produce maximum output using given inputs. He came up with two components of efficiency, technical efficiency (TE) and allocative efficiency (AE) as discussed below;

2.2 Types of Efficiencies

2.2.1 Technical Efficiency

TE of a firm or a Decision Making Unit (DMU) relates to its ability to use a given set of inputs to produce maximum possible outputs/outcomes (Worthington, 2004). A technically inefficient DMU consumes more inputs relative to outputs or simply produces fewer outputs relative to the inputs used in the production process. TE can be viewed from an input or output orientation perspective. Input orientation entails minimizing the amount of inputs for a maximum number of outputs while output orientation entails maximizing the outputs for a given set of input resources. TE can be split into "pure" and scale efficiency (SE). Pure TE is concerned with relationship between inputs and outputs while SE asses the scale of production.

A DMU can be technical efficient yet scale inefficient in that its size can be the source of inefficiency. SE is the level of optimal production in that if the size of operation of the DMU is increased or decreased efficiency drops (Yawe, 2010). Such DMU is operating at constant returns to scale (CRS) in that a percentage increase/decrease in inputs leads to equal proportionate increase/decrease in outputs. Scale inefficiency takes the form of variable

returns to scale (VRS) in which proportionate increase/decrease in input(s) does not result in equal proportionate increase in output(s). This can take the form of decreasing return to scale (DRS) or increasing return to scale (IRS). At DRS, a percentage increase in inputs results in less than proportionate increase in outputs. In this case DMU is experiencing diseconomies of scale that emanates from managing a large entity. A DMU operates at IRS when a percentage increase in inputs results in more than proportionate increase in outputs. This is a case of economies of scale. In essence TE is concerned with eliminating wastage in inputs usage.

2.2.2 Allocative Efficiency

AE is concerned with how well the DMU's different inputs at their given prices are combined to produce the desired maximum output by exploiting the available technology (Worthington, 2004). For AE to be achieved, the inputs should be in such proportion that the total costs of production are kept at a minimum. A DMU like health centre for instance can use more of labour than capital to produce an output or more of capital than labour to produce the same output. As long as the maximum output is achieved the DMU is deemed technically efficient but not necessarily allocative efficient due to differences in prices of inputs. Since there is price component, AE not only requires data on quantities of outputs produced and inputs used but also their respective prices. A profit maximizing DMU will select input proportions that keep the costs as low as possible. However in health care industry profit maximization or cost minimization might not be the objective particularly in public sector.

Figure 1.1 explains the DMUs technical and allocative efficiencies. The DMU uses the inputs X_1 let's say labour (nurses or doctors) and capital X_2 (drugs) to produce an output(s) Y (immunizations, surgeries). Along SS_1 the DMU is at isoquant and is fully technical efficient. This implies that both points Q and Q_1 are at maximal production but differ in combination of inputs X_1 and X_2. The firm uses quantity of inputs at point P to produce quantities of output

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at point Q hence the TE of the firm is OP/OQ. At Q the firm is technically efficient since it lies along the efficient isoquant SS_1. The line AA_1 represents the input price ratio. The AE is OR/OP with RQ representing reduction in production costs. The DMU will be both technically and allocative efficient at Q_1

Figure 2.1 Diagram Illustrating Allocative and Technical Efficiency.
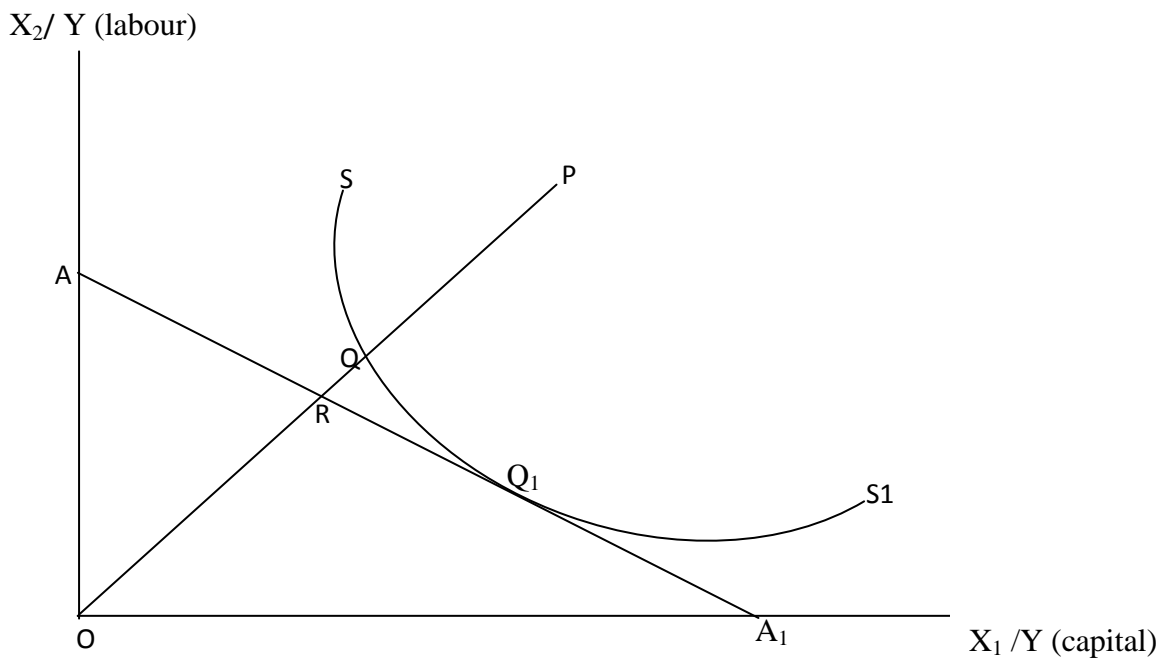
2.3 Efficiency Measurement Techniques

Efficiency measurements that employ frontier models estimate efficiency as the maximum possible output produced by a DMU against an estimated efficient frontier. (Cindy et al; 2000) The frontier imposed is the maximum achievable output that can be realized using the current best known production technology in comparison to the output that is actually produced by a similar DMU (Worthington, 2004). The frontier of a fully efficient

DMU should be known or idealized which will be used as a yardstick against which the peers will be compared (Hollingworth, 2008).

2.3.1 Ratio Analysis

The ratio analysis (RA) aims at comparing selected ratios between an input and an output used in production process among a particular group of DMUs. This ratio can take the form of cost per day, cost per diagnosis and cost per bed among others. RA in essence is the average cost of production and not efficiency measurement in strict terms. The DMUs that realizes a given output at the minimum cost possible without compromising quality is deemed efficient. The technique is simple to use requiring less expertise. However it has drawbacks in that it is only suitable in scenarios where a single input is being compared to a single output (Zere et al. 2005). In addition it is difficult to assign, distribute and allocate shared costs to a particular output in the production process.

2.3.2 Data Envelopment Analysis

Data envelopment analysis was developed by Charnes, Cooper and Rhodes in (1978) and it produces an index of efficiency that incorporates multiple inputs and outputs variables. This index is non-stochastic in that any deviation from frontier is assumed to be as a result of inefficiency.

DEA can be modelled either with CRS or VRS. CRS is present when an increase in inputs by a certain proportion leads to an increase in output by the same proportion and the converse is true. In VRS output changes more or less proportionately than changes in inputs. DEA can measure efficiency using input or output orientation approach (Yawe, 2010). The input oriented approach focuses on minimum inputs for a given level of output while output orientation approach focuses on maximum output using a fixed amount of inputs.

DEA should assume four assumptions in its applicability that includes technology assumption on delivery process (VRS or CRS), efficiency analysis orientation (input or output), the choice of inputs and outputs and whether to include weight restrictions on inputs/outputs (Pelone et al; 2014). Whether to use CRS or VRS is contextual relying heavily on the objectives of the study. For instance CRS is preferred if the analysis is from policy makers point of view while VRS is better from managerial perspectives. The decision on the choice of orientation is based on what managers have greater control or influence, either the resource inputs or outputs. In an ideal world all the inputs used and outputs produced should be incorporated in estimating efficiency, (Mohamed, 2013). However three inputs categories in physical or monetary value of labour, capital and consumables are often employed.

2.3.3 Stochastic Frontier Analysis

Lovell, et al., (1977) proposed this as an econometric/parametric technique that specifies a frontier production function in which DMU failure to reach the specified production frontier can be due to inefficiency or statistical randomness. The method is based on Cobb-Douglas production function;

Log $\gamma = \beta\chi + v - \mu$

Where γ = is the observed outcome/efficiency score

$\beta\chi + v$ = is the optimal production frontier comprising of $\beta\chi$ the deterministic part of the frontier while v is the stochastic part

μ = is the inefficiency

In this model error term ε is made up of two independent components ν -μ where μ measures the technical inefficiency. Further, it is based on an assumption that ν has a normal distribution and μ follows a half normal distribution.

A disturbance term is introduced representing measurement error or "noise", external shocks that are beyond the control of production unit. Therefore deviation from the frontier can be due to inefficiency in the production process or due to external variables or "noise". This method imposes a functional form on the inefficiency distribution half normal or exponential in practice. This carries the risk of misspecification of inefficiency distribution and could lead to biased estimates (Cindy et al; 2000).

2.4 Empirical Literature Review

Herr, (2008) and Tiemann & Schneyogg, (2006) studies reported inefficiency among public owned hospitals than private hospitals in Germany. This was attributed to cost cutting measures and the obligation of public hospitals to justify spending. Contrasting results are reported in Austrian study in that private hospitals were more efficient than their public counterparts (Cyzplonka et al., 2014). In Austria there is no provision for government to bailout private hospitals in case of financial difficulties as it is the case with public hospitals. The financial risks of private owned hospitals in case of insolvency forces them to be cost conscious compared to their public counterparts. Similar conclusions are made by Kontodimopoulis, et al; (2011) in a Greek study of dialysis centres. The average efficiency score was 68.2% with private owned dialysis being less efficient.

Masiye et al., (2006) Zambian study reported high efficiency among private owned health centres of 70% compared to 56% of public run health centres. The study attributed inefficiency in private health centres to excess inputs while in public health centres inefficiency was due to mal-distribution of health workers and the lure of health workers to

work in private hospitals due to better terms. However due to a small sample size (3.7% of total facilities) and high proportion representation of private health centres (42.5%) in the study, the findings needs to be taken with caution.

In a Ghanaian study quasi-public hospitals (government owned but autonomously managed) had an efficiency estimate of 83.9%, 70.4% for public hospitals, 68.6% for mission hospitals and 55% for private hospitals (Jehu-Appiah et al; 2014). Serving a special population of discipline forces the quasi-public hospitals enjoyed high utilization rate due to payment exemption. The above studies gives mixed results as far as ownership and efficiency is concerned. In their review Amico et al; (2013) postulated that in general DMUs that rely heavily on government grants are generally less technically efficient due to lack of market pressure and incentives to make profits.

Location of a health facility can influence efficiency either positively or negatively. For instance Shreay et al., (2013) study on dialysis centres in United States of America (USA) reveals high efficiency among rural located centres while Kontodimopoulis et al., (2011) study on dialysis centres in Greece reports location either urban or rural had a borderline effect. In general centres that are urban located on average incur higher costs compared to those that are rural located. This can be attributed to high input prices, cut throat competition, high overhead costs and handling of more emergency cases necessitating excess staffing for emergency preparation (Thorpe, 1988)

As with ownership the size of DMU has an effect on efficiency and studies shows mixed results. Kontodimopoulis et al; (2011) study associated efficiency with large dialysis centres that performed at least twelve thousands dialysis in a year. Similar findings are reported in USA study in which large dialysis centres (functional area of more than eleven thousand metres square) were less efficient (Shreay et al., 2014). In another USA study small sized

dialysis centres were associated with high efficiency (Amico et al., 2013). However the definition of size (large or small) is contextual and depends on how the concept is operationalized and measured. For instance, in some studies size is defined using number of outputs while in others the functional area is employed. Lack of homogeneous measurement necessitates cautious comparisons and conclusions.

A study in Burkina Faso of primary care facilities reported that inefficiency was associated with long distance to the health facility and "being Animist" a local religion (Marschall & Flessa, 2011). Long distance and restriction imposed by Animist religion on services like immunizations and Family Planning (FP) led to poor access and utilization. Surprising findings are reported in an Ethiopian study in that less distance to the nearest health facility was positively associated with inefficiency (Sebastian & Lemma, 2013). This shows that access hence utilization is not only affected by distance but other factors like attitude of health workers, quality of services, availability of drugs, payment mechanisms among others.

In Africa several studies have been done to estimate efficiency of health centers and majority indicates inefficiency. For instance Akizili, et al., (2008) study on eighty nine health centers in Ghana reported that only 31 (35%) and 19 (21%) of the facilities were technically and scale efficient respectively. Similar findings are reported by Kirigia, et al., (2004) study in Kenya that used DEA to assess TE of public health centers. Of the 32 public health centers involved in the study 14(44%) and 18 (56%) were technically and scale efficient respectively.

2.5 Overview of Literature

There has been academic argument which technique, DEA or SFA should be used to measure and analyse efficiency of health care organizations (Michael and Mitter, 2008). Each of the methods has their merits and drawbacks and one should not be looked as

dominating the other, rather their application should depend on objectives of the study and contextual factors (Cindy et al; 2000). For instance cost oriented SFA might not be applicable where accurate prices of input are unavailable hence measurement of TE using DEA might be appropriate. This is the main reason why this study shall consider DEA as appropriate method due to unavailability of data on prices

These studies clearly indicate health care institutions across the world and in particular SSA operates under inefficiency frontier yet health indicators remains poor. The studies indicate mixed results from one study to another and from one place to another in that there is variation in efficiencies based on ownership, kind of activity, quality of outputs and location. Most of the studies have used DEA due availability of data and multiple input and output nature of health care industry. On recommendations to eliminate inefficiency and achieve efficiency there is need for input and output adjustments either by increasing or decreasing the factors of production.

3.0 CHAPTER THREE: METHODOLOGY

Introduction

This chapter presents the description of the analytical model, model estimation, data sources and study area.

3.1 Analytical Framework

Different methods of efficiency measurements have been developed and are broadly dichotomized based on functional form imposed on production technology that ultimately affects production process (Cindy et al; 2000). According to Worthington, (2004) and Yawe, (2010) technical efficiency can be assessed from an input or output orientation. In a context where managers have considerable influence over health outputs than inputs, output oriented approach is widely used. Health centers work with relatively fixed inputs as managers have no control over staffing and medical supplies. However managers are in a position to influence outputs through campaigns, outreach services and social marketing. Therefore output oriented approach is employed in this study. Since health centers employ multiple inputs to produce multiple outputs their individual technical efficiency can be defined as:

$$Technical\ efficiency = \frac{weighted\ sum\ of\ inputs}{weighted\ sum\ of\ outputs} = Max_{ho} = \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i y_{ijo}}$$

Subject to:

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \qquad j=1\ldots j_{o,\ldots,n}$$

$$u_r \geq 0, r, \ldots, s\ \&\ v_i \geq 0, i=1\ldots m$$

Where max_{ho} = is the technical efficiency for decision making unit

y_{rj0} and x_{rjo} represents the amount of output r and the amount of input i for unit j_o.

A score of one indicates that the DMU is fully efficient while an otherwise score indicates presence of inefficiency. This study will use variable return to scale model. Variable return to scale model assess whether decision making unit is operating under decreasing, constant or increasing return to scale.

$$Max_{ho} = \sum_{r=1}^{s} u_r y_{rjo} + z_{jo}$$

Subject to: $\sum_{i=1}^{m} v_i x_{ijo} + z_{jo} = 1$

$$\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} + z_{jo} \leq 0 \quad j=1\ldots n$$

$$u_r \ v_i \geq 0$$

Increasing return to scale is present if the value of z_{jo} is greater than 1, constant return to scale is present if the value of z_{jo} is equal to zero and decreasing return to scale is present if the value of z_{jo} is less than one;

3.2 Model Estimation

The study is carried out in two stages. At first stage data envelopment analysis (DEA) technique is used to estimate technical efficiency of health centers in Kakamega County. Quantitative data on inputs and outputs for the years 2013 and 2014 is used to estimate technical efficiency (Cook & Seiford, 2009). This approach is rooted in the concept of efficiency as described earlier in literature (Kirigia, et al 2004). DEA is employed in the analysis since it can incorporate multiple inputs and outputs a situation that characterizes production process of health centres. Furthermore DEA does not require accurate prices of

inputs or accurate values of outputs in the analysis. This makes it convenient to apply in public health centres where valuing of inputs and outputs can be a challenge or difficult.

We propose ordinary least square method to be used at second stage of analysis. The efficiency score obtained in first stage is used as dependent variable to determine factors that are responsible for efficiency of health centres. Michael & Mitter (2008) argues that environment in which production takes place can have positive or negative effect on efficiency. We consider the specific regression model of a health centre based on Euler's theory of production. The expanded production model shall take the following form;

$$Y_{it} = \beta 0 + \beta i X i j t + \varepsilon$$

Where Y_{it}, a dependent variable of the ith health facility which is explained by a vector of independent variables X_{ijt} (j=beds, nurses etc.) The β_i are unknown regression coefficients, β_0 represents a constant and ε is the error term reflected in the residuals.

3.3 Estimation Technique and Model Specification

Before estimation the data is subjected to normal econometric tests to ensure consistency. Tests for normality, collinearity and homoscedasticity are conducted. Since there is both time component as well as cross sectional characteristics, the study specified the following dynamic panel model;

$$Y_{it} = \beta_0 + \beta_1 OPDit + \beta_2 FPit + \beta_3 ANCit + \beta_4 MPit + \beta_5 EXPit + \beta_6 BEDit + \beta_7 IMMit + \varepsilon$$

Where:

Y_{it} is inefficiency observed in i[th] health center year t (2013 or 2014)

OPDit is Curative Outpatient visits in i[th] health center year t

FPit is Family Planning visits in i[th] health center year t

ANCit is at least four antenatal visits in i^{th} health center year t

MPit total number of medical personnel in i^{th} health center year t

BEDit total number of beds in i^{th} health center year t

IMMit number of fully immunized children in i^{th} health center year t

β_2 coefficients to be estimated

ε is the error term

3.4 Data sources, collection and analysis

The study uses panel data collected from Kakamega County health records for years 2013 and 2014. Intermediate health outcomes (such as immunization) will be used as output variables. Ideally the final health outcome such as quality adjusted life years and improved health status should be used as the output variables. However due to difficult in measuring final health output and unavailability of such data, the study considered intermediate health outputs.

The unit of analysis is public health center. As per the year 2013 Kakamega County had forty one public health centers. All the health centers are included in the study. However due to incomplete data in five of the facilities thirty six health centers are incorporated in the final analysis.

The study uses Curative Outpatient Department (OPD) visits, number of deliveries, number of at least four Antenatal Care (ANC) visits, Family Planning (FP) visits and total number of fully immunized children as output variables. The input variables include the number of registered clinical officers & nurses, "other professionals" (which includes laboratory technicians, public health technicians & pharmaceutical technologist) and number of beds/coats. The choice of inputs and outputs is based on other studies done in Africa on efficiency of health centers (Mwari, 2013, Akizili, et al., 2008, Kirigia, et al., 2004).

A questionnaire was used to collect data on study variables from county health records. For efficiency estimates the coded data is analyzed using data envelopment analysis programme (DEAP) version 2.1 while for regression analysis STATA version 12.1 software is employed.

3.5 Study Area

Kakamega County is one of the forty seven devolved counties in Kenya's administrative and political structure. The county is located in western part of Kenya covering an area of 3224.9 square kilometers. According to 2009 household survey and population census Kakamega County was the most populous rural County in Kenya and second overall with total population of 1,660,651 people translating to population density of 544/Km^2 of which 57% lived below poverty line (KNBS, 2010).

The HIV/AIDS prevalence rate of 5.6% is higher than the national average of 4.3%. This high prevalence has been associated with several factors including poor uptake of testing, early sexual debut, cultural practices, home deliveries among others. Malaria is the leading cause of morbidity and mortality in the county. Kakamega County lags behind on maternal and child health indicators compared to other counties (KNBS and ICF micro, 2015). For instance KDHS 2014 report indicates that only 47% of deliveries in the county took place in health facilities compared to 61.2% national average. During the same period ANC attendance stood at 45% compared to 57.6% national average.

The main economic activity of Kakamega County is agriculture mainly both small and large scale sugar cane farming. Other agricultural activities includes small scale mixed farming of maize, beans, millet, tea, soya beans sunflower and dairy products.

4.0 CHAPTER FOUR: STUDY FINDINGS

Introduction

This chapter presents efficiency results on thirty six public health centres across Kakamega County for the years 2013 and 2014 (72 observations). Estimation of health centres variable return to scale technical efficiency is conducted using data envelopment analysis. A health centre's score of unity means it's fully efficient while an otherwise score indicates inefficiency. Then efficiency estimate obtained is used as dependent variable to assess factors influencing efficiency at second stage of analysis. Since the data is not normal distributed (after carrying out normality test) and is panel data variable fixed model is used for regression analysis.

4.1: Preliminary data analysis

From the results it is observed that public health centers in Kakamega County on average produced 15057 total outpatient visits, 223 deliveries, 1518 family planning visits, 200 of at least four antenatal care visits and 536 children were fully immunized during the period of study. In production of these services the health centers on average used 11 medical personnel and 16 beds/cots.

Table 4-1: Summary of Descriptive Statistics of Variables Used in the Study

Variable	Observations	Mean	Std. Dev.	Min	Max
Technical efficiency	n=72	0.87	0.18	0.15	1
Total number of outpatient visits		15057.74	7325.76	578	39881
Number of deliveries		223	174.09	0	750
Total number of family planning visits		1517.78	907.42	18	5562
Number of at least four antenatal visits		199.51	114.82	2	517
Number of children fully Immunized		535.69	285.23	41	1647
Medical personnel		10.67	3.46	4	19
Number of beds/cots		16.7	23.03181	0	90.6

4.2 Technical efficiency scores

The study observes that in 2013 the average technical efficiency estimate of public health centers is 0.84. The facilities in general could have reduced their inputs by 0.16 and still produce the same number of outputs. Similarly the facilities could have increased their outputs by 16% at the same level of inputs. Fifteen of the facilities (42%) are fully technical efficient.

Table 4-2: Summary Statistics of Efficiency Score of Health Centers for 2013

	Technical efficiency (CRS)	Pure technical efficiency (VRS)	Scale efficiency (CRS/VRS)
Mean	0.78	0.84	0.91
Maximum value	1	1	1
Minimum value	0.12	0.15	0.12
Total number of facilities on frontier	12	15	13

The study finds that in 2014 the average technical efficiency estimate of public health centers is 0.90. The facilities could have reduced their inputs by 10% and still produce the same number of outputs. Nighteen (53%) of the facilities were fully technical efficient. APPENDIX I and APPENDIX II gives a summary of individual health centers efficiency estimates score for 2013 and 2014 years respectively.

Table 4-3: Summary Statistics of Efficiency Score of Health Centres for 2014

	Technical efficiency (CRS)	Pure technical efficiency (VRS)	Scale efficiency (CRS/VRS)
Mean	0.83	0.90	0.93
Maximum value	1	1	1
Minimum value	0.18	0.55	0.18
Total number of facilities on frontier	15	19	18

When the two years are considered together as panel data it is observed that average technical efficiency score is 0.87. The health facilities in general could have reduced their

inputs by 13% and still produce the same number of outputs. In general 62% of the health centers were technically inefficient.

These findings are similar to those of other studies done in Kenya and other African countries where inefficiency was reported. A study conducted on 32 public health centers in Kenya reported that 56% of the facilities were technically inefficient (Kirigia et al., (2004). A Ghanaian study of 89 public health centers found that 65% of them were technically inefficient (Akizili et al., 2008). This confirms the popular opinion that health facilities and programmes in African countries are run inefficiently.

4.3. Determinants of technical efficiency

A regression analysis is performed in order to assess factors influencing technical efficiency. Before running the model, variable inflationary factor test for multicollinerity and Shapiro Wilks test for normality of error term is conducted. The variable inflationary factor test shows strong collinearity between total number of outpatient visits and number of at least four antenatal visits as shown in APPENDIX III. Number of antenatal care visits is retained while total number of outpatient visits is dropped. This is due to health centres crucial role of health promotion and prevention of which antenatal care services forms the bulk.

On testing for normal distribution of error term the p value of 0.00796 confirms that the data is not normal distributed. The appropriate transformation of independent variables is done by conducting logarithmic transformation of the independent variables. Hausman specification test is done to determine the best fit model. Test for significance of variables is conducted at 95% and 99% level. It is observed that the number of at least four antenatal visits positively influences efficiency. On the other hand the number of medical personnel and number of beds/cots influences efficiency negatively. The rest of the variables statistically don't influence efficiency.

Table 4.4: Regression Results for Random Effects Model

Dependent variable	Robust			
	Coefficients	**Std. Err.**	**z**	**P>z**
Total number of family planning visits	0.034	0.033	1.030	0.305
Number of at least four antenatal visits	0.117*	0.062	1.890	0.059
Number of children fully Immunized	0.000	0.075	0.000	0.996
Medical personnel	0.143*	0.074	-1.930	0.054
Number of beds/cots	-0.054**	0.013	-4.060	0.000
Constant	0.183	0.283	0.650	0.516

R-square: Within   = 0.19   Prob > chi2   =   0.00

Between = 0.52

Overall   = 0.39

*significant at 10%,
**significant at 1%

From the study results, all the variables fit the model well since the overall p value is 0.00. The R square within the panels is 0.19, between the panels is 0.52 and the overall is 0.39. This implies that the independent variables explain technical efficiency by 39% on overall, 52% between panels and 19% within panels. The rest of the variations in the respective panels are attributed to other excluded factors and thus error term.

4.4. Discussion of the Results

It is observed that technical inefficiency is present in public health centres in Kakamega County despite devolution of health care services. This indicates that there still exists wastage of resources in service provision. However some of the health centres are fully efficient while others are not. Several factors have been cited for differences in efficiency among similar facilities as earlier discussed in literature.

Health centers located in Butere and Kakamega central sub-counties has efficiency score of one or close to one (Eshimukoko, Shikunga, Shitsitswi, Mabole). This contrast with those health centers that are located in Lugari and Mumias sub-counties whose score is below or around 50% (Bukaya, Bungasi, Lusheya, Kongoni and Chakalini). This perhaps could be attributed to differences in population density, structure and distance from the nearest health facility. The former sub-counties are densely populated than the later sub-counties (see APPENDIX IV)

Regression analysis shows that an addition of medical personnel to the health centre reduces technical efficiency by 14.34% holding other factors included in the model constant. This finding is in tandem with that of Mwari, (2013) and Kioko, (2000) that associated medical personnel with inefficiency. Medical personnel alone can't function efficiently since they need equipment, drugs and other essential medical supplies in order to provide meaningful health care services. There have been reports of public health facilities in Kenya being chronically undersupplied with drugs and other supplies. This lack of appropriate equipment and supplies leads to underutilization of medical personnel.

The results also associate inefficiency with the number of beds/cots at the health centres. For a unit increase in number of beds/cots, technical efficiency is reduced by 5.43% holding other factors included in the model constant. This may be due to the fact that primary level health facilities predominantly offer ambulatory health care services that don't require beds/cots. Kioko, (2000) study associated bed occupancy rate with hospital efficiency. This was due to usage of inpatient services by hospitals that requires beds.

Finally an additional antenatal care visit to the health centre leads to 11.72% increase in technical efficiency holding other factors included in the model constant. Consumption of antenatal care services is the first step in which an expectant woman starts utilizing maternal child health and family planning services. A woman who attends antenatal care clinic is

likely to subsequently use a health facility for delivery, immunizations and family planning. These services form the bulk of health centres outputs which subsequently determines their efficiency.

5.0 CHAPTER FIVE: CONCLUSIONS, DISCUSSION AND POLICY RECOMMENDATIONS.

Introduction

This chapter presents the summary of the study findings and conclusions on technical efficiency and factors influencing technical efficiency of public health centres in Kakamega County. Thereafter, policy recommendations are made.

5.1. Discussion of the study results

Several health care reforms including cost sharing, decentralization and devolution have been undertaken in the country to ensure proper use of scarce resources and health facilities are efficient. Available evidence however reveals existence of inefficiency in public health sector in Kenya. Due to this, the study considered assessing technical efficiency and factors influencing (in) efficiency in Kakamega County for the years 2013 and 2014.

The study established that public health centres in Kakamega County are operating inefficiently with mean technical efficiency of 87%. Further the study observed that 62% of the facilities are inefficiently operated. The least efficient health centre operates at 15.3% while the most efficient health centre operates at 100%. We conclude that inefficiency still exists among public health centres in Kakamega County and there is still wastage of resources even after devolution. This implies that there exist potential for saving of resources if the public health centres operated efficiently. Such resources can be used to improve quality of health care services provided or to produce more health care services to the population.

Lastly the findings indicate that the number of medical personnel and beds/cots are statistically significant in that they affect efficiency negatively. On the other hand the number of

antenatal care visits affects efficiency positively. However number of children fully immunized and number of family planning visits are statistically insignificant.

5.2. Policy Recommendations

The county government of Kakamega should put in measures that will ensure that health centres operate efficiently. The county government needs to redistribute health care resources from facilities with excess resources to facilities with fewer resources within the county based on assessed needs. For instance the study suggests redistribution of health care workers since health they affect efficiency negatively. In addition employment of health care personnel should be in tandem with equipping health facilities with drugs, supplies and other essential inputs to ensure proper utilization of health care workers.

Due to positive correlation between efficiency and antenatal care visits we recommend the county government to scale up consumption of antenatal care services through public campaigns. This is because antenatal care services are associated with efficiency. Furthermore the 2014 KDHS report indicates that Kakamega County lags behind in utilization of antenatal care services (KNBS and ICF micro, 2015). Expectant women who use antenatal care services are likely to deliver in a health facility, take their children for immunization and be receptive to family planning services. Importantly any health dangers to the mother and/or the baby can be identified and eliminated earlier before complications sets in.

Finally, we recommend excess beds/cots to be redistributed to hospital which specializes in inpatient care. This will reduce or eliminate underutilization of beds/cots in health centres. This is due to the fact health centres specialize in ambulatory outpatient care which does not heavily require beds/cots.

5.3. Areas of further study

The study employed six outputs and three inputs. However, other factors thought to influence efficiency such as medical expenditure and maintenance were not included due to lack of data. Therefore, future studies need to consider these variables. Further, a study is required focusing on the allocative efficiency of public health care centres. A similar study need to be conducted for a longer duration of time as opposed only to two years to cater for time dynamics for both public and private health centres. The study recommends a similar study to be conducted focusing on hospitals within the county. Lastly a comparative study needs to be done on efficiency of public health facilities versus private health facilities in the county.

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APPENDICES

APPENDIX I: Table 4-5: CRS TE, VRS TE and SE of Public Health Centers in Kakamega County for the Year 2013

HEALTH CENTRE	CRSTE	VRSTE	SE	-
Eshimukoko	1.000	1.000	1.00	-
Shikunga	1.000	1.000	1.000	-
Shitsitwsi	1.000	1.000	1.000	-
Shiseso	1.000	1.000	1.000	-
Eshinutsa	1.000	1.000	1.000	-
Eshiabwali	0.117	1.000	0.117	IRS
Matete	1.000	1.000	1.000	-
Shivanga	1.000	1.000	1.000	-
Khalaba	1.000	1.000	1.000	-
Bushiri	1.000	1.000	1.000	-
Kharanda	1.000	1.000	1.000	-
Sivilie	1.000	1.000	1.000	-
Kambiri	0.970	1.000	0.970	DRS
Shamakhubu	1.000	1.000	1.000	-
Shinyalu	0.970	1.000	0.970	DRS
Shikusa	0.907	0.996	0.911	DRS
Elwangale	0.661	0.912	0.725	IRS
Kilingili	0.696	0.898	0.775	DRS
Bukura	0.700	0.897	0.780	DRS
Mumias model	0.883	0.892	0.990	DRS
Lukohe	0.887	0.891	0.995	DRS
Ileho	0.858	0.884	0.970	DRS
Mirere	0.807	0.882	0.915	IRS
Chombeli	0.655	0.835	0.784	DRS
Mabusi	0.622	0.755	0.823	DRS
Eleswero	0.741	0.748	0.992	DRS
Shiraha	0.715	0.718	0.995	DRS
Mabole	0.710	0.708	0.999	DRS
Khwisero	0.618	0.693	0.892	DRS
Lusheya	0.867	0.683	0.983	DRS
Bungasi	0.495	0.620	0.799	DRS
Bukaya	0.595	0.595	1.000	-
Kuvusali	0.423	0.584	0.723	DRS
Kongoni	0.566	0.572	0.990	DRS
Chekalini	0.351	0.373	0.942	DRS
Emalindi	0.119	0.153	0.778	DRS
Mean	**0.776**	**0.841**	**0.912**	

APPENDIX II: Table 4-6 CRS TE, VRS TE and SE of Public Health Centres in Kakamega County for the Year 2014

HEALTH CENTRE	CRSTE	VRSTE	SCALE	
Eshimukoko	0.908	0.932	0.975	IRS
Mabole	0.791	0.791	1.000	-
Lukohe	1.000	1.000	1.000	-
Shikunga	1.000	1.000	1.000	-
Shiraha	0.529	0.548	0.965	IRS
Shitsitswi	1.000	1.000	1.000	-
Kilingili	0.945	1.000	0.945	DRS
Shiseso	1.000	1.000	1.000	-
Elwangale	1.000	1.000	1.000	-
Eshinutsa	0.882	0.984	0.896	IRS
Emalindi	0.176	1.000	0.176	IRS
Khwisero	1.000	1.000	1.000	-
Eshiabwali	0.567	1.000	0.567	IRS
Kongoni	0.652	0.657	0.991	IRS
Mabusi	0.654	0.954	0.686	DRS
Chakalini	0.549	0.549	1.000	-
Matete	0.731	1.000	0.731	DRS
Bukura	0.760	0.779	0.975	DRS
Elswero	1.000	1.000	1.000	-
Chombeli	0.656	0.781	0.841	DRS
Kuvusali	1.000	1.000	1.000	-
Shivanga	1.000	1.000	1.000	-
Khalaba	1.000	1.000	1.000	-
Mirere	0.819	0.819	1.000	-
Lusheya	0.872	0.886	0.984	IRS
Bukaya	1.000	1.000	1.000	-
Mumias model	0.938	0.987	0.95	DRS
Bungasi	0.755	0.770	0.981	IRS
Bushiri	1.000	1.000	1.000	-
Kharanda	1.000	1.000	1.000	-
Sivilie	1.000	1.000	1.000	-
Ileho	0.872	0.889	0.982	DRS
Kambiri	1.000	1.000	1.000	-
Shamakhubu	0.777	0.786	0.989	DRS
Shikusa	0.586	0.591	0.991	DRS
Shinyalu	0.525	0.649	0.808	DRS
Mean	**0.831**	**0.899**	**0.929**	

APPENDIX III :Table Showing VIF Test for Multicollinearity

Variable	VIF	1/VIF
Total number of outpatient visits	**17.60***	**0.06**
Number of at least four antenatal visits	**14.14***	**0.07**
Medical personnel	**11.36***	**0.09**
Total number of family planning visits	9.50	0.11
Number of children fully Immunized	7.77	0.13
Total number of deliveries	6.48	0.15
Total number of beds/cots	2.00	0.500
Mean Variable inflationary factor	9.84	

*Confirms Multicollinearity

APPENDIX IV: Map of Kakamega County
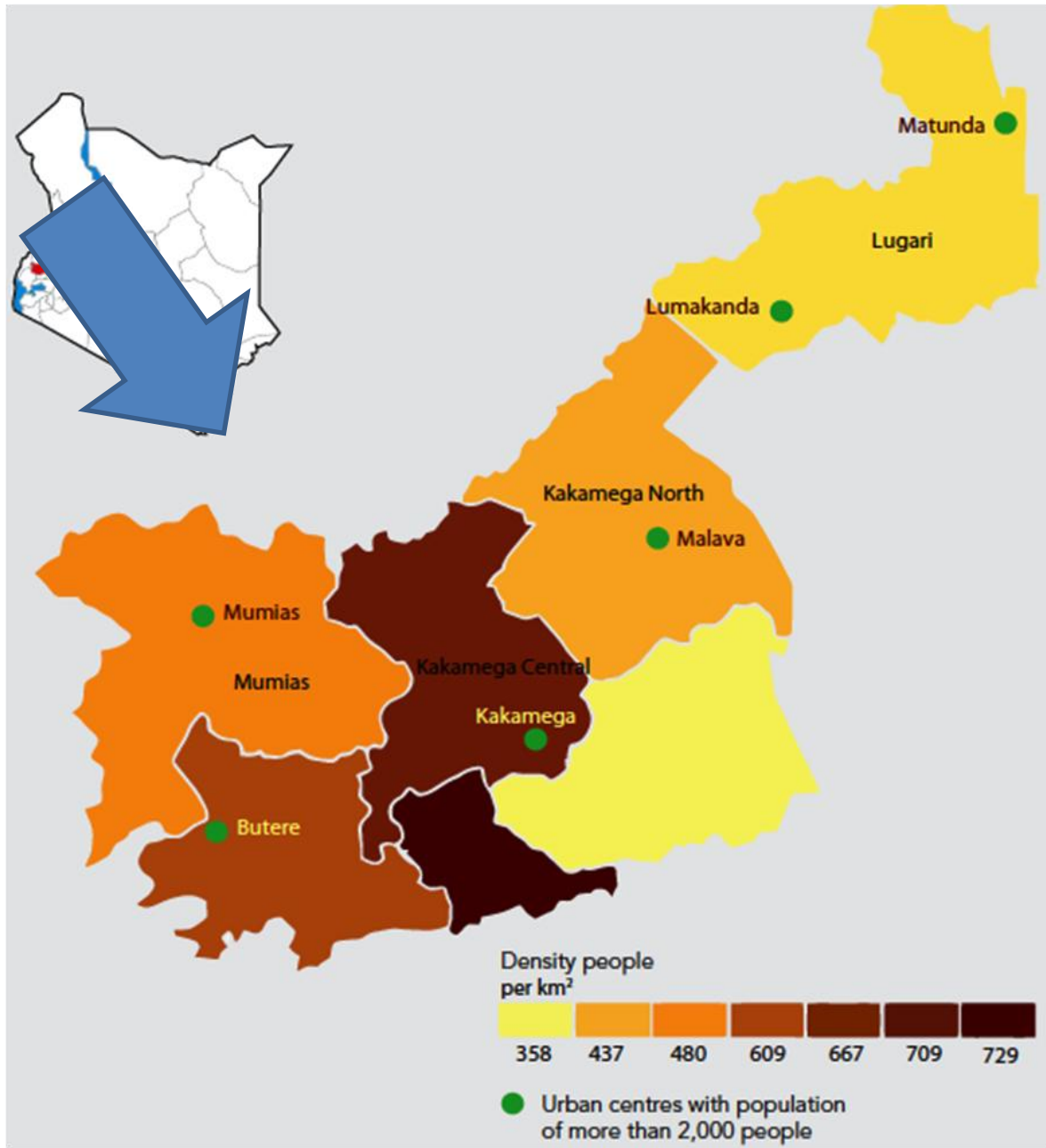
Source: *Kenya National Bureau of Statistics(KNBS) and Society for Internal Development (SID)(2013):* Exploring Kenyas Inequality, Pulling Apart or Pulling Together.