TECHNICAL EFFICIENCY AT PUBLIC HEALTH DISPENSARIES IN KENYA:

A CASE STUDY OF THE IMENTI-SOUTH SUB-COUNTY

ERIC BUNDI

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Declaration

This research paper is my original work and has not been presented for an award in any other university

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

Eric Bundi

X53/73148/2014

This research paper has been presented for examination with my approval as University Supervisor

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

Prof. Germano Mwabu

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Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
BoM	Board of Management
CHAK	Christian Health Association of Kenya
CMS	Company Medical service
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DHS	Demographic and health Survey
DMU	Decision Making Units
HIV	Human Immunodeficiency Virus
KECC	Kenya Episcopal Conference- Catholic secretariat
MDGs	Millennium Development Goals
MoH	Ministry of Health
MoD&P	Ministry of Development and Planning
SARAM	Service Availability and Readiness Assessment Mapping
SDGs	Sustainable Development Goals
VRS	Variable Returns to Scale
WHO	World Health Organisation

ABSTRACT

Back ground

The Imenti sub-County in Meru County inherited a large health system infrastructure from the Central Government but the performance of this system remains unknown. Meru is a rapidly growing county in terms of population, which is projected to reach 1.6 million in 2016. The demand for medical services is also growing. This study had the following objectives: to determine the level of technical efficiency in public health dispensaries in Imenti sub-county; to estimate the input reductions and output increases needed to make any inefficient public dispensaries efficient; to determine the factors influencing the level of efficiency of dispensaries in the study area; and to make recommendations to the County Government.

Methods

The two stage Data Envelopment Analysis (DEA) method was used to estimate efficiency levels and the OLS and Tobit methods were used to explain variation in the efficiencies. The data on output variables were obtained from the County health records, while the information on inputs was collected from the universe of the sub-county dispensaries.

Results and conclusion

Forty-one percent of the dispensaries were found to be inefficient, with the average for variable returns to scale efficiency being 70 percent. The means for constant and scale efficiencies were 55% and 80%, respectively. The factors influencing variation in efficiencies include gender of the head nurse, education of the head of the management board, and size of the dispensary. The study concludes that the county health policy makers together with dispensary management boards can increase the volume of health service delivered by dispensaries by up to 38 percent by implementing efficiency improving measures without increasing staff or health infrastructure.

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CHAPTER ONE

1.0 Introduction

Kenya is an east African country covering an area of 582,646 sq km and bordering Ethiopia in the north, Uganda to the west, South Sudan to the northwest, United Republic of Tanzania to the South, Somalia to the Northeast and Indian Ocean to the Southeast. Due to its strategic location of the port of Mombasa, Kenya plays out to be the region's economic and transport hub (SARAM 2013). According to the 2009 national census Kenya had a population of 38,610,097 and 44,354,000 in 2013 (WHO 2015) with the population growing at 2.97% and life expectancy of 63.3 years (UNDP 2013). The Kenyan landscape is endowed with diverse physical features; lowlands and highlands, lakes and rivers and the Great Rift Valley that determines the climate, economic and social activities, type of foods available as well as the type and pattern of diseases especially tropical diseases (WHO web site). In the new Constitution Kenya was divided into 47 counties and thus devolved most of the national government functions which included provision of health services (Republic of Kenya, 2010). The Kenyan economic growth in 2012 was 4.6%, up from 4.4% in 2011 (KIPPRA 2013). Though the goal of having every Kenyan being able to read and write has not been achieved yet, the literacy level in 2013 was at 87% among persons aged above 15 years (WHO 2015). Between 1990 and 2013 life expectancy in Kenya increased from 60 to 61 (WHO 2015). The improvement can be attributed to better economic and health system performances.

Since independence the public health system has been managed solely by the ministry of health at the national level. After the elections of 2007 there was, for the first time, a coalition government that led to the ministry of health being split into two (ministry of medical services and ministry of health services and sanitation) each headed by an independent cabinet secretary. Currently, the country is being governed under the new constitution that devolved much of the health functions to counties. The National Government provides leadership in health policy development, manages national referral health facilities, helps in capacity building and technical assistance to the counties. The County Governments are responsible for county health services which include health facilities, pharmacies, ambulatory services, promotion of primary

healthcare, licensing and control of sales of food to public, cemeteries, funeral parlours and crematoria, and waste management (KPMG 2014, MoH 2014).

1.1 Health system

Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO 1948). On the other hand, the health system includes all activities whose primary purpose is to promote, restore or maintain individual's physical, mental and social well-being (WHO, 2000)**.** The health system in Kenya is hierarchical in nature that begins with primary healthcare, the lowest unit being the community -- that handles mainly self limiting cases, with the complicated cases being referred to higher levels of healthcare system. The current structure consists of six levels as follows; level 1: community (villages, households , families, individuals) which contributes to health through promotive and preventive health services (KSPA 2004); level 2: dispensaries and clinics; this level provides the link between the community based health care and the formal health system; level 3: health centres, maternities, nursing homes; level 4: primary referral facilities; level 5: secondary referral facilities; and level 6: tertiary referral facilities (Kenyatta national hospital and Moi teaching and referral hospital). The six levels are planned to be revised to four, namely, community, primary health care facilities, county hospitals and national referral hospitals (MOH 2014).

Successive administrations in Kenya have taken measures to improve health sector in terms of infrastructure (building new and expanding existing facilities) sourcing of funding for specific diseases or health programmes e.g. HIV/AIDS, malaria, polio etc. The current government's policy of providing free maternal care is a step towards achieving millennium development goal of reducing child mortality (MDG 4) and improving maternal health (MDG 5). In the financial year 2013/2014 the government of Kenya allocated Ksh 34.7bn for preventive and curative health services (Dorah and Nesoba 2013). The allocation to health has grown over the years since independence; however, Kenya has not attained the Abuja target of allocating 15% of the government budget to health. According to the World Health Statistics 2015, Kenya is lagging behind the Abuja target. The African Region average is 11.4%, the global average is 11.4% while the (Kenyan one is 5.9%.(see Table 1). Kenya has low per capita spending in relation to the region and the world at large (Table 2).

Almost half of Kenya's total health expenditure is taken care of by the external sources which are far much higher than the regional average of 11.5%. The private sector on the other hand contributes 59% to total health expenditure in Kenya which is10% higher than the regional average and 17% higher than the global average. Out of pocket expenditure in the year 2012 was high at 76% compared to region and global average of 60% and 52% respectively. Kenya is not generally doing very well in achieving the health related MDGs, in relation to the set target for 2015 though it has achieved the target for having the measles immunization to children under one year old (WHO 2015), table 6. Some of the challenges facing the country's health system is the shortage of skilled personnel and medical supplies (medication and other consumables) (complicated by rampant industrial unrests by health workers). Devolution implementation problems have also affected the pace of achieving the health related MDGs. Thus, there is need to ensure that all resources allocated to health care are utilized efficiently. To deal with the inefficiencies and inequalities in the health sector, the government over the years has undertaken various reforms that include, expansion of preventive health services and family planning services; harmonization and decentralization of healthcare delivery system; introduction of medical insurance scheme; selective integration of traditional and modern medicine; and introduction of user-fee charges in government run health facilities (Mwabu, 1995). In addition there is much being done by international donors towards specific programs NASCOP diseases like HIV/AIDS. Introduction of user fees in public facilities, contributed to a fall in the utilisation of inpatient and outpatient services (Mwabu et al, 1995 and 1997).

Kenyan constitution gives every person right to access health services including reproductive health care and emergency services, education, right to be free from hunger, right to clean safe water among other rights (constitution of Kenya 2010). Despite the rights in the Kenyan constitution, inequity is evident in the Kenyan health system and other related areas (WHO 2015) table 4.

Table 1: Health expenditure ratios for Kenya 2012

Health expenditure Ratios	Kenya	African Region	Global
Total expenditure on health as % of GDP	4.5	5.6	8.6
Govt exp on health as % of total exp on health	40.9	50.8	57.6
Private expenditure on health as % of total expenditure on health	59.1	49.2	42.3
Govt exp on health as % of total Govt exp (Abuja target)	5.9	11.4	14.1
External resources for health as % of total expenditure on health	48.5	11.5	0.5
Social security expenditure on health as % of general government expenditure on health care	13.1	9.6	59.3
Out-of-pocket expenditure as % of private expenditure on health	76.1	60.6	52.6
Private prepaid plans as % of private expenditure on health	9.3	29.3	36.2

Source: World Health Statistics 2015.

Table 2. Per capita health expenditure for Kenya, 2012

Ratios	Kenya	African region	Global
Per capita total expenditure on health at average exchange rate (US$)	42	105	1025
Per capita government expenditure on health at average exchange rate (US$)	17	53	615

Source: World Health Statistics 2015.

Table 3. Life expectancy 2013

At birth			
	Kenya	**African Region**	**Global**
Both sexes	61	58	71
Male	60	57	68
Female	63	60	73
Age > 60 years			
	Kenya	African region	Global
Both sexes	18	17	20
Male	17	16	19
Female	18	17	22

Source: World Health Statistics 2015.

Table 4 Health Inequities DHS 2008-2009

Indicators	**Sex**		**Residence**		**Wealth quintile**		**Education level of woman**	
	Male	Female	Rural	Urban	lowest	highest	none	Secondary & higher
Contraceptive prevalence modern methods (%)			37	47	17	48	12	52
Antenatal care coverage: at least 4 visits (%)			44	60	36	63	35	64
Birth attended by skilled health personnel (%)			37	75	20	81	19	72
DTP3 immunization average among 1year olds	83	90	86	88	78	90	82	92
Children under five who are stunted (%)	37	33	37	27	44	25	39	25
Under five mortality rate (per 1000 live births)	90	77	85	75	97	69	86	58

Source: World Health Statistics 2015.

Table 5: Mortality Rates 2013

Health Indicators		**Kenya**	**African region**	**Global**
Neonatal mortality rate (per 1000 live births)		26.3	30.5	20.0
MDG 4	Infant mortality rate	47.5	59.9	33.6
	Under five mortality rate	70.7	90.1	45.6
Adult mortality	Male	299	332	182
	Female	250	281	121
Maternal mortality ratio		400	500	210

Source: World Health Statistics 2015.

Table 6 Progress in achieving the MDGs against 2015 targets

MDG	**Target**	**Kenya**	**Africa**	**Global**
Under 5 mortality reduction 1990-2013(%)	67	28	49	49
% Measles immunisation coverage among 1yr olds 1990-2013	90	93	74	84
% reduction of maternal mortality ratio 1990-2013	75	18	49	45
% of births attended by skilled health worker 2007-2014	90	44	51	74
% antenatal coverage at least 1 visit 2007-2014	100	92	77	83
% Unmet need for family planning 2012	0	26	24	12

Source: World Health Statistics 2015.

1.2 The Meru County

Meru County lies within the central part of the former eastern province. Being located on the slopes of Mount Kenya and along the Equator has significantly influenced the county's natural conditions. There are several rivers that originate from the catchment areas within Mount Kenya and Nyambene ranges and have a very high influence on the agricultural activities that drive most of the county's economy (Republic of Kenya2013). The most dominant is livestock keeping and farming that includes cash crops like coffee, tea and the controversial stimulant Khat (Miraa). Food crops are in plenty and especially bananas are gaining popularity as income earner to the small farmers. The County is made up of eight administrative sub-counties and nine parliamentary constituencies. The population as per 2009 census was 1,356,301 which is approximately 3.5% of the Kenyan population with a population growth rate in 2012 estimated at 2.1% (KNBS 2013). This population is projected to be slightly above 1.53 million persons by end of 2015 and 1.6 million by 2017 (KNBS 2013). Meru County has 462 health facilities of which 31% are health dispensaries and 20% of these dispensaries are public health dispensaries. About 56% of public health dispensaries in Meru County are in Imenti South sub-county (MoH web site 2015).

The county boosts of 98% coverage for immunisation of children below the age of 5 with all the vital vaccines. This has resulted in the reduction of the mortality rate of children below five years by 26% between year 2000 and 2012. However, the county is faced with the challenge of HIV/AIDS with its prevalence at 6.3% and that of malaria standing at 15% (MCDP 2013).

Table 7. Dispensaries in Meru County as per ownership

Sub county	MoH	Faith based	NGO owned	Private	CHAK	KECC	C M S
Buuri	11			2	1	3	1
Igembe south	10				1	3	
Igembe central	12				2	2	
Igembe north	2						
Meru central	5				5	2	
Imenti south	17				10	3	
Imenti north	13	1	1	1	2	5	
Tigania east	13						
Tigania west	15	1					

Source: Ministry of Health (ehealth-Kenya facilities) 2015.

1.3 Research Questions

It is imperative to note that the government of Kenya has continually been setting goals to improve health since independence. This has been evidenced by the numerous programmes in each government regime to improve health. Programs that are specific to diseases (HIV/AIDS, malaria), target vulnerable groups (children under five, pregnant mothers, drug users). Kenya MoH has a vision to support "an efficient and high quality health care system that is accessible, equitable, and affordable for every Kenyan" (IHME 2014). The Kenyan constitution on the other hand grants every person a right to the highest standard of health, which includes right to health care services, (constitution of Kenya 2010). In line to these rights the Kenyan government has a number of parallel programs running to promote health in various capacities e.g. Free deliveries and subsidised maternal health care in all public facilities, beyond zero campaign initiated by the first lady of the republic of Kenya Margaret Kenyatta. Despite all these efforts Kenya is far from achieving the target for MDGs in particular health related goals, under five mortality rate in 2013 was 70.7 against a target of 32 in 2015, infant mortality rate at 47.7 in 2013 and the target is 22,

maternal mortality ratio of 400 2013 against a target of 147 in 2015 births attended by a trained health worker was at 44% in 2014 and the target 90%.(WHO 2015). Health financing is also another impediment facing the government in terms of providing the best health care. In addition to not meeting the Abuja declaration target of 15% of total government budget being allocated to health, Kenya's government per capita spending of US$ 17 is way below the regional per capita spending by governments of US$ 53 (WHO 2015).

There is dire need for efficient use of all the scarce health system resources. Kirigia *et al* 2002 study of public hospitals revealed that 26% of the facilities were inefficient. Kirigia *et al* 2004 study of the public health centres revealed that 56% of the facilities were inefficient. To date no study as attempted to investigate the technical efficiency of the public health dispensaries in the new counties. Kioko in a study commissioned by World Bank in 2013 came closer but was not dedicated to the public dispensaries but Kenya health sector. This study will attempt to answer the following questions:

1. Are the public health dispensaries producing maximum outputs with the available inputs?
2. Are the public health dispensaries operating at an optimal scale?

1.4 Study Objectives

The aim of the study is to generate evidence on economic efficiency of public health dispensaries in Meru sub-County. The specific objectives are;

a. To determine the level of technical and scale efficiencies in public health dispensaries in Imenti sub-county, Meru County.

b. To estimate the input reductions and output increases needed to make any inefficient public health dispensaries efficient.

c. To make recommendations for policy action.

1.5 Justification of the study

We cannot over-emphasis the need for efficient use of already scarce resources in the public health sector (WHO 2000). In the Kenyan health system, health dispensary is the first formal contact between the patients and the health system. Thus the study will contribute towards providing information on the efficiency level in the public health dispensaries in the county. The efficiency score will constitute a baseline against which the county government can scrutinize the efficiency trends overtime and the effects of future health sector reforms. The methodology used in this study can be applied by to carry out similar studies in other counties in the country and also in designing ways to improve and monitor dispensary performance levels as well in determining the likely savings from their improvements.

CHAPTER TWO

2.0 Literature Review

2.1 Overview of the Literature

The literature on the production and cost functions has provided insight into the various variables that influence production and cost of health services. Most of the studies used variables that are consistent with economic theory, and hence, they have been useful in deciding the variables to be used in these studies. It should be noted that in the theory of production, physical amounts of factor inputs are used in the production functions. Nevertheless, because of problems of measuring the physical amount of inputs, especially with respect to capital, some of the reviewed studies used cost value for the amount of inputs. For instance (Schmidt and Lovell, 1979) used actual cost of plant to measure capital input, while (Zere, 2000) used recurrent expenditure as a proxy for quantities of inputs in hospitals.

It is evident that the approaches that are currently being used in the estimation of frontiers are broadly classified as parametric and non-parametric. The parametric approach consists of the deterministic and stochastic frontier models, while non-parametric approach is dominated by the data envelopment analysis (DEA). Besides, there is evidence that both approaches seem to converge on the level of average efficiency, but diverge on scoring individual producers. Ferrier and Lovell (1990) recommended that both approaches be applied to the same set of data on the basis of the strengths and weaknesses of the two approaches, to improve the reliability of the results of efficiency analysis. In the estimation of the econometric model, both ordinary least squares and maximum likelihood methods have been used. This notwithstanding, the estimates from maximum likelihood method have been noted to be more efficient (Schmidt and Lovell, 1979; Janet and Ronald, 1993; Dennis 1993)

2.2 Efficiency measurement in the Healthcare system

Efficiency refers to the degree to which a health decision making unit (DMU) uses the available health resources (human resource, health facilities, equipments) to produce the maximum health related outputs (number of patients treated, number of children immunized) and outcomes (number of life years gained, quality of a given quality) (Kirigia et al 2004) . There are three main measures of efficiency to meet the needs of researchers, healthcare managers and policy makers (Culyer, 1992). Firstly, technical efficiency refers to the use of productive resources in the most technologically capable manner. Also technical efficiency implies the maximum possible output from a given set of inputs. Within the context of healthcare services, technical efficiency may then refer to the physical relationship between the resources used (say, capital, labor and equipment) and some health outputs (number of patients treated, patient-days, etc.) or outcomes (lower mortality rates, longer life expectancy, etc.) (Palmer and Torgenson 1999).

Secondly, allocative efficiency refers to the ability of an organisation to use its inputs in optimal proportions, given their respective prices and the available production technology. In other words allocative efficiency is concerned with choosing between the different technically efficient combinations of inputs used to produce the maximum possible outputs. "Palmer and Torgenson (1999) illustrate healthcare-related allocative efficiency as for example, a policy of changing from maternal age screening to biochemical screening for Down's syndrome. Biochemical screening uses fewer amniocenteses but it requires the use of another resource – biochemical testing. Since different combinations of inputs are being used, the choice between interventions is based on the relative costs of these different inputs."

When taken together allocative efficiency and technical efficiency determine the degree of productive efficiency (also identified as total economic efficiency). Thus, if a healthcare organisation uses its resources wholly allocatively and technically efficient, then it can be said to have achieved total economic efficiency. Alternatively, to the extent that either allocative or technical inefficiency is present, then the organisation will be operating at less than total economic efficiency.

In the production of health care, health facilities should act efficiently in terms of using their inputs to obtain maximum output. In most economies, efficiency in one year affects the budget of health facillities in the following year. Dispensaries produce multiple outputs using multiple

inputs, and for this reason the study will use Data Envelopment Analysis (DEA) to estimate their efficiency.

2.3 Data Envelopment Analysis (DEA)

DEA is a technique originally described by Farrell (1957) and later developed as a benchmarking technique by Charnes, Cooper and Rhodes (1978) initially to evaluate non-profit and public sector organisations. The objective of the DEA is to measure performance of each producer relative to the best practice in the sample of producers concerned. The initial task is to determine which of the set of producers, as represented by observed data, form an empirical production function or envelopment surface. The producers that lie on the empirical production frontier or surface are deemed efficient, otherwise inefficient (Ali and Seiford, 1993). There are two types of envelopment surfaces in DEA referred to as constant returns to scale (CRS) and variable returns to scale (VRS). The appropriateness of either CRS or VRS is determined by economic and other assumptions about the data to be analysed (Ali and Seiford, 1993). In the CRS, increase in all factors of production by a certain proportion would result in the increase in output by the same proportion. However, in the VRS, output changes more or less proportionately than the changes in all inputs.

DEA has the ability of: 1. Comparing service units taking into account all resources used and services provided, indentifying the most efficient and inefficient units. 2. Calculates the level of adjustments required to make the inefficient units as efficient as the benchmark, also estimates the amount of additional service that can be provided by an inefficient unit without need for additional resources. 3. Helps inform DMU on what quantities of inputs can be transferred from the inefficient units to improve their efficiency. However, DEA has a limitation that it is likely to overestimate the inefficiencies since it does not decompose the error term into inefficiency and statistical noise and data measurement errors (Forsund 1980). Nevertheless DEA has a number of advantages implicit in this mathematical programming approach that makes it attractive on a theoretical level. Given its nonparametric basis, substantial freedom is given on the specification of inputs and outputs, the formulation of the production correspondence relating inputs to outputs, and so on. Thus, in cases where the usual axioms of production activity breakdown, then the programming approach may offer useful insights into the efficiency of these types of industries.

Similarly, it is entirely possible that the types of data necessary for the statistical approaches are neither available nor desirable, and therefore the imposition of as few as possible restrictions on the data is likely to be most attractive. Simulation studies have also indicated that the piecewise linear production frontier formulated by DEA is generally more flexible in approximating the true production frontier than even the most flexible parametric functional form (Worthington, 2004).

If a DMU has a single input and a single output technical efficiency (*TE*) is basically defined as:

TE = Output / Input

Conversely, in more practical scenario dispensaries have multiple inputs (health workforce, medicines, non-medical supplies, capital inputs) and outputs (preventive, curative, rehabilitative services) and the equation is modified to accommodate this reality. Thus Technical efficiency (*TE*) of a DMU (a dispensary) can be expressed as a maximum ratio of total sum of weighted outputs to total sum of weighted inputs (Charnes, Cooper and Rhodes, 1978).

$$Efficiency = \left(\frac{Weighted\ sum\ of\ dispensary\ \ outputs}{weighted\ sum\ of\ dispensary\ \ inputs}\right)$$

According to Charnes *et al*, efficiency of a target dispensary from the set "j" can then be obtained by solving the following fractional programming model:

$$maxTE = \left(\frac{\sum_{r=1}^{s} u_r\ y_{r0}}{\sum_{i=1}^{m} v_i\ x_{i0}}\right)$$

Subject to: $\left(\frac{\Sigma_{r=1}^{s} u_r y_{rj}}{\Sigma_{i=1}^{m} v_i x_{ij}}\right) \leq 1$

$\mu_i \geq 0$; i = 1.....m
$v_r \geq 0$; r = 1.....s

where: Y_{rj} is the amount of health service output r (r = 1,…, s) from dispensary j; X_{ij} is the amount of health system input i (i = 1,…, m) in j^{th} dispensary; u_r is the weight given to health service output r; v_i is a weight given to health system input i; and n is the number of dispensaries in the sample.

2.4 Empirical Literature

Osei *et al.* (2005) estimated technical efficiency of public district hospitals and health centres in Ghana. The output variables used were maternal and child health care visits, deliveries, and inpatient discharges, while inputs consisted of doctors, dentists, subordinate and beds. The study utilized data for the year 2000, with a sample of 17 hospitals and 17 health centres. The DEA (VRS) method was applied in the estimation, with results showing that 9 (53%) of the hospitals were technically efficient, with a relative technical efficiency (TE) score of 100%. The remaining 8 (47%) had a TE score of less than 100%, hence they were technically inefficient. On the other hand, 14 (82%) of the health centres had TE of 100%, while 3 (18%) were technically inefficient. The major limitation of the study is that it excluded drugs, which are an important input in provision health care services. The authors acknowledge this fact, attributing it to lack of data.

A public community health hospitals in 2007 conducted by Kirigia and Asbu (2013), employed DEA to estimate the technical efficiency in Eritrea. It would be more statistically viable to use man hours spent by the health workers and equipments machine hours as the input but for this study, these inputs used were number of physicians, nurses and midwives, laboratory technicians and operational beds and cots. The outputs included number of outpatient visits and inpatient discharges. The choice of these variables was due to the fact that past studies used the same, it is what was available in the ministry's annual service activity report. The researchers also wanted to demonstrate to the ministry that the data they had was useful to inform policy. In this study the technical and scale efficiency scores were computed using DEAP 2.1 programme that was developed by Professor Tim Coelli. A regression of the efficiency score was also carried out to establish the effect of the external factors to hospital efficiency. Initially the sample for this study was 19 after having one hospitals report missing. Out of this 42% were constant to scale technically efficient at 100% and 58% fell between 91% and 17.2%. 68% of the hospitals were

variable returns to scale technically efficient at 100% and 32% fell between 91% and 74.1%. Hospitals that were scale efficient were 42% and 58% scored between 99% and 31%. The policy makers are able to use the findings from this study to achieve the strategy to increase coverage of health services and reducing hospital inputs.

In a study involving 155 primary healthcare clinics of Kwazulu-natal province in SouthAfrica conducted by Kirigia, Sambo and Scheel DEA was employed to measure the technical and scale efficiency of the clinics. They used two inputs that are number of nurses and number of general staff. The outputs included, antenatal care visits, number of deliveries/births, number of child health care visits, number of dental care visits, number of family planning visits, number of psychiatry visits, number of sexually transmitted diseases related care visits and number of tuberculosis related care visits. The study utilised data for the period March 1995 to April 1996 from the 155 clinics. According to this study 30% of the clinics were technically efficient with efficiency score of one, 16% had scale efficiency of 100%. Out of the 70% inefficient clinics 16% had a score below 50%. . The study had about four limitations that included the lack to use inputs like pharmaceutical and non pharmaceutical supplies buildings and others in the analysis, the study scores were not for total efficiency since the allocative efficiency was not captured, the study did not calculate total factor productivity change and technological change since the data used was for only one year, the study used proxy outcome measures.

Marschall and flessa in sort to find out the efficiency of primary care in Burkina Faso and there method of analysis was DEA (Marschall and Flessa 2011). The objective of the study was to estimate the relative efficiency of primary care facilities and also analysis the factors influencing the efficiency. This study utilised 4 inputs 1) Personnel cost, 2) Facility building area m^2, 3) Depreciation of the equipments, and 4) Vaccination costs. The side of output also had 4 measures 1) General consultation and nursing care, 2) Deliveries, 3) Immunisation, 4) special services like family planning, prenatal and postnatal consultations. Due to missing data on vaccination in some facilities, the results were divided into two (scores with the vaccination and scores without). With 3 inputs 3 outputs consideration 9 (36%) of the facilities were efficient with a score of 1 and with vaccination included 11 (44%) of the facilities were efficient.

Luis G Sambo *et al*, (2011) studied TE of primary health units in Sierra Leone (Kailahun and Kenema districts) with the objectives of estimating the technical efficiency, estimate the output

increases needed to make the inefficient efficient and explore the strategies for rising the Technical efficiency of the facilities. The primary health units studied were three namely, community health centres (CHC), community health posts (CHPs), maternal and child health posts (MCHPs). The variables utilised in this study included three outputs; number of outpatient visits, maternal, child health and family planning visits and third immunisation visits: two inputs were the number of community health officers plus state enrolled community nurses and number of support stuff (cleaners, drivers, gardeners, watchmen and others). From the two districts selected, the study constituted of 6.9% of MCHPs, 12.4%of CHCs and 11.9% of CHPs in the entire country It was realised that the MCHPs had a constant returns to scale technical efficiency (CRSTE) of 42.7% on average with a standard deviation (SD) of 43.6. CHCs on average manifested a CRSTE of 62% with SD of 32.7. lastly but not least CHPs scored 57% CRSTE, 59% VRSTE and 95.5% scale efficiency with a standard deviation of 35.8,34.7 and 9.4 respectively.

In a study to estimate the technical, allocative and cost efficiency of health centres in Zambia, Masiye *et al*, 2006 utilised DEA. The study found out that about 83% of the studied health centres were technically inefficient with 88% of these being allocatively and cost inefficient. Of importance to note is that privately owned health centres were found to be more efficient than public centrres. The sample comprised of 3.7% of the facilities in the country and of these 58% was state owned and 42% were private for profit. 77% of the private facilities were allocatively inefficient though none scored below 0.50. 96% of the public health centres were allocatively inefficient with 59% scoring below 0.50. allocative efficiency score ranged from 0.56 to 0,97 for private and 0.27 to 0.98 for government. On the other hand 77% of privately owned facilities were cost inefficient with 62% scoring blow 0.50, 96 % of the public owned centres were cost inefficient and 91% of them scored below 0.50. Cost efficiency score ranged between 0.11 to 0.75 and 0.12 to 0.89 for private and government respectively.

In a study to estimate the technical efficiency of public health centres in Kenya, Kirigia et al 2004 found 44% of the public health centres to be inefficient. The study had four objectives that includes ; to determine the degree of technical efficiency of individual primary health cae facilities in Kenya; to recommend the performance targets for inefficient facilities; to estimate the magnitude of excess inputs; and to recommend what should be done with those excess inputs. During the time of the study, there were approximately 350 public health centres and the selected

sample had 32 health centers' that translated to 9.1% of the facilities. 11 inputs were merged to form 6 inputs and 10 outputs were merged to come to a total of 4. 56% of the facilities were technically inefficient with 2 of them scoring below 50%, 9 (28%) scoring between 51% and 74%, 6 (19%) of the centres between 75 and 99%. This translated to an average score of 65% with a standard deviation of 22%. This meant that on average they could reduce their utilisation of all inputs by approximately 35% without reducing output. In terms of scale efficiency 19 (59%) of the 32 centres analysed were efficient thus 41% were inefficient. Of the inefficient facilities 4(13%) scored below 50%, 3 (9%) scored between 51and 75% 6 (19%) score lay between 76 and 99%. On average the inefficient facilities scored 70% with a standard deviation of 19%. This meant that outputs could be increased by 30% using the existing capacity.

Kioko (2013) in a study commissioned by World Bank in 2013 noted substantial inefficiencies in the Kenyan health facilities. The study used data from dynamic Costing Model and Ministry of Health Information system between March and June 2013. The inputs and outputs varied according to the level of facility in question. The facilities were categorised into hospitals, health centres and dispensaries. To enable peers grouping the analysis was done separately and utilized DEA to measure technical efficiency and scale efficiency. For the dispensaries in particular, the study had a sample of 38 public dispensaries and to estimate the efficiency the study used equal number of outputs and inputs. Inputs, 1) total expenditure; 2) number of nurses and clinical staff; 3) number of administrators. 21% of the dispensaries were technically efficient with a score of 100%, 9% had an efficiency score that ranged from 21-30%. Under CRS 79% of the dispensaries were technically inefficient and 29% had an efficiency score of 100% under VRS. More analysis revealed that 47% of the dispensaries were operating on decreasing return to scale while 8% operated on increasing return to scale.

CHAPTER THREE

3.0 Methodology

3.1 Conceptual framework

In the production process, a dispensary turns inputs (factors of production) into outputs (health services). The dispensaries use multiple inputs to produce multiple outputs and this was the reason why the Data envelopment analysis (DEA) was used. The interaction between inputs, process and outputs during production is as shown in the figure below

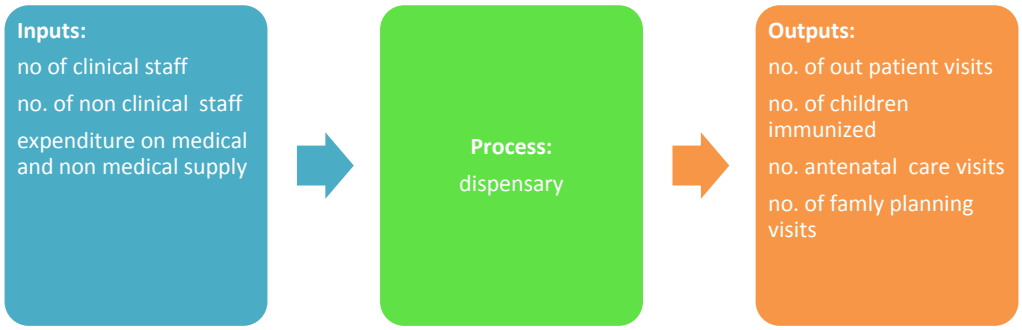

Figure 1. Relationship between health inputs, process and outputs.

The basic concept underlying efficiency is that there needs to be inputs (resources) that are processed to yield desired outputs (products) and the resources are scarce. This means that the output will be limited. Efficiency is measured in two basic ways; Allocative efficiency, meaning how various inputs are combined to produce a certain output. Technical efficiency, means achieving maximum outputs at the least cost. The combined effect of allocative and technical efficiency measures the overall efficiency (Coelli TJ 1996). Technical efficiency will be between 1 and 0 compared to peer dispensaries. Technical efficiency can be determined by using minimum amount of resources to produce a given amount of output or producing maximum

amount of output from a given amount of inputs. Thus if more than necessary is used to produce a certain amount of output or the output produced from a given quantity of resource is less than expected, then in the two cases the system is inefficient. (Charnes A *et al,* 1994). This implies that inefficiency is the degree of how many unnecessary resources have been spent in a given process. Using DEA enable comparison of DMU efficiency against realistic benchmarks and on the other hand compare against peers.

3.2 First stage model specification

According to Charnes *et al* 1978, technical efficiency (TE) of a target DMUs is the maximum ratio of weighted outputs to weighted inputs subject to the condition that similar ratios for individual units (dispensary) be less than or equal to one. This is obtained by solving the following fractional programming model:

$$maxTE = \left(\frac{\sum_{r=1}^{s} u_r y_{r0}}{\sum_{i=1}^{m} v_i x_{i0}}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Subject to: $\left(\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}}\right) \leq 1$

$\mu_i \geq 0$; i = 1.....m
$v_r \geq 0$; r = 1.....s

where: Y_{rj} is the amount of health service output r (r = 1,…, s) from dispensary j; X_{ij} is the amount of health system input i (i = 1,…, m)in j^{th} dispensary; u_r is the weight given to health service output r; v_i is a weight given to health system input i; and n is the number of dispensaries in the sample.

Charnes *et al* 1978 converted model (1) into the following constant returns to scale (CRS) linear programming model:

$$Max\ E_0 = \sum u_r y_{rj0} \text{ .....(2)}$$

$$subject\ to: \sum_{r=1}^{s} v_i x_{ij0} = 1$$

$$\sum_{i=1}^{m} u_r y_{rj} - \sum v_i x_{ij} \le 0,\ j = 1,...,N.$$

The latter constraint means that all DMU's are either on or below the frontier. Model (2) implies that if a dispensary increases the amount of all health system inputs by the same proportion, outputs will increase by exactly the same proportion as the inputs, e.g. doubling of all inputs lead to a doubling of outputs. This CRS model assumes that DMUs' are operating at an optimal scale of production, and hence, technical efficiency is equal to scale efficiency.

However, in reality a dispensary could manifest constant returns to scale (CRS), increasing returns to scale (IRS) or decreasing returns to scale (DRS). In an IRS (or economies of scale) scenario, if a dispensary increases the amount of all health service inputs by the same proportion output will increase by a larger proportion than each of the inputs, e.g. a doubling of all inputs will lead to more than a doubling of outputs. In case a dispensary is experiencing DRS (or diseconomies of scale) a doubling of all inputs would lead to less than doubling of output. The relative efficiency score (E) lie between 0, which means the DMU is completely technically inefficient, and 1 implying DMU is completely technically efficient.

3.3 Second stage model specification

There are environmental and institutional factors that could be beyond the management control but they influence the efficiency score in one way or another. To find out how these factors impact on the efficiency score a regression will be performed. However, due to the nature of the efficiency score (0-1) the ordinary least squires (OLS) will yield biased result. The efficiency score is referred to as censored and limited to the interval 0-1 and for this reason a (censored)

Tobit model will be used to analyse the relationship (Hoff A, 2007). This calls for the classical linear regression model to be adjusted accordingly.

$$Y = \beta_0 + \beta_i X_i + \varepsilon \quad \text{..... (4)}$$

Where Y, is the dependent variable explained by a vector of independent variables X_i. The β_i are unknown regression coefficients, β_0 represents a constant and ε is the error term.

$$y_t^* = \beta X_t + \varepsilon_t \quad \text{..... (5)}$$

$$y_t = y_t^* \; if \; y_t^* > 0; \;\; y_t = 0 \; otherwise.$$

y_t^* is the unobserved latent variable and y_t is the DEA score. X_t is a vector of observation specific variables for DMU k that affect its efficiency score through the vector of parameters β to be estimated.

3.4 Sample Selection

The selection of the Meru County was non -probability but the sub-County selected was the one with the largest number of public health dispensaries, that is, 17 (17% of the public dispensaries, 11% of all the dispensaries in county), as per the the Ministry of Health website, 2015. The study selected all the public health dispensaries in the sub-county for analysis.

3.5 Data collection and sources

Data on the facility outputs was collected by the principal researcher centrally from the county information system offices and visited the facilities to collect data on various inputs especially the number of personnel. Health is multidimensional and thus assessing the quality of life of patients is rather subjective (Clewer and Perkins, 1998). Because of this it challenging to measure health improvement with accuracy, thus dispensary output is measured as intermediate health services assumed to improve health services (Grosskopf and Valdmanis,1987).

3.6 Sample Size and Variable Description

Based on (Dyson et al 200)1there are some DEA data guidelines and protocols (at times refered to as rule of thumb) that govern the measurement of technical efficiency using the DEAP 2.1 to ensure errors are minimised. One being getting a balance between the number of variables and the sample size, (Dyson et al 2001) recommends that the sample size be approximately two times the product of the number of inputs and outputs. Going by this rule the variables of antenatal care visits and the family planning visits were combined to form maternal health care visits. This led to having three outputs; general outpatient visits, immunisation visits and maternal health care visits. There were two inputs used in the analysis; number of medical staff and the number of support staff in the dispensaries.

3.7 Data Management and Analysis

The data on the inputs and outputs were entered into excel sheet, organised into a table, and then pasted into a notepad for use by DEAP 2.1 software. The DEAP runs on data organized in a particular format, without data preceding the input data. The instruction file tells the program the file that holds the data and the file to which DEA output will be deposited. The instruction file also tells DEAP the size of the sample as well as whether the efficiency calculation is output oriented or input oriented. It also informs the program whether calculations of efficiency levels are to be done under constant or variable returns to scale assumptions. The scores efficiency scores that were calculated were subsequently analyzed using OLS and Tobit methods.

CHAPTER FOUR

4.0 Results and Discussion

The study involved the entire population of the public dispensaries in the sub county which were 17 in number. Table 8 shows the technical and scale efficiency levels for individual dispensaries in the study. Out of the 17 dispensaries, 7 (41%) were technically efficient. Among the inefficient facilities, 50% scored below 50% and the score among the inefficient facilities ranged between 18% and 94%. The average score for the sample of 17 dispensaries was 70% and the average for the inefficient ones was 50%.

Approximately 47% of the 17 facilities were scale inefficient, which is usually associated with size of the facility either being too large or too small. The average scale efficiency for the sample was 82% with scores of the inefficient dispensaries ranging from 6%to 90%. The scale inefficient dispensaries had an average score of 62% implying that if all the inefficient dispensaries had an optimal size, output would have increased by 38% without increasing the inputs. About 6 (35%) of the dispensaries manifested decreasing returns to scale; 18% of the decision making units (DMU) had increasing returns to scale, and 47% had constant returns.

Table 8 Summary of Technical Efficiency Scores

DMU	**crste**	**vrste**	**Scale**	**DMU**	**Crste**	**Vrste**	**scale**
1	0.644	0.644	1.000	**10**	0.627	0.773	0.811 drs
2	0.560	0.776	0.722 drs	**11**	0.727	1.000	0.727 drs
3	0.365	0.404	0.903 drs	**12**	1.000	1.000	1.000
4	0.529	1.000	0.529 irs	**13**	0.456	0.563	0.811-drs
5	0.660	0.947	0.697 drs	**14**	0.086	0.190	0.455 irs
6	1.000	1.000	1.000	**15**	0.201	0.201	1.000
7	1.000	1.000	1.000	**16**	0.182	0.182	1.000
8	0.381	0.381	1.000	**17**	0.061	1.000	0.061 irs
9	1.000	1.000	1.000	**mean**	**0.558**	**0.709**	**0.748**

Note: crste = technical efficiency from CRS DEA vrste = technical efficiency from VRS DEA
scale = scale efficiency = crste/vrste.

Table 9 summary of output targets

DMU	Output 1	Output 2	Output 3	DMU	Output 1	Output 2	Output 3
1	11279	613	1714	**10**	12189.333	650	1715.333
2	13099.667	687	1716	**11**	14010	724	1718
3	11649.2	0.00	174202	**12**	9326	79	805
4	3974	0.0	500	**13**	12189.333	650	1715.333
5	13099.667	687	1716.667	**14**	3974	0	500
6	8697	631	1467	**15**	11279	613	1714
7	11279	613	1714	**16**	11279	613	1714
8	11279	0	1714	**17**	420	0	16
9	15083	1508	2764				

Table 10 Summary of input targets

DMU	Input 1	Input 2	DMU	Input 1	Input 2
1	3	2	10	4	2.333
2	5	2.667	11	6	3
3	4	2	12	3	1
4	2	2	13	4	2.333
5	5	2.667	14	2	2
6	4	1	15	3	2
7	3	2	16	3	2
8	3	2	17	2	1
9	8	3			

Table 11: Descriptive Statistics for Outputs and Inputs

Outputs	Mean	Standard deviation	Maximum	Minimum
Outpatient visits	7228	4593	15083	420
Total immunisation visits	301	402	1508	0
Total maternal care visits	937	723	2764	16
Inputs				
Clinical staff	4	2	8	2
Support staff	2	1	5	1

Table 12: Output increases and input decreases required to make the inefficient dispensaries efficient

DMU	**Output 1**	**% (+)**	**Output 2**	**%**	**Output 3**	**%**	**Input 1 (% -)**	**Input 2 (% -)**
1	4014	55	413	207	917	115	0	1
2	2937	29	336	96	439	34	0	1
3	6942	147	0	0	1061	173	0	0
5	701	6	164	31	1194	95	0	2
8	6983	162	0	0	1096	177	0	0
10	2765	29	364	127	523	44	0	1
13	5326	78	549	543	959	126	0	3
14	3324	511	0	0	405	426	0	0
15	9009	396	550	873	1599	1390	0	0
16	9229	450	583	1943	1550	945	0	0

Table 12 shows the increases on output and reduction of inputs that are required to make the inefficient dispensaries efficient. About 40% of the inefficient dispensaries require less than 50%

increase in general outpatient visits and 50% of them need above 100% increase that is they need to attend to double the number of the patients they attended during the period of study. Approximately 43% of the inefficient dispensaries are efficient in immunisation; however 50% of them need more than 100% increases in number of immunisations with 1 requiring close to 2000% increase on this dimension. In relation to maternal health visits on the other hand, 70% of the inefficient dispensaries require over 100% increase; this means they are operating at half their capacity in this aspect, with only 20% of them requiring less that 50% increase in maternal health-related visits.

Table 13: Determinants of Efficiency: Dependent Variable is Technical Efficiency

(Absolute *t*-Statistics in Parentheses)

Variables	Log Variable Returns to Scale Efficiency	Log Constant Returns to Scale Efficiency	Log Scale Efficiency
Head Nurse (1=Female)	-0.573 (1.28)	-0.729 (1.57)	-0.157 (0.35)
Education of Board Head (1=College; 0= Secondary)	0.074 (0.22)	0.347 (0.98)	0.271 (0.79)
Log Total Staff	0.409 (0.93)	1.293 (2.85)	0.883 (2.01)
Constant	-.210 (0.180)	-1.92 (1.61)	-1.749 (1.49)
R-squared	0.196	0.154	0.288
F-Statistic (*p*-value)	0.4017	0.0213	0.206
N	17	17	17

The OLS results in Table 13 show that the gender of the head nurse, education level of the chairman of the facility's board of management influence technical efficiencies (see Appendix Table 1 for Tobit results). Efficiency in dispensaries that are headed by female nurses is about 72% lower than in facilities that are managed by men but this difference is only statistically significant at 10% level. The dispensaries with boards that are chaired by college educated people have higher efficiency levels than the dispensaries chaired by persons with secondary education. However, this difference is statistically insignificant. The coefficient on log of the size of a dispensary influences technical efficiency. Large dispensaries have more staff and are more efficient. For example, a percentage increase in the number of total staff increases scale efficiency by .88 percent, while a percent increase in total number of staff increases constant returns to scale efficiency by 1.29 percent.

CHAPTER FIVE

5.0 Conclusions and Recommendations

From the analysis of the study, it is evident that the inefficiency experienced at the dispensaries is output related. This calls for campaigns by the health sector in the sub-county to increase the volume of the services rendered by the dispensaries. Also, the dispensaries may wish to encourage promotive health care so as to increase attendance at outpatient and maternal departments. On the case of immunisation, there is better performance there but follow up work is necessary to ensure that the children complete their vaccinations as required. This is because in some dispensaries the number of the fully immunised children is less than the number that received specific vaccines.

Further studies need to be done covering the entire Meru county health facilities at their respective levels and in other counties in the country. This would facilitate measurement of dispensaries' performance in line with the Sustainable Development Goal Number 3 -- intended to ensure healthy lives and well-being for all at all ages (United Nations, 2015).

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Appendix Table

Table A1: Tobit Regression Results: Dependent Variable is Technical Efficiency (*t*-Statistics in Parentheses)

Variables	Log Variable Returns to Scale Efficiency	Log Constant Returns to Scale Efficiency	Log Scale Efficiency
Head Nurse (1=Female)	-0.573 (-1.46)	-0.729 (-1.80)	-0.157 (-0.4)
Education of Board Chairman (1=College; 0= Secondary)	0.074 (0.25)	0.347 (1.12)	0.271 (0.9)
Log Total Staff	0.409 (1.07)	1.293 (1.84)	0.883 (2.3)
Constant	-.210 (-0.20)	-1.96 (-1.84)	-1.749 (1.7)
Log likelihood	-14.064	-14.667	-14.095
sigma	0.553	0.573	0.554
N	17	17	17

UNIVERSITY OF NAIROBI
SCHOOL OF ECONOMICS

Telephone: Nairobi 318262 ext. 28122
Fax: + 254 2 24 30 46 or + 254 2 245566
E-Mail: economics@uonbi.ac.ke

P.O. Box 30197
Nairobi, Kenya.

COUNTY HEALTH SERVICES MERU COUNTY GOVERNMENT
30 OCT 2015
P. O. Box 120 -60200 MERU

Permitted on condition of sharing the findings with CHMT, cc & Ec
Dr Ikoona
30/10/15

26/10/2015

DIRECTOR OF MEDICAL SERVICES,
MERU COUNTY

Dear Sir/Madam.

RE: ERIC BUNDI: REG NO.: X53/73148/2014

This is to confirm that the above named is a Masters in Science in Health Economics and Policy student in the school of Economics, University of Nairobi.

The student has completed coursework and is currently working on his research paper entitled: **"Technical Efficiency of Public Health Dispensaries in Meru County; A case Study of Imenti South Sub-County".** He will require data for the project to be satisfactorily completed.

We therefore request your kind consideration in providing the student with any assistance he may require.

UNIVERSITY OF NAIROBI
SCHOOL OF ECONOMICS
P.O. Box 30197, NAIROBI

MEDICAL SUPERINTENDENT
03 NOV 2015
KANYAKINE DISTRICT HOSPITAL

GLORY WAUSI
ADMINISTRATIVE ASSISTANT
SCHOOL OF ECONOMICS