INSTITUTIONAL EFFICIENCY AND SUSTAINABLE RESPONSE TO HIV/AIDS IN NYANZA AND WESTERN KENYA

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DECLARATION

Student's declaration

This proposal is my original work and has never been presented in any other University for examination.

Signature……………………………………Date…………………………………

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X50/79406/2015

Supervisor's declaration

This proposal has been submitted for appraisal with my approval as University Supervisor.

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DEDICATION

I dedicate this paper to my wife Margaret, sons Owen and Ayden and to my parents Mama Magdalene and Mwalimu Nicholas Wabuyabo who have encouraged me to aim higher in academics.

LIST OF ACRONYMS

DEA	Data Envelopment Analysis
DMUs	Decision Management Units
CRTS	Constant Returns to Scale
IRS	Increasing Returns to Scale
DRS	Decreasing Returns to Scale.
VCT	Voluntary Counseling and Testing
PMTCT	Prevention of Mother to Child Transmission
ART	Anti-Retroviral Therapy
HIV/AIDs	Human Immunodeficiency Virus/ Acquired immune deficiency syndrome
WHO	World Health Organization
GDP	Gross Domestic Product
SDGs	Sustainable Development Goals
NCDs	Non Communicable Diseases
TFP	Total Factor Productivity
RNM	Resource Needs Model
UNAIDs	United Nations Program on HV/AIDS
PEPFAR	The United States President's Emergency Plan for AIDs Relief
CDC	Center for Disease Control
NGO	Non –Governmental Organization
LPTFs	Local Partner Treatment Facilities
LMICs	Low Middle Income Countries
OLS	Ordinary Least Squares
MPI	Malmquist Productivity Index
TB	Tuberculosis

NCD	Non-Communicable Diseases
TOPs	Technically Optimal Productive Scale
CCD	Caves, Christensen and Diewert model
CCR	Charnes, Cooper and Rhodes Model
BCC	Banker, Charnes and Cooper Model
PLHIV	People Leaving with HIV/AIDs
NASCOP	National Aids/STI Control Program

DEFINITION OF TERMS

Production Frontier represents a quantity of output that can be obtained for a certain quantity of inputs using a given technology.

Parametric Production Frontier model makes assumptions about defining properties of the population distribution from which data is drawn. Uses tests such as t-tests

Non-Parametric Production Frontier model does not make assumptions about defining properties of the population distribution from which data is drawn. Uses tests such as chi-square tests.

Productivity is a ratio of Outputs to Inputs

Total Factor Productivity is a productivity measure involving all factors of production.

Technical change is the comparison of productivity over time.

Technical Efficiency is a scenario where a firm is able to generate maximum output from a given set of inputs.

Allocative efficiency is a scenario when a firm is able to choose from different technically efficient sets of inputs, the one which costs the least.

Isocost line is the locus of optimal input combinations.

Isoquant frontier is the locus of different input combinations through which (on given technology) same level of output can be acquired

Technically Optimal Productive Scale (TOPs) is the point on the production frontier at which a ray from the origin is tangential to the production frontier.

Hicks-Mooresteen approach is a Total Factor Productivity index that measures growth in output, net of growth in input.

Malmquist TFP Index is a CCD (Caves, Christensen and Diewert) approach that measures the radial distance of the observed input and output vectors between two time periods relative to a reference technology. The approach measures technical and efficiency change.

ABSTRACT

Introduction: Sustainable Development Goal number three (SDG3) targets to attain healthy lives and well-being for all at all ages with greater focus on HIV/AIDS. By end of 2015, the number of people living with HIV/AIDs globally totaled 36.7 million of whom 34.9 million are adults, 17.8 million are women, 1.5 million are children below 15 years and 25.5 million (69per cent) living in Africa of which estimated 1.5 million are in Kenya (PEPFAR, 2017). PEPFAR is one of the prime donors of HIV/AIDs programs in Kenya. Specifically, PEPFAR has funded faith based hospitals located in Western and Nyanza parts of Kenya since 2011. One of the expectations of Pepfar 3.0 strategy is to integrate efficiency in HIV/AIDs program delivery the bottom line being achieving more with less. Following this development, various initiatives have been developed, notably the 90-90-90 rule by UNAIDs (NASCOP, 2016). Under the rule, all HIV/AIDs partners are required to identify 90 percent of PLHIV, provide 90 percent of them with ART, and achieve viral suppression in at least 90 percent of those on ART.

Problem statement: Global funding for HIV programs reduced byUS$511 million from US$7.5 billion in 2015 to US$7 billion in 2016 (Kaiser/UNAIDs, 2017). By extension, Pepfar funding of faith based hospitals in Western Kenya also declined from 2011 to 2015 while prevalence rates in the region have remained the highest in Kenya. The Faith Based Health Centres in Nyanza and Western Kenya do not have alternative sources of income to support HIV/AIDs initiatives within their locality and are 100% Pepfar dependent. This complicates matters more as Pepfar funding could end by 2022 (Kenya Aids Report, 2015). Reaching 90-90-90 targets with the limited resources requires working more efficiently. However, there has been limited focus on measuring efficiency in faith based facilities but rather, much focus has been on public health facilities. Many of the Faith Based hospitals under the Pepfar fund may not therefore meet the efficiency expectation due to lack of technical know-how or limited research resources in integrating efficiency in their operations.

Objective: The four objectives of the study is to determine the level of efficiency for faith based health facilities tackling HIV/AIDs problem in Nyanza and Western Kenya between 2014 to 2016, determine the level of productivity of each health facility between 2014 to 2016, determine the optimal level of inputs for each health facility given respective efficiency levels and suggest policy decisions to take in order for the health facilities to remain efficient in the donor declining environment.

Methodology: The study uses VRS Barnes, Charnes and Cooper (BCC) output oriented DEA model to measure respective efficiency scores per facility and the Malmquist Total Factor Productivity Index (TFP) to measure productivity growth between 2014 and 2015. Output variables used are the number of HIV Testing Services and number of patients enrolled on ART while inputs are the number of medical officers, Clinicians, Pharmacists, Nurses, Laboratory Technicians, Site Coordinators, Community health workers, social workers and Counselors.

Key finding: Out of 47 site facilities, Thirty two (68%), sixteen (34%) and Seventeen (36%) of the site facilities were run inefficiently in 2014, 2015 and 2016 respectively. The Malmquist productivity index of annual mean was zero, a decrease by 100 percent between 2014-2016 due to a technical regress of 100%.

Recommendation: The hospitals should consider adoption of demand wise differentiated HIV testing and care initiatives, transfer of staffing needs, invest more in health strengthening systems to be more efficient and increase collaboration in order to sustain HIV/AIDs initiatives.

TABLE OF CONTENT

LIST OF FIGURES AND TABLES

CHAPTER ONE

BACKGROUND AND PROBLEM STATEMENT

UNAIDs (2016) report shows that there are 2.1 million new infections from HIV/AIDs reported in 2015 down from 3.1 million in 2000. The same report reveals that there were 1.1 million HIV/AIDs related deaths in 2015 down from 1.5 million reported in the year 2010. The reduction is attributed to the fact that the number of people living with HIV/AIDs who are on anti-retro viral therapy rose from 7.5 million in 2010 to 18.2 million in June 2016 (UNAIDS 2016 estimates). By the end of 2015, people living with HIV/AIDs globally totaled 36.7 million of whom 34.9 million are adults, 17.8 million are women, 1.5 million are children below 15 years and 25.5 million (69per cent) living in Africa (PEPFAR, 2017)

In Kenya, UNAIDs estimated 1.5 million people lived with HIV/AIDs at the end of 2015 up from 1.4 million in 2010. HIV prevalence reached a peak of 10.5per cent of Kenya's population in 1995-1996, and thereafter declined by about 40 per cent to reach approximately 6.7per cent in 2013 (Kenya Aids Response Progress Report 2014). Ninety percent of the infected population was 15 years and above while 10 percent was children aged 0-14 years. In 2015, the United Nations member states agreed to work towards achievement of 17 Sustainable Development Goals. SDG 3 targets to attain healthy living and well-being for all at all ages with greater focus on maternal and child health, HIV/AIDS, tuberculosis (TB), malaria, non-communicable diseases (NCDs), and injuries. By the year 2030, UNAIDs targets to attain fewer than 200,000 HIV/AIDS infections. To achieve this target, UNAIDs recommends application of efficient and cost effective approaches towards utilization of resources meant for HIV/AIDs programs.

The WHO (2015) report indicates that up to 40 per cent of health spending is lost through inefficient processes in Low and Middle Income Countries. With improved efficiency, allocative and technical efficiency can be achieved in these countries. Optimizing use of Information Technology and staff rationalization in hospitals are usually the most immediate strategic options applied in achieving efficient practices (Ngugi, 2016).

Similarly, the United States through an Executive Order of 2007 directed that all US funded health care programs must integrate quality, efficiency and transparency at all times (White House, 2007). In this perspective, the US PEPFAR developed an inter connected five action agenda towards efficient HIV/AIDs epidemic Control which include Impact, Efficiency, Sustainability, Partnership and the Human Rights Action Agendas (PEPFAR 3.0, 2014).

1.1 Hiv/Aids Funding in Kenya

Globally, international funding of HIV programs in poor countries decreased by US$511 million from US$7.5 billion in 2015 to US$7 billion in 2016 (Kaiser/UNAIDs,2017). Eighty one percent of Kenya's support on HIVAIDs is from global partners of which 70 percent of this funding is from PEPFAR. However, PEPFAR has reduced funding for Kenya and plans to end the funding by the end of 2022 (White House 2017). Over the last 10 years, Kenya has received about US$2.9 billion from PEPFAR and US$357.7 million from the Global Fund to Fight HIV and TB (Kenya Aids Response Program, 2016). With this support, the access to Anti-Retroviral Care and drugs has greatly increased leading to reduction and suppression in HIV/AIDs prevalence.

From above, it is clear that Kenya heavily relies on foreign donor support on the fight against HIV/AIDS and could face a severe humanitarian crisis in case PEPFAR withdraws funding for fight against HIV/AIDs. Kioko (2012) forecasts that the cost of the HIV response in Kenya could go up by114per cent between 2010 and 2020 while funding deficit will reach US$1.75 billion in the same period, an equivalent of 20 Per Cent of Kenya's current annual budget.

To address the funding gap in Kenya, the Kenya Aids Response Strategic Framework (2014-2019), plans to implement a domestic financing model through trust funds, AIDs Bond, Airline levy and Private sector appeals. To date, not much has been realized from the proposed domestic funding sources.

1.2 Statement of the Problem

In 2011, PEPFAR funded 7 faith based Local Partner Treatment Facilities (LPTFs) with USD 3.2 million in Kenya's Western and Nyanza regions. The number of facilities increased to 16 in 2012 and 2013 with a funding of USD 5.3 million and USD 8.7 million respectively. Funding in 2014 and 2015 moved to USD 6.1 million down from 8.7 million in 2013 but the number of facilities funded increased from 16 to 48 (KCCB-KARP, 2015). Seventy per cent of this funding, on average, went towards funding salaries of medical personnel working as nurses, clinicians, medical officers, community social workers, laboratory technicians and support staff. Within the same period, the facilities did not record any alternative financial support from other available local sources meaning the program is 100per cent dependent on the PEPFAR funding.

With the funding spread thin over increasing LPT facilities, the HIV prevalence in the seven counties has remained the highest in Kenya between 2011 and 2015. Homabay recorded 27.1 per cent prevalence, Kisumu 18.7 per cent, Siaya 17.8 per cent, Migori 13.4 per cent, Kisii 8.9 per cent, Kakamega 5.6 per cent and Bungoma at 3.5 per cent. Kenya's average national prevalence is placed at 7 per cent (Kenya Aids Report 2015). The core expectation of PEPFAR to the recipient Local Partner Treatment Facilities, given the declining resources, is to ensure efficient delivery of care and treatment services. As a requirement, recipient facilities must measure and monitor efficiency periodically. A major challenge faced by the 47 facilities under the study is the lack of technical capacity to measure efficiency from the data collected by the facilities from 2014 to 2015. Integrated and purposeful effort to transform the data collected into information that can measure and monitor efficiency levels per facility is a core opportunity for research work which this study aims to fill.

1.3 Research Questions

(i) Are the 47 health facilities under the PEPFAR support efficient enough to achieve sustainable fight against HIV/AIDs?

(ii) What are the optimal levels of input per health facility given the levels of efficiency measured?

(iii) What was the productivity measure of the health facilities in the period under the study?

(iv) What policy measures should the health facilities take to remain efficient?

1.4 Objective of the Study

The objective of this research is to determine how institutional efficiency attains sustained response to fight against HIV/AIDs.

Specific objectives

(i) Determine the level of efficiency for faith based health facilities tackling HIV/AIDs problem in Nyanza and Western Kenya

(ii) Determine the optimal level of inputs for each health facility given respective efficiency levels.

(iii) Estimate the level of productivity of each health facility for the study time periods.

(iv) Suggest policy decisions to take in order for the health facilities to remain efficient in the donor declining environment.

1.5 Justification of the Study

Homabay and Kisumu counties in Kenya have the highest HIV prevalence of 27 percent and 18 per cent respectively (Kenya Aids Response Report 2015). The prevalence has not dropped in the recent years given the intervention efforts partly due to cultural practices such as wife inheritance and polygamy. Further, studies under taken on efficiency in healthcare largely focus on public hospitals. There is little or no focus on studying efficiency in Faith Based hospitals which play a vital role just as public hospitals in Kenya. In the recent doctor's strike, Kenyans relied heavily on the services provided by the Faith Based Health Institutions.

Additionally, majority of available studies on efficiency in hospitals focus more on inputs and outputs within facilities. There is less focus on the relationship between efficiency and a sustained approach towards fight against HIV/AIDs in the face of resource constraints. However, Kenya does not have a well-structured National Efficiency Center. Following from this, the faith based facilities in this study do not have the technical know-how on measuring efficiency and determining optimal input-output mix in their respective program. This study could offer an opportunity for policy intervention towards establishment of a National Efficiency Center and creation of Efficiency Officers within HIV/AIDs programs.

1.6 Organization of the Study

This research is organized in five chapters. Chapter one gives the back ground information, objectives and problem statement on the study. Chapter two outlines in detail the published theoretical and empirical literary works in the field of efficiency measurement. Chapter three gives the conceptual framework, methodology and model specification that the study intends to follow. Chapter four discusses the results of the study. The study summarizes the results of the study and policy recommendations in chapter five.

CHAPTER TWO

LITERATURE REVIEW

INTRODUCTION

This chapter brings out the various forms of efficiency estimation models. Some researchers prefer using parametric (Berger, 1993) while others prefer nonparametric (Seiford and Thrall, 1990) models to measure efficiency of a Decision Making Unit. This chapter discusses in detail the theoretical models and empirical studies on efficiency and productivity in hospitals.

2.0 Theoretical Review

Frontier efficiency models are used widely in finance, banking, agriculture, environmental economics, public economics, development economics and health economics.

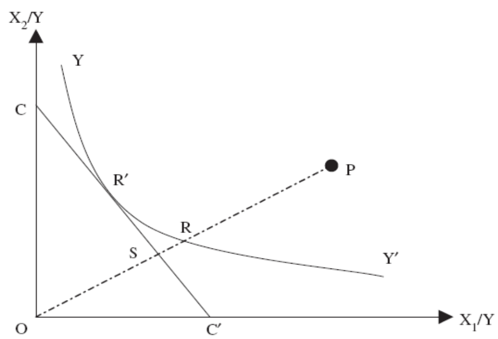
2.11 Allocative and Technical Efficiency

Michael J. Farrell (1957) decomposes efficiency of a Decision Making Unit into technical and allocative elements assuming CRS and that price for inputs is available. Figure 1 illustrates allocative and technical efficiency of a facility say Hospital H using input X_1/Y (medical Officer) to produce output X_2/Y (Tests and treatment). Isoquant YY' represents the technological set of minimum combinations of X applied towards production of a unit of Y. Any production point along YY' is considered **technically efficient** represented as (1-RP/OP) or OR/OP. Any production point away from YY' such as point P is technically inefficient represented by ratio RP/OP. Production Point R' is both technically and allocative efficient. The allocative efficiency (AE) at point P is determined by the ratio OS/OR.

Technical efficiency measures are categorized as either pure or scale efficient. Pure technical efficiency deals purely with a relationship between inputs and outputs while Scale Efficiency determines whether production is under DRS, CRS or IRS. A DMU operates under

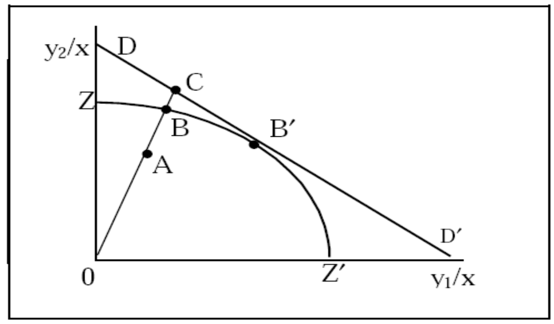
CRS where an increase and decrease in inputs corresponds to a similar increase and decrease in outputs respectively. Under VRS, a DMU exhibits DRS tendency when an increase in inputs corresponds with to a similar decrease in output. In such a scenario, the DMU is experiencing diseconomies of scale. Similarly, a DMU exhibits IRS tendency when an increase in inputs results to more than a similar increase in output. In this situation, the DMUs are experiencing economies of scale.

Fig 1: Technical and Allocative Efficiency measure



The output and input oriented measures can only provide equivalent measures under CRTS but will be unequal under VRS where IRS or DRS exists (Fare and Lovell, 1978). Figure 2 depicts technical efficiency (TE) under an out-put orientation where TE= OA/OB. Given price information, the iso-revenue is determined as DD’ in order to define the allocative efficiency as OB/OC. Economic Efficiency therefore becomes OA/OC. All the three measures are bounded by zero and one. In simple terms, allocative efficiency is about doing right things while technical efficiency is about doing things in the right way.

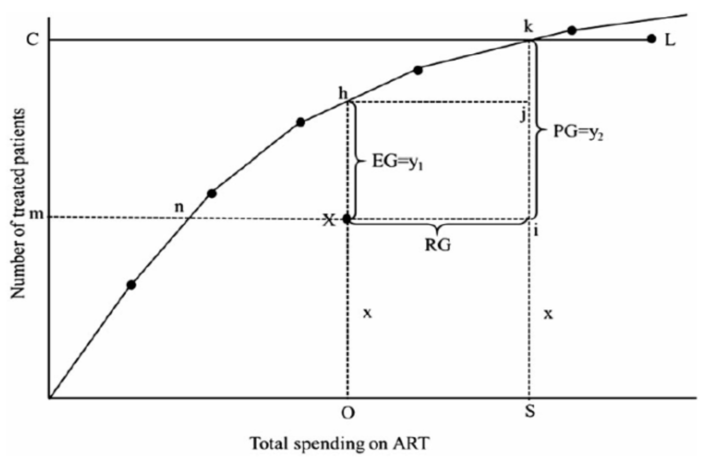
Figure 2: Technical and Allocative Efficiency under an output orientation.



2.12 Futures Resource Needs Model

Faced with resource constraint challenge and borrowing from the analytical framework of Wu Zeng (2015) uses a DEA based RNM model in the context of a hospital, to show a relationship between efficiency, resources and performance gaps.

Fig 3: Analysis of Efficiency gap in Hospital J



Where, EG stands for Efficiency Gap, RG for Resource Gap and PG for Performance Gap.

The output oriented efficiency score (OX/Oh for hospital J) shows the extent to which outputs (services) could be improved in order to be efficient, along the vertical line. The input oriented efficiency score (i.e. mn/mX for hospital J) shows the extent to which input(s) could be reduced in order to achieve efficiency, along the horizontal line. Output orientation maximizes output given a set of input resources while input orientation minimizes inputs for a maximum number of outputs.

Coelli et.al (2005) outlines Data Envelopment Analysis (non-parametric), Stochastic Frontiers (parametric) and Ratio Analysis as methods of efficiency measurement.

2.13 Non Parametric Frontier Model (DEA)

Coelli and Perelman (2000) illustrate the importance of production frontier functions in a multiple output environment that does not assume cost minimization and profit maximization behavior. Charnes, Cooper and Rhodes (1978) research discovered the term DEA with an input orientation under Constant Returns to Scale environment. Subsequently, Banker, Charnes, Cooper (1984) proposed a DEA model under Variable Returns to Scale environment where inputs can be varied. Data Envelopment Analysis technique first identifies the best performers using data to produce a production frontier under which the rest of the Decision Management Units (DMUs) are evaluated (Hollingsworth 2008; Hussey et al.2009). An important advantage of DEA over other techniques is the ability to model technical efficiency with multiple inputs and outputs without necessarily having input prices (Cooper et al 2006). The choice to apply either output or input orientation and CRS or VRS is dependent on whether the study in question has control over inputs or outputs.

2.14 Parametric Frontier Models (Stochastic Frontier Analysis)

Parametric methods are used widely when input prices are available. Lovell et.al (1977) developed a Stochastic Frontier model that is parametric. The model is based on production function of the form;

$\text{Log}\ \gamma = \beta x + v - \mu$ where; ……………………………………1

γ is the observed efficiency score

βx is the deterministic production frontier

v is the stochastic production frontier

μ is the technical inefficiency

Stochastic Frontier analysis therefore imposes a functional form on the inefficiency distribution. The model uses either panel or cross-sectional data. However, use of the cross sectional data has its limitation. This model is ideal when input prices are readily available and covers errors or statistical noise in the study variables.

2.15 Ratio Analysis

Ratio analysis evaluates output of health service in relation to input(s) consumed (PR Sodani) and includes measures such as number of patients per doctor and beds per doctor. Ratio analysis is not widely used as a measure of efficiency as it has an inherent limitation of suppressing the implicit interdependency amongst the different services and resources. Erroneous conclusions are therefore likely from use ratio analysis.

In a scenario where a functional form of the production frontier in impossible to apply, Bayesian models can be applied. These models can also apply in a multiple outputs environment. Semi parametric techniques under multiple output orientation are also in existence (Sickles et.al, 2002). These models use multivariate kernel estimators to address the endogeneity of multiple outputs.

2.2 Empirical Review

Over three hundred and twenty-five studies on efficiency using DEA have been undertaken in Africa since the year 2000 (Mujasi, 2016). Case studies on Efficient and sustainable HIV responses are numerous around the globe. Some of these studies were very instrumental in the making of the 2012 UNAIDs report titled '*Together we will End Aids*.' The report captures countries that have effectively appropriated production inputs using allocative and technical efficiency techniques towards achieving desirable outcomes such as increased coverage of services and access to local resources towards fight against HIV.

UNAIDs (2013) report shows that Cambodia and Myanmar reallocated resources towards high impact priorities through studying policy cost effectiveness, resource tracking, population studies and outcome analysis. Arising from this model coverage of target groups increased while costs and infections reduced (National Aids Authority 2012).Similarly, the Swaziland Ministry of Health attested that transparency and competitive procurement processes for anti-retroviral drugs in South Africa and Swaziland realized a saving of $640 million and $12 million respectively in 2012.In May 2006, the Africa Ministers of Health, resolved to institutionalize efficiency measurement in their respective national health facilities. Specifically, Kenya, Namibia and Malawi have developed strategies geared towards reduced dependence on external funding in fight against HIV/AIDS (Kioko,2012) and integrate efficiency in management of HIV/AIDs.

The WHO (2015) study outlines various policy instruments and reforms on improving health care efficiency in Burundi, Chile, China, DR Congo, Ethiopia, Korea and Uruguay. For example, the Introduction of free child and maternal health care in Burundi in 2006 led to a dramatic increase in the use of the services. The quality of service provision was compromised as a result of overstretched staff and increased claims by service providers. Many mothers opted to use private services rather than free government provided services. To reverse the inefficiency, the government of Burundi introduced performance and incentive based financing in 2010. Arising from this policy intervention, the percentage of deliveries at health facilities increased by 72.9 per cent in 2012 compared to 2010. Technical quality at health facilities improved from 59 per cent to 79 per cent from 2010 to 2012.

Similarly, in DR Congo, following decade long conflicts, donor activities in the health sector had no coordination mechanisms leading to duplication and waste of resources. In 2005, the DR Congo government in partnership with donors developed a health management procedures manual and created a support unit to implement it. National procurement and supply chain of essential medicines and human resources was enhanced in the process. The reform reduced management costs of internationally funded projects from 28 per cent in 2005 to 9 per cent in 2011 realizing a saving of USD 56 million. The government of DR Congo was also able to realize substantial wage savings by redeploying 98 workers and retiring 170 staff (Direction d'Etudes et Planification, Ministère de la Santé Publique, 2010). The remaining staffs were able to be paid well hence increasing their motivation and productivity. For example, the salary (in Euros) for a physician improved from 50 to 230 Euros while that of Nurse in job group A1 moved from 20 to 90 Euros.

Also, the Republic of Korea ran 3 different medical insurance schemes, one for teachers, another for civil servants and another for self-employed. Premium rates charged were determined based on the level of income giving rise to high administrative costs. In 2000, the schemes were merged into one enabling a reduction of administrative costs from 7.87 per cent to 2.38 per cent between 1996 and 2008. Consequently, contributions from the self-employed increased from 89.6 per cent in 2000 to 96.3 per cent in 2008 (Health Insurance Statistics, 2012). The savings necessitated expansion of health insurance benefits to many more citizens of the Korean Republic.

Kirigia et.al (2011), using DEA measures productivity changes among 23 zonal hospitals in Benin between 2003 and 2007. Input variables used in the study are the number of doctor hours; nurse hours; lab tech, x-ray, anesthetics, paramedics' hours; overhead costs and hospital bed capacity. The output variables used are the frequency of outpatient visits and admissions in the 23 health facilities in the study. The estimated average efficiency levels were 63per cent in 2003, 64 per cent in 2004, 78 per cent in 2005, 78 per cent in 2006 and 86 per cent in 2007. On average, the productivity of hospitals decreased by 5.3 per cent over the entire five year period, largely attributed to technical regress. The study finding indicated that with improved efficiency, additional outpatient, inpatient, curative and preventive care can be accessed without additional funding.

Osei et.al (2005), estimates efficiency of 17 public hospitals and 17 health centers in Ghana using DEA. The study results found that 8 public hospitals were inefficient with a Technical Efficiency score of 61per cent, 10 had scale inefficiency of 81per cent. Further, 3 health centers were technically inefficient while 8 had a scale inefficiency of 84per cent. The study encouraged policy makers in Ghana to continuously monitor efficiency in all health facilities. Kirigia et.al (2008) used DEA-based Malmquist productivity index to assess the technical and scale efficiency and productivity change from 2001 to 2004 among 17 public health centers in Seychelles. The results of this study showed productivity increase of 2.4per cent over 4 years due to innovation.

Wu Zeng et al (2015) constructed an input oriented resource needs model using DEA to illustrate ability to achieve universal access to HIV/AIDS care and treatment in 45 countries in Africa and Asia. Wu Zeng uses empirical data from 2002 through 2007 in 61 countries to estimate the resource needs for 45 countries in 2006 to meet the 2010HIV/AIDS goal. In this study, the inputs considered are the national expenditure on HIV/AIDS while the output is the Volume of Voluntary Counseling and Testing (VCT), Prevention of Mother to Child Transmission (PMTCT) and Anti-Retroviral Treatment (ART). A major drawback of this study is that it assumes that all study countries are efficient. Wu Zeng uses efficiency scores from DEA as dependent variables and environmental factors as independent variable to construct a tobit model. The results determined that efficiency is significantly associated with environmental factors such as government commitment, a country's economic status, population size and prevalence of HIV/AIDs (Zeng et al. 2012). The findings from the analysis concluded that under maximum efficiency, the projected resource needs of the 45 countries is 47 per cent ($6.3 billion) of the UNAIDs estimated resource requirements of $ 13.5 billion in the year 2010. The DEA and the RNM model brings out the importance of incorporating efficiency in HIV/AIDs programs in resource constrained health facilities (Shepard et al. 2007; Vassall and Compernolle 2006). The study by Wu Zeng confirms three things. One, that there is a substantial resource gap towards

HIV/AIDs programs. Two, integrating efficiency in HIV/AIDs programs plays an important role towards reducing the resource gap. Three, to achieve HIV/AIDs goals, efficiency and resources must be strengthened at all levels.

Kirigia (2002), among other studies, studied technical efficiency of 54 public hospitals in Kenya using Data Envelopment Analysis technique in order to single out inefficient hospitals for policy formulation. Inputs included medical officers, pharmacists, dentists, clinical officers, nurses including enrolled, registered, and community nurses, administrative staff, technicians, other staff, subordinate staff, pharmaceuticals, on-pharmaceutical supplies, maintenance of equipment, vehicles, and buildings, and food and rations. Outputs included Outpatient Department casualty visits, special clinic visits, MCH/FP visits, dental care visits, general medical admissions, pediatric admissions, maternity admissions, and amenity ward admissions. The results show that 14 public hospitals were technically inefficient due to excess inputs or insufficient outputs. The study recommended as a policy measure that excess inputs could be channeled towards provision of curative and preventive services.

Mujasi et al. (2016), using DEA to analyze cross sectional secondary data of 14 public hospitals and 4 private non-profit hospitals in Uganda, regressed efficiency scores against identified institutional and environmental variables to estimate impact of efficiency. The study found that idle capacity was common in facilities estimated to be inefficient where outputs could have been maximized without necessarily increasing the accompanying inputs.

Xenos (2017) uses Bootstrap Malmquist Productivity Analysis and random effects tobit model to study productivity and efficiency in 108 General Hospitals in Greece from 2009 to 2012 when Greece was experiencing economic meltdown. Input variables in the study included doctors, beds, expenditure and other personnel density. Output included total number of diagnostic procedures and patient discharges. The study results indicate that productivity index of 0.72 on average. Productivity increase recorded in some facilities was attributed to technology change as a result of efficient and effective health care systems and processes. From the study, the overall factors contributing to productivity are higher admission rates, category and size of the health facilities.

Using DEA, Ade et.al (2005) estimates efficiency of 37 health facilities in Pujehun, Sierra Leone. The inputs included technical staff, subordinate staff, materials & supplies and capital inputs. The output under study were number of antenatal and postnatal care, babies delivered, nutrition growth, birth control visits, under-five children immunized and level of health education. Results from this study showed that 22 health care facilities were technically inefficient with 63per cent score while 24 were scale inefficient at 72per cent. The study showed the importance of institutionalizing health facility efficiency in Sierra Leone's health sector.

Di Georgio et al (2016) studies the potential of expanding ART through improvement of efficiency in health facilities in Kenya, Uganda and Zambia using a combination of DEA, SFA and regression analysis models (Ensemble model). Inputs in the study included number of full time facility staff and the number beds. For Outputs, the study uses number of outpatient services, ART visits, antenatal care visits, births and inpatient bed days. The study concludes that with the same resources, Health facilities in Kenya, Uganda and Zambia could have admitted 459,000 new ART patients (40per cent increase) if the facilities reached 80per cent efficiency and identifies managerial and internal process improvements factors to be significant in determining improved efficiency.

Kinyanjui et.al (2016) studied Technical Efficiency of 30 sampled hospitals owned by Faith Based Organizations in Kenya using Data Envelopment Analysis. Inputs used in the study include number of doctors, nurses, beds and cots. Outputs included the number of inpatients and outpatients. On average 36 per cent of the facilities were found to be inefficient due to lack of clear, strategic and centralzed governance structure. Related to the study by Kinyanjui, Kembo (2015) study on faith based hospitals in Tanzania using Data envelopment Analysis concludes that more resources should be allocated to facilities with IRS scale efficiencies. Zakumumpa et. al (2017) studies alternative financing initiatives for ART in Uganda using a mixed methods approach. The study results indicate that diversifying funding sources reduces dependance on Global Health Initiative funding and increase local ownership of HIV programs. Some of the innovative approaches for alternative financing proposed by the study include multiple proposal writing, establishment of executive clinics, introduction of modest service charges and provision of HIV related insurance covers.

Shattock et.al (2017), uses optima model to determine allocative, technical and implementation efficiency of programs by decreasing the unit and overhead costs of treatment and increasing the productivity of indirectly related programs in Kazakstan. The results of this study indicate that Kazakstan can achieve ambitious hiv intervention targets by realizing savings through reducing management and ART drug costs. Carlos Avilla et.al (2013) uses a random effects model to identify independent predictors of public financing in 125 countries. The study estmates that LMICs demonstrated increased domestic funding as a result of economic growth and high HIV prevalence.

Kirigia et.al (2011), using DEA, estimates technical efficiency of 36 maternal and child health facilities, 22 Community health centers and 21 Community health facilities in Kailahun and Kenena Districts of Sierra Leone. Inputs used were health workforce, medicines and supplies, capital resources and other resources while output included number of outpatient care, MCH/FP services, immunizations, vector control and health education. The average technical efficiency was 68 per cent for MCHPs, 69 per cent for CHCs and 59 per cent for CHPs. The study recommended strengthening use of health information systems in order to facilitate regular efficiency analysis.

2.3 Overview of the Literature

The reviewed empirical studies largely focus on optimal allocation of production inputs to hospital decision making units towards maximal output production of health services. Of importance to note is the fact that most efficiency studies in the health sector have focused more towards public owned health facilities than faith based health care facilities. This is a major issue of concern given that about 50% of Kenya's health sector is funded and managed by religious entities. Of much relevance to this study of efficiency in faith based hospitals in Kenya (Kinyanjui et. al, 2016). Arising from this study, contextual factors identified to be causes to inefficiencies include lack of clear, strategic and centralzed governance structure. Similarly, strengthening use of health information systems facilitates regular efficiency analysis (Kirigia et. al, 2011).

Additionally, there is great focus on efficiency by donor agencies such as PEPFAR and Global Fund that partner with Faith Based Health facilities. With minimal inputs, it is possible to widen or increases health services coverage through improved efficiency (Di Georgio, 2016). Programs that exhibit IRS scale efficiencies have a higher probability of attaining sustainable and sufficient donor support (Bwana, 2015).

CHAPTER THREE

METHODOLOGY

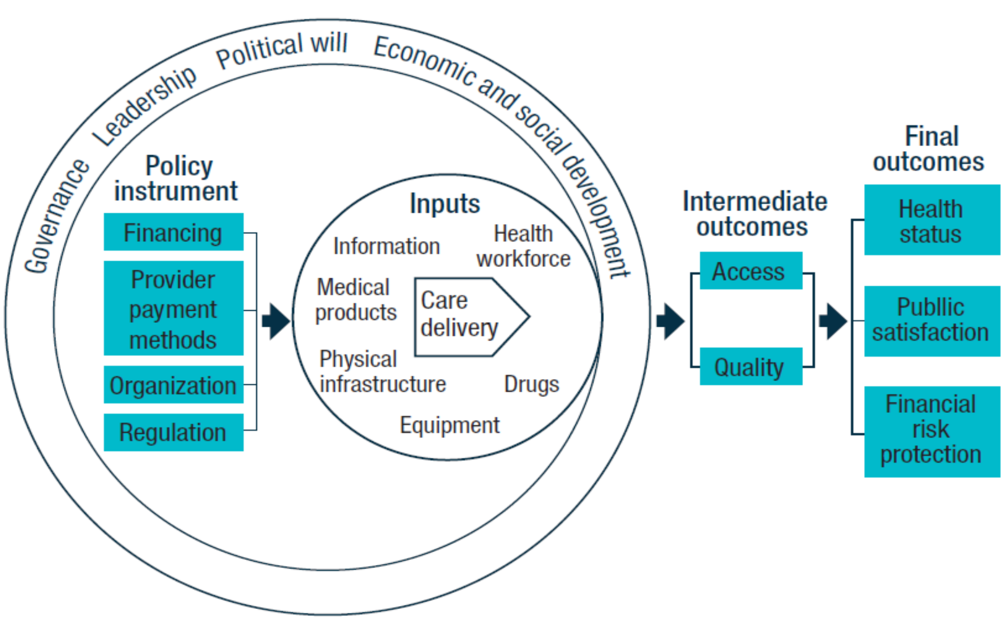
INTRODUCTION

The chapter illustrates analysis of the model, estimation, data source and area of study.

3.1 Conceptual Framework

A macro-economic production framework of a health system can be represented in figure 4 below;

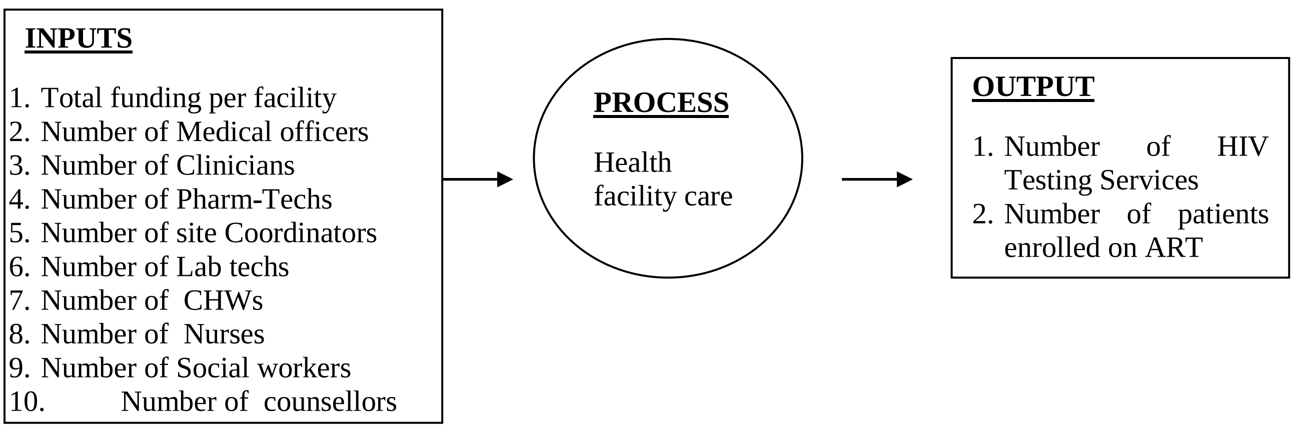
Fig 4: A system framework for analyzing the efficiency of health care resource use (WHO,2015)



Financing, provider payment methods, organization and regulation are policy instruments that determine allocative and technical efficiency of a health unit.

The production process of hospitals involves transforming inputs into outputs. Inputs include factors of production such as capital, labor and materials. Capital items could include beds and equipment. Labor includes doctors, nurses, lab techs and support staff. Materials could include consumables such as drugs, test kits, detergents and gloves. The relationship between the inputs and outputs in the context of this study is illustrated in figure 5 below.

Fig5: Relationship between inputs, production process and output (Kirigia, 2005)



3.2 Choice of Technique

DEA helps in identifying medical resources deployment policies by establishing priorities through provision of information on the needs of the hospitals in a multiple input and output environment. Price of inputs and outputs does not have to be available to use DEA. However, DEA has some limitations which can be addressed. One, DEA can only be applied to multiple DMUs on a per year basis and hence cannot estimate efficiency change over time. Malmquist Productivity Index (MPI) overcomes this limitation. Two, efficiency scores are very sensitive to the number of inputs, outputs and sample size (Bhagvath, 2006). DEA is also sensitive to high end outliers. In order to detect the outliers in DEA, the smoothed bootstrap method is used (Simaret.al, 1998). Unlike SFA technique, DEA does not prior functional relationship of production frontiers and the inefficiency random error terms. Additionally, DEA has little sensitivity to outliers as compared to the SFA Model.

The study will use DEA based Malmquist Total Factor Productivity Index because just as DEA, Malmquist Index can work effectively in the absence of price data on inputs and outputs.

3.3 Economic Model

The study shall estimate efficiency per facility through DEA. DEA allows for use of multiple inputs and outputs. The study uses input oriented VRS Banker, Charnes, Cooper (BCC) model of the form;

$$TE_{qo} = Max_{up,\, vi} \sum_{1}^{N} u_p\, y_{pq0} + U_o ....2$$

Subject to:

$$\sum_{1}^{N} u_p y_{pq} - \sum_{1}^{n} v_i\, x_{i\,p} + U_o \leq 0;\ \forall j ....3$$

$$\sum v_i\, x_{i\,q0} = 1 ....4$$

$$u_p,\ v_p \geq 0;\ \forall p,\ \forall i:$$

Where: y_{pq} = total output *p* produced by DMU q,

X_{iq} = total input *I* used by DMU q,

U_p = total weight given to output p, (p= 1, …….,t and t is the total outputs)

v_i = total weight given to input i, (i= 1, …., m and m is the total inputs)

n = total number of facilities

j_0 = the hospital under assessment

With the VRS, Increasing returns to scale is present if $U_o > 1$, constant returns to scale if $U_o=0$ and reducing returns to scale if $U_o < 1$. From aforementioned, the Scale efficiency Score =CRS TE Score/VRS TE Score.

To measure productivity change between time periods, the DEA based Malmquist Total Factor Productivity (TFP) index is used to decompose productivity into pure efficiency change and technological change as follows (Caves et. al, 1982);

$$M_o(y^{t+1}, x^{t+1}, y^t, x^t) = \left(\frac{H_o^{t+1}(x^{t+1}, y^{t+1})}{H_o^t(x^t, y^t)}\right) x \left(\frac{H_o^t(x^{t+1}, y^{t+1})}{H_o^{t+1}(x^{t+1}, y^{t+1})} \; x \; \frac{H_o^t(x^t, y^t)}{H_o^{t+1}(x^t, y^t)}\right)^{1/2} \ldots\ldots 5$$

MPI = [Efficiency change] x [Technical change]

Fare et. al (1994) decomposes Efficiency Change under CRS as a product of Pure Efficiency Change and Scale Efficiency Change as follows;

$$\frac{H_o^{t+1}(x^{t+1}, y^{t+1})_{CRS}}{H_o^t(x^t, y^t)_{CRS}} = \left(\frac{H_o^{t+1}(x^t, y^t)_{VRS}}{H_o^t(x^t, y^t)_{CRS}} \; x \; \frac{H_o^{t+1}(x^{t+1}, y^{t+1})_{CRS}}{H_o^{t+1}(x^{t+1}, y^{t+1})_{VRS}}\right) \ldots\ldots 6$$

where; (t, t+1) is time periods for all t=1

x is the input vector

y is the output vector

H_o is Malmquist distance function

$M_o(y^{t+1}, x^{t+1}, y^t, x^t)$ is the output based Malmquist Productivity Index (MPI) with respect to two different time periods in relation to technology at t+1.

An MPI attains the value of greater than, equal to or less than one if the health facility has achieved productivity growth, stagnation or productivity decline between the defined time periods respectively. Pure Efficiency change measures change in technical efficiency under VRS technology while scale efficiency change measures changes in efficiency due to movement toward or away from the production frontier. Efficiency change is greater than, equal to or less than one if a hospital is moving closer to, constant or receding from the production frontier respectively. Technical change is greater than, equal to or less than one when innovation is improving, constant or regressing respectively (Kirkal et.al, 2004)

3.4 Empirical Model Specification

Thus, study shall empirically estimate efficiency using the BCC approach as follows;

$$TE_{jo} = \text{Max}\,u\left(ART + HT_{\ jo} \right) + U_{o} \ldots\ldots\ldots\ldots\ldots\ldots..7$$

Subject to:

$$\sum_{1}^{N} u_t \left(ART + HTS_{\ jt} \right) - \sum_{1}^{N} v_{it}(TF_{1\ jt} + MO_{2jt} + CO_{3jt} + NO_{4jt} + LB_{5jt} + PT_{6jt} + CO_{7jt} + CH_{8jt} + CS_{9jt} + SW_{10jt}) + U_o \leq 0; \ldots\ldots 8$$

$$\sum v_{it}(TF_{1jt} + MO_{2jt} + CO_{3jt} + NO_{4jt} + LB_{5jt} + PT_{6jt} + CD_{7jt} + CH_{8jt} + CS_{9jt} + SW_{10jt}) = 1 \ldots\ldots\ldots\ldots..9$$

$u, v_i \geq 0; \forall r, \forall i:$

Where;

u_r= the weight given to output r, (r = 1)

v_i=the weight given to input i, (i= 1, …., 10)

n = Number of facilities

j_0= Hospital under assessment

Uo = Determines whether model is IRS, CRS or DRS

TE= Technical Efficiency

TT= Number of patients Tested

ART= Number of patients under ART

HTS= Total number of HIV Testing Services

TF= Total funding per facility

MO=Number of Medical officers

CO=Number of Clinic Officers

NO- Number of Nursing Officers

LB=Number of Lab techs

PT= Number of Pharm Techs

CD= Number of Hospital Coordinators

CH=Number of CHWs

CS= Number of counselors

SW=Number of Social workers

3.5 Diagnostic test

Given that DEA is sensitive to input and output specification and the size of the sample, the study shall use the Banker and Morey model (1989) of the form;

$$N \geq 3(x+y) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. \; 9$$

Where; n is the number of DMUs in the study

x is the number of inputs in the study

y is the number of outputs in the study

3.6 Data Sources and Collection

The study shall obtain panel data from three publicly available sources namely the Access Bottlenecks Cost and Equity (ABCE) Project, Pepfar portal (https://data.pepfar.net/portal), and published audited financial statements of the Kenya Aids Response Program. Data shall be gathered from 2014 to 2016 then formatted in excel for estimation through DEAP 2.1 Application that will determine Technical, allocative, scale, economic efficiencies and productivity change between 2014 and 2016.

CHAPTER FOUR

STUDY FINDINGS

Introduction

This chapter outlines efficiency measures of 47 health facilities using panel data from 2014 to 2016 composed of 2 outputs and 10 input study variables. The number of observations in total is 141 observations. To ease the computation, the study uses Data Envelopment Analysis Application Version 2.1. Efficiency measures per year are determined annually using DEA and the scores are between zero and unity. A score of one indicates that the service unit is technically efficient while a score less than unity indicates that the Service Unit is inefficient.

4.1 Descriptive Statistics

The geometric means of the 141 observations reveal that on average, the technical efficiency of the individual facility is 0.875 while the average output per facility is 7749 people underwent HIV/AIDs testing while 1402 were enrolled for ART services annually. As depicted in table 1 below, the average inputs include average funding of about twelve million Kenya Shillings per facility to fund on average 2 Clinicians, 2 Nurses, 1 Lab Tech, 1 Pharm Tech, 1 Coordinator, 17 CHWs, 1 Counselor and 2 Social Workers per facility annually.

Table 1: Summary of Descriptive Statistics

Variable	Observations	Mean	Std. Dev	Min	Max
TE	141	0.925		0.224	1
Total Tested		7749	6499	386	28884
On ART		1402	1197	123	5983
Funding		11905158	10061700	22457	41500000
Medics		0	0	0	1
Clinicians		2	1	0	8
Nurses		3	3	0	11
Lab Techs		1	1	0	3
Pharm Techs		1	1	0	4
Coordinator		1	0	0	1
CHWs		17	18	0	80
Counselors		1	1	0	4
Social Workers		2	1	0	7

4.2 Technical and Scale Efficiency Scores

The average efficiency scores as depicted in table 2 below for CRSTE, VRSTE and SE are 0.646, 0.925 and 0.695 respectively while twenty, twenty four and three facilities on average displayed decreasing, constant and increasing returns to scale respectively.

Table 2: Mean Efficiency Scores

Year	CRTE	VRSTE	SE	DRS	CRS	IRS	Min	Max
2014	0.124	0.891	0.154	42	5		0.224	1
2015	0.907	0.945	0.965	9	33	5	0.42	1
2016	0.908	0.94	0.965	9	34	4	0.5	1

Average Mean	0.646333	0.92533	0.6947	20	24	3	0.382	1

Respective Hospital efficiency score per facility is illustrated in appendix 5 with a summary under table 3 below;

Table 3: CRSTE/VRSTE/SE Efficiency Scores

Year	No. of Inefficient Hospitals (<1)			No. of Efficient Hospitals (=1)		
	CRSTE	VRSTE	SE	CRSTE	VRSTE	SE
2014	45	32	42	2	15	5
2015	22	16	14	25	31	33
2016	21	17	13	26	30	34

4.3 Input Slacks

The input slacks represent the level by which each facility can reduce or increase the inputs employed without compromising the level of output. The summary annual input reduction are depicted in table 3 below the detail of which is available under appendix 3.

Table 4: Input Reduction

	INPUT									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2014	23,810,216	1	5	8	5	1	1	68	7	5
2015	38,714,608	1	1	6	11	3	4	98	9	9
2016	86,289,102	2	2	10	14	6	6	96	10	15

4.4 Output Slacks

The output slacks represent the level by which each facility can increase or reduce output production with the same available input quantities. The summary annual output improvement are depicted in table 4 below, the detail of which is available under appendix 4.

Table 5: Output Slacks

	OUTPUT	
Year	**1**	**2**
2014	1214	1390
2015	3457	843
2016	4672	2235

4.5 Malmquist Total Factor Productivity Change

The mean total factor productivity change between year 2 and 3 is 1.036. The positive productivity is attributed to an efficiency change of 1.004, technical change of 1.032, pure efficiency change of 0.996 and scale efficiency change of 1.007. The Malmquist Index of firm means is outlined in appendix 5 below.

4.6 Discussion of the Results

Efficiency score of less than one depicts inefficiency in the health facility while a score of one shows that the hospital under study is efficient and emulates best practice. Kirigia et. al (2004) study to measure technical efficiency of 32 health centers in Kenya estimated that 44 per cent of the centres in the sample operated inefficiently and needed to ether reduce their inputs or increase their outputs in order to become efficient. From table 3 above, in 2014, 2015 and 2016, out of 47 site facilities, fifteen (32%), Thirty one (66%) and Thirty (64%) hospitals operated efficiently by recording a VRSTE score of one respectively while Thirty two (68%), sixteen (34%) and Seventeen (36%) of the site facilities operated inefficiently by recording an efficiency score of less than one during the study period. The mean VRSTE score for the 47 hospitals is 0.89, 0.95, and 0.94 in 2014, 2015 and 2016 respectively. Going by the results, the hospitals under the study on average would have increased annual output by 11 per cent, 5 per cent and 6 per cent in 2014, 2015 and 2016 respectively without varying the input levels. The mean efficiency score for the three years of 0.93 confirms that on average, all the 47 hospitals could increase output by 7 percent without changing the level of input. To increase output to optimal levels, the health facilities should consider adoption of demand wise differentiated HIV testing and care initiatives such as promotional activities to key populations, women, men, children and youth clusters (Mwabu et.al, 1993). Further, Kinyanjui et.al (2016) study on faith based hospital in Kenya showed that on average 36 per cent of the facilities were found to be inefficient and could increase output and operate efficiently if they developed clear, strategic and centralzed governance structure. The same is applicable for in efficient hospitals in this study.

Given that this study assumes that all inputs are variable, increases in the use of inputs automatically affects the respective output levels in three ways. One, the Decreasing Returns to Scale (DRS) or diseconomies to scale signifies that doubling the input variables could result to less than the doubling of output due to shortages of complementary inputs, low staff morale and leadership problems (Kirigia et. al, 2008). Two, Constant Returns to Scale (CRS) possibility represents a scenario where doubling of inputs may lead to doubling of output. In this case, technical efficiency is equal to scale efficiency. The third possibility is the Increasing returns to scale (IRS) or economies to scale which represents the possibility where doubling of inputs may lead to more than doubling of output. IRS could arise due to indivisibilities of some inputs, greater specialization, innovation or employee motivation (Kirigia et. al, 2008).

In 2014, 2015 and 2016, fourty two (89 %), Nine (19%) and Nine (19%) hospitals manifested decreasing returns to Scale respectively. In the similar period, Five (11%), Thirty Three (70%) and Thirty four (72%) hospitals manifested Constant Returns to Scale (CRS) while zero (0%), Five (11%) and four (9%) had increasing returns to scale in the respective years. On average 20 hospitals experienced decreasing returns to scale, 24 hospitals on average recorded constant returns to scale and 3 hospitals on average recorded increasing returns to scale for the three years under the study. Kembo (2015) study on faith based hospitals in Tanzania using Data Envelopment Analysis concluded that more resources should be allocated to facilities with IRS scale efficiencies. Ideally, more resources should be allocated to the facilities with increasing returns to scale since more is achieved with less while facilities with Decreasing Returns to Scale tendencies should benchmark and learn from the facilities with IRS. Facilities with Constant Returns to Scale are operating at their most productive scale sizes and no resources should be added or scaled. The 2014, 2015 and 2016 mean scale efficiency scores for the 47 hospitals was 0.154, 0.965 and 0.965 respectively with a three year average of 0.69. Kirigia et. al (2002), estimated the average scale efficiency among public hospitals in Kenya to be 96.8 %.

Using DEA Version 2.1, the specific reduction or transfer of input resources is illustrated in tables 5 below. For the facilities to be efficient therefore, the indicated annual input scale downs or transfers are necessary.

Table 6: Input/Output Scale down/up Levels

	INPUT									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2014	23810216	1	5	8	5	1	1	68	7	5
2015	38714608	1	1	6	11	3	4	98	9	9
2016	86289102	2	2	10	14	6	6	96	10	15

Similarly, it is necessary to boost the output levels of the hospitals in order to remain efficient as follows;

	OUTPUT	
Year	**1 (HTS)**	**2 (ART)**
2014	1214	1390
2015	3457	843
2016	4672	2235

To determine productivity growth per facility within the three year period, the Malmquist Total Factor Productivity Index is determined using DEA Solver 2.1. A score of more than one indicates a productivity growth while a score of less than one indicates a productivity regress. Increased productivity results into improved, effective access and utilization of HIV Testing services while productivity decrease results to waste of health resources (Kirigia et. al, 2008). The total factor productivity growth/regress comes as a result of efficiency changes, technical changes, pure efficiency changes and the scale efficiency changes. Efficiency change is a product of pure efficiency change and scale efficiency changes.

This study takes 2014 as the technology reference year and uses output oriented index measures which define the index as a measurement of increased output derived from the inputs net growth. As illustrated in appendix 5, the Malmquist index of annual means summary shows that on average Malmquist Total Factor Productivity (MTFP) change was zero, a decrease by 100 percent between 2014-2016 due to a technical regress of 100 %. The MTFP change was zero in 2015 and 1. 036 in 2016, a growth in output by 3.6 per cent. On average nine hospitals (19%) recorded MTFP index of greater than one indicating growth in productivity explained by positive efficiency change. Conversely, thirty eight hospitals (81%) had MTFP Index scores of less than one indicating regress in productivity over time largely due to decline in technical efficiency.

Ten hospitals (21%) had an average pure efficiency change score of less than one, twenty four (51%) registered a pure efficiency change of one while thirteen (28%) have a pure efficiency change of more than one. The average pure efficiency change for the three years was 1.051 showing that pure efficiency change increased efficiency change by 5.1 percent. Similarly, one hospital (2%) recorded scale efficiency change of less than one, four hospitals (9%) had scale efficiency change of one while Forty two hospitals (89%) had scale efficiency change of more than one. The average scale efficiency change for the three years was 4.555 indicating that the scale of production on average increased efficiency change by 455 per cent. All the 47 hospitals (100%) recorded technical change of less than one indicating a decline in technical innovation. This largely explained why the overall MTFP was zero. Technological regression relies to a greater extend on access to health systems, complementary inputs, institutional changes, collaboration with stakeholders and teams and continuous training (Killick, 1981). For the 47 facilities to register positive productivity, adaptation of these initiatives will improve the technical change index.

CHAPTER FIVE

CONCLUSION AND POLICY RECOMMENDATION

Introduction

This chapter summarizes the results of the study regarding measurement of technical efficiency and productivity in faith based health facilities. The scores obtained are an important input in determining and recommending policy measures for adoption.

5.1 Study Summary

Global funding for HIV programs reduced byUS$511 million from US$7.5 billion in 2015 to US$7 billion in 2016 (Kaiser/UNAIDs, 2017). This complicates matters for HIV/AIDs partners such as faith based hospitals of Kenya that are 100% Pepfar dependent on this funding. With the limited resources, these partners are expected to integrate efficiency in their operations. A core objective of this study is to measure efficiency and productivity of 47 faith based hospitals running HV/AIDs programs in Western and Nyanza parts of Kenya from 2014 to 2016 using DEA technique. Output variables used are the number of patients tested and enrolled on ART while inputs are the number of medical officers, Nurses, Clinicians, Laboratory Technicians, Pharmacists, Coordinators, Community health workers and Counselors. Of 47 site facilities, Thirty two (68%), sixteen (34%) and Seventeen (36%) of the site facilities were run inefficiently in 2014, 2015 and 2016 respectively. 20 hospitals experienced decreasing returns to scale, 24 hospitals on average recorded constant returns to scale and 3 hospitals on average recorded increasing returns to scale for the three years under the study. The Malmquist index of annual mean was zero, a decrease by 100 percent between 2014-2016 due to a technical regress of 100%.

5.2 Policy Recommendation

For the facilities to record sustained efficiency scores, raft of measures is recommended. More resources should be allocated to the efficient facilities exhibiting increasing returns to scale and positive productivity since more is achieved with less while resources should be scaled down or transferred from less efficient facilities that exhibit Decreasing Returns to Scale and negative productivity tendencies (Kembo, 2015). The hospitals should also invest more in health care systems, institutional changes, collaboration with stakeholders and teams and continuous training (Killick, 1981), cut or transfer staff in facilities with decreasing returns to scale, introduce employee motivation programs (Kirigia et. al, 2008), develop clear, strategic and centralzed governance structure (Kinyanjui et.al, 2016) . Additionally, the health facilities should consider adoption of demand wise differentiated HIV testing and care initiatives such as promotional activities to key populations, women, men, children and youth clusters (Mwabu et.al, 1993). To achieve sustainability, the hospital management should adopt multi stakeholder approach by establishing a wider collaboration network to avoid dependence on a single donor in this case Pepfar.

5.3 Opportunities for further study

DEA has its limitations as a technique. Common among other limitations is that the DEA attributes any deviation from the frontier to inefficiency and is non-statistical. Contextual or environment factors were therefore not considered in the study since DEA does not capture random noise. Further, it was not possible to access factor prices of the inputs in this study in order to measure allocative efficiency. There is therefore need to use statistical techniques such as the Stochastic Frontier Analysis to determine efficiency levels in faith based hospitals. The study also focused only on faith based hospitals based in western and Nyanza parts of Kenya. There is need to include Pepfar funded faith based hospitals that exist in other parts of Kenya in order to have a national efficiency outlook of all faith owned hospitals.

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Appendix 1: Study area in Nyanza and Western Kenya

Source: Kenya Conference of Catholic Bishops- Kenya Aids Response Program

Appendix 2: Efficiency Scores per Site Facility

2014					2015					2016				
firm	crste	vrste	scale		firm	crste	vrste	scale		firm	crste	vrste	scale	
1	0.021	1.000	0.021	drs	1	0.650	0.755	0.860	drs	1	0.603	0.814	0.741	drs
2	0.130	1.000	0.130	drs	2	1.000	1.000	1.000	-	2	1.000	1.000	1.000	-
3	0.111	1.000	0.111	drs	3	0.845	0.845	1.000	-	3	0.791	0.917	0.863	irs
4	0.017	1.000	0.017	drs	4	0.904	0.947	0.954	drs	4	0.913	1.000	0.913	drs
5	0.014	1.000	0.014	drs	5	0.979	0.984	0.996	drs	5	1.000	1.000	1.000	-
6	0.173	1.000	0.173	drs	6	1.000	1.000	1.000	-	6	1.000	1.000	1.000	-
7	0.018	1.000	0.018	drs	7	1.000	1.000	1.000	-	7	0.860	0.990	0.869	drs
8	0.017	1.000	0.017	drs	8	1.000	1.000	1.000	-	8	0.964	0.981	0.982	drs
9	0.096	0.493	0.195	drs	9	0.699	1.000	0.699	irs	9	0.653	0.653	1.000	-
10	0.356	1.000	0.356	drs	10	1.000	1.000	1.000	-	10	1.000	1.000	1.000	-
11	0.016	1.000	0.016	drs	11	0.971	1.000	0.971	drs	11	1.000	1.000	1.000	-
12	0.023	0.799	0.029	drs	12	0.975	1.000	0.975	irs	12	1.000	1.000	1.000	-
13	0.052	0.957	0.054	drs	13	0.935	0.973	0.960	irs	13	1.000	1.000	1.000	-
14	0.048	0.743	0.064	drs	14	1.000	1.000	1.000	-	14	1.000	1.000	1.000	-
15	0.021	1.000	0.021	drs	15	0.969	0.992	0.977	drs	15	0.925	0.973	0.951	drs
16	0.014	1.000	0.014	drs	16	1.000	1.000	1.000	-	16	1.000	1.000	1.000	-
17	0.012	0.978	0.012	drs	17	1.000	1.000	1.000	-	17	0.960	0.970	0.990	drs
18	0.042	1.000	0.042	drs	18	1.000	1.000	1.000	-	18	1.000	1.000	1.000	-
19	0.016	1.000	0.016	drs	19	0.865	0.893	0.968	drs	19	0.764	0.788	0.969	drs
20	0.114	1.000	0.114	drs	20	1.000	1.000	1.000	-	20	1.000	1.000	1.000	-
21	0.104	1.000	0.104	drs	21	0.909	0.909	1.000	-	21	0.726	0.726	1.000	-
22	0.018	1.000	0.018	drs	22	1.000	1.000	1.000	-	22	1.000	1.000	1.000	-
23	0.025	1.000	0.025	drs	23	0.936	0.936	1.000	-	23	1.000	1.000	1.000	-
24	0.023	1.000	0.023	drs	24	1.000	1.000	1.000	-	24	1.000	1.000	1.000	-
25	0.070	1.000	0.070	drs	25	1.000	1.000	1.000	-	25	1.000	1.000	1.000	-
26	0.015	1.000	0.015	drs	26	0.781	0.781	1.000	-	26	0.560	0.665	0.842	irs
27	0.116	1.000	0.116	drs	27	1.000	1.000	1.000	-	27	1.000	1.000	1.000	-
28	0.019	1.000	0.019	drs	28	1.000	1.000	1.000	-	28	0.986	1.000	0.986	irs
29	0.015	1.000	0.015	drs	29	1.000	1.000	1.000	-	29	0.768	1.000	0.768	drs
30	1.000	1.000	1.000	-	30	1.000	1.000	1.000	-	30	1.000	1.000	1.000	-
31	0.597	0.597	1.000	-	31	0.689	0.689	1.000	-	31	0.972	0.972	1.000	-
32	0.496	0.496	1.000	-	32	0.533	1.000	0.533	irs	32	0.747	0.747	1.000	-
33	0.757	0.757	1.000	-	33	0.420	0.420	1.000	-	33	0.502	0.502	1.000	-
34	1.000	1.000	1.000	-	34	0.625	0.625	1.000	-	34	0.653	1.000	0.653	irs
35	0.017	1.000	0.017	drs	35	0.871	1.000	0.871	drs	35	1.000	1.000	1.000	-
36	0.012	1.000	0.012	drs	36	1.000	1.000	1.000	-	36	1.000	1.000	1.000	-
37	0.013	0.555	0.023	drs	37	0.864	0.913	0.947	drs	37	0.837	0.837	1.000	-
38	0.065	0.874	0.074	drs	38	1.000	1.000	1.000	-	38	1.000	1.000	1.000	-
39	0.015	0.246	0.061	drs	39	1.000	1.000	1.000	-	39	1.000	1.000	1.000	-
40	0.007	0.224	0.033	drs	40	1.000	1.000	1.000	-	40	1.000	1.000	1.000	-
41	0.014	1.000	0.014	drs	41	1.000	1.000	1.000	-	41	1.000	1.000	1.000	-

42	0.047	1.000	0.047	drs
43	0.022	0.974	0.023	drs
44	0.020	1.000	0.020	drs
45	0.015	0.662	0.023	drs
46	0.011	0.540	0.020	drs
47	0.013	1.000	0.013	drs
mean	0.124	0.891	0.154	

42	1.000	1.000	1.000	-
43	0.807	0.980	0.824	drs
44	1.000	1.000	1.000	-
45	0.766	0.766	1.000	-
46	0.625	1.000	0.625	irs
47	1.000	1.000	1.000	-
mean	0.907	0.945	0.961	

42	1.000	1.000	1.000	-
43	0.736	0.888	0.830	drs
44	1.000	1.000	1.000	-
45	0.876	0.876	1.000	-
46	0.887	0.887	1.000	-
47	1.000	1.000	1.000	-
mean	0.908	0.940	0.965	

Appendix 3: VRS Input Slacks Analysis

		INPUT									
Year	**Facility**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2014	H9			1	1						1
	H12			1							
	H13	1430872									1
	H14	976341								1	
	H17	11543785				1			33	1	
	H37				4	1			19	3	
	H38	692315			1						
	H39	1283718							2	1	1
	H40			1	1						
	H43	248377	1	2	1	1		1	14	1	
	H45	3817404				1	1				
	H46	3817404				1					2
Subtotal		**23810216**	**1**	**5**	**8**	**5**	**1**	**1**	**68**	**7**	**5**
2015	H1	3762123			4	1			10	1	
	H3	32807								2	
	H4								34	1	
	H5	171779				1		1	1		1
	H13					1					
	H15	8714334				1	1		17		1
	H19	6167166				2	1	1		2	
	H21	1807043			1	1					3
	H23				1	1		1	7		1
	H26								1		
	H31	30406									1
	H33	906496									
	H34	902922									
	H37	8727887	1			1			23		1
	H36										
	H43	7491645		1		1		1	5	3	
	H45					1	1				1
Subtotal		**38714608**	**1**	**1**	**6**	**11**	**3**	**4**	**98**	**9**	**9**
2016	H1	14571344			4	3	1	1	16	1	1
	H3	3223371			2	1	1			1	
	H7	11630959			1	1	1	1	7		
	H8	6066528			1	1				1	4
	H9							1	2		1
	H15	5190302				1			15		1
	H17	6909700	1			1	1		32	1	
	H19	11784627			1	1	1	1	6	2	
	H21	3564943			1	1		1			3

	H26	1209001									
	H31	311393									1
	H32	248740									
	H33	339931									
	H37	11881074	1	1		1			13	1	1
	H43	4633313		1		1		1	5	3	
	H45	3280868				1	1				1
	H46	1443008				1					2
Subtotal		**86289102**	**2**	**2**	**10**	**14**	**6**	**6**	**96**	**10**	**15**

Appendix 4: Output Slacks

		OUTPUT	
Year	**Facility**	**1**	**2**
2014	H9	338	
	H12		123
	H13		287
	H14		50
	H17		145
	H31	122	
	H32		92
	H33		63
	H38		77
	H39	259	
	H40		62
	H43		88
	H45		403
	H46	495	
Subtotal		**1214**	**1390**
2015	H1		140
	H3		58
	H13	127	
	H19		11
	H21		40
	H31		122
	H33	1498	
	H34	1367	
	H37	465	
	H43		244
	H45		368
		3457	**843**
2016	H1		265
	H8	5436	
	H9	508	
	H17		41
	H21	130	
	H31		168
	H32		93
	H33	1230	
	H37	65	
	H43		20
	H45		13
	H46		96
Subtotal		**7369**	**696**

Appendix 5: Malmquist Index Summary of Annual Means

year	effch	techch	pech	sech	tfpch
2	22.827	0.000	1.108	20.597	0.000
3	1.004	1.032	0.996	1.007	1.036
mean	4.787	0.000	1.051	4.555	0.000

Malmquist Index Summary of Firm Means

Firm	effch	techch	pech	sech	tfpch
1	11.330	0.123	1.176	9.632	1.389
2	2.775	0.153	1.000	2.775	0.423
3	2.674	0.130	0.958	2.792	0.347
4	7.367	0.151	1.000	7.367	1.114
5	8.559	0.102	1.000	8.559	0.876
6	2.401	0.103	1.000	2.401	0.247
7	6.907	0.149	0.995	6.941	1.032
8	7.568	0.117	0.990	7.641	0.883
9	2.603	0.080	1.151	2.263	0.207
10	1.675	0.097	1.000	1.675	0.162
11	7.800	0.131	1.000	7.800	1.021
12	6.547	0.000	1.119	5.851	0.000
13	4.401	0.137	1.022	4.305	0.601
14	4.569	0.153	1.160	3.939	0.699
15	6.643	0.138	0.986	6.735	0.915
16	8.557	0.133	1.000	8.557	1.139
17	9.029	0.113	0.996	9.064	1.024
18	4.866	0.000	1.000	4.866	0.000
19	6.923	0.128	0.888	7.798	0.887
20	2.959	0.103	1.000	2.959	0.305
21	2.647	0.000	0.852	3.107	0.000
22	7.438	0.131	1.000	7.438	0.978
23	6.297	0.000	1.000	6.297	0.000
24	6.656	0.126	1.000	6.656	0.840
25	3.771	0.156	1.000	3.771	0.590
26	6.157	0.000	0.816	7.550	0.000
27	2.931	0.113	1.000	2.931	0.330
28	7.211	0.000	1.000	7.211	0.000
29	7.251	0.118	1.000	7.251	0.856
30	1.000	0.081	1.000	1.000	0.081
31	1.276	0.082	1.276	1.000	0.105
32	1.227	0.084	1.227	1.000	0.103
33	0.815	0.000	0.815	1.000	0.000
34	0.808	0.000	1.000	0.808	0.000
35	7.574	0.113	1.000	7.574	0.859

36	8.950	0.000	1.000	8.950	0.000
37	8.019	0.131	1.228	6.528	1.051
38	3.923	0.132	1.069	3.668	0.518
39	8.170	0.092	2.015	4.054	0.753
40	11.697	0.000	2.112	5.539	0.000
41	8.588	0.000	1.000	8.588	0.000
42	4.596	0.000	1.000	4.596	0.000
43	5.722	0.161	0.955	5.995	0.924
44	7.040	0.134	1.000	7.040	0.942
45	7.579	0.108	1.150	6.589	0.822
46	9.079	0.113	1.281	7.089	1.022
47	8.912	0.114	1.000	8.912	1.016
mean	4.787	0.000	1.051	4.555	0.000