DETERMINANTS OF TECHNICAL EFFICIENCY IN CHAM FACILITIES IN MALAWI

MASTER OF ARTS (ECONOMICS) THESIS

NICHOLOUS DELSON MPHANGWE MKANDAWIRE

UNIVERSITY OF MALAWI

CHANCELLOR COLLEGE

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By

NICHOLOUS DELSON MPHANGWE MKANDAWIRE
B.Sc. (Agri-Business Management)-University of Malawi

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Chancellor College

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DECLARATION

I, the undersigned declare that this thesis is my original work and hence any errors made herein are mine alone. The opinions expressed in the study are those of the researcher and do not necessarily represent the views of the supervisors. Where other researchers' work has been used, due acknowledgements have been made accordingly. I further declare that this thesis has never been submitted in any university or any institution of high learning for similar purposes.

NICHOLOUS DELSON MPHANGWE MKANDAWIRE

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Full Legal Name

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Signature

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Date

CERTIFICATE OF APPROVAL

I declare that this thesis is the student's own work and effort and where he has used other sources, acknowledgement has been duly made. Hence the thesis is submitted with my approval on behalf of the University of Malawi, Chancellor College, Zomba.

__________________________________Date: _______________________________

Spy Munthali, PhD (Senior Lecturer)

SUPERVISOR

DEDICATION

This work is dedicated to Dr. and Mrs. Zidana and my four brothers Kelvin Mkandawire (late), Lloyd Mkandawire, Elliot Mkandawire and Penjani Mkandawire and lastly but not least my lovely Mum Eunice Kapira Mkandawire.

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ABSTRACT

The main objective of this study was to determine technical efficiency of CHAM facilities and some of its determinants in Malawi. This study used input and output variables from 26 CHAM facilities in Malawi using a two- stage analysis involving data envelopment analysis and tobit regression. The study finds that most CHAM facilities (69%) are technically efficient in Malawi and that only 31% of CHAM facilities are operating at optimal scale size having a scale efficient score of 100%. The study further finds that increase in average length of stay; bed turnover ratio and regional location of a facility in the north decreases technical inefficiency in CHAM facilities. The results of this study showed that 31% of CHAM facilities are operating at less than optimal level. This finding implies that the inefficient hospitals could significantly improve their efficiency by better resource management. The study concludes that decision makers and administrators of the inefficient facilities could identify causes of inefficiencies and take appropriate actions and in some cases consider downsizing both the services provided and staff compositions of inefficient facilities to increase efficiency.

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LIST OF ACRONYMS

ANC	Antenatal Clinic
AIDS	Acute Immune Deficiency Syndrome
ASWAp	Agriculture Sector Wide Approach
ALoS	Average Length of Stay
BTR	Bed Turnover Ratio
BCC	Banker, Charnes and Cooper
CHAM	Christian Health Association of Malawi
CLAD	Censored Least Absolute Deviations
CCR	Charnes, Cooper and Rhodes
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DHS	Demographic and Health Survey
DMU	Decision Making Unit
DRG	Diagnosis Related Groups
DRTS	Decreasing Returns to Scale
DHS	Demographic Health Survey
EHP	Essential Health Package
GDP	Gross Domestic Product
GoM	Government of Malawi
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information System
HSA	Health Surveillance Assistant
IPD	Inpatient Department
IHS	Integrated Household Survey
IRTS	Increasing Returns to Scale
JICA	Japanese International Cooperation Agency
IPD	Inpatient Department
INPD	Inpatient Days
LP	Linear Programming

MPSS	Most Productive Scale Size
MPI	Malmquist Productivity Index
MDGs	Millennium Development Goals
MGDS	Malawi Growth Development Strategy
MoH	Ministry of Health
MoU	Memorandum of Understanding
MNHA	Malawi National Health Accounts
NHA	National Health Accounts
NSO	National Statistical Office
OECD	Organisation of Economic Cooperation and Development
OPD	Outpatient Department
OCC	Bed Occupancy Rate
PHC	Primary Health Care
PPP	Public-Private Partnership
PNFP	Private Not For Profit
PoW	Programme of Work
RTS	Returns to Scale
SE	Scale Efficiency
STI	Sexually Transmitted Infections
SFA	Stochastic Frontier Analysis
SLA	Service Level Agreements
STI	Sexually Transmitted Infections
SSA	Sub-Sahara Africa
TE	Technical Efficiency
TB	Tuberculosis
UNFPA	United Nations Population Fund
UNICEF	United Nations Children Fund
VAHs	Voluntary Agency Hospitals
VRS	Variable Returns to Scale
VCT	Voluntary Counselling and Testing
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background Information

The vision of the health sector is to achieve a state of health for all the people of Malawi that would enable them to lead a quality and productive life (GoM, 2011). This implies that all stake holders use available resources efficiently to maximize health gains since resources are usually limited. The Ministry of Health has a responsibility to ensure that opportunities identified for health service delivery are appropriate to address client needs efficiently (GoM, 2011). This is important because resources are limited and hence they have to be used efficiently. Efficiency is defined as the pareto optimal allocation of resources (Aday et al., 1998). Pareto efficiency implies that the production system cannot increase one unit of production without decreasing production of the other unit. A firm is technically efficient when it produces the maximum outputs from a given amount of inputs or produces a given output with minimum inputs quantities (Hollingsworth, 2003). The health of the population determines the productivity of a nation as sick people are not productive, as such the health of every nation is critical and essential for the development agenda of that nation. Since resources are scarce; it is important that they are used efficiently. In the presence of inefficiencies, costs of service delivery are overvalued, you use more resources to produce less, output levels and quality are below desired levels. This leads to wastefulness on resource use and compromises on the quality of the health of the nation.

The government is the largest provider of services and accounts for 61% of health facilities (Phoya et al., 2014). This is followed by the not for profit Christian Health Association of Malawi (CHAM). CHAM provides 37% of national health facilities (Phoya et al., 2014). CHAM is a non-profit body made up of independent church-related health facilities and the government assists it by providing it with an annual grant that covers part of its local staff salaries. The objectives of CHAM are to coordinate, facilitate, provide technical support and develop health services among all members in order to provide quality health care and in all matters act for the benefit of people of Malawi. CHAM facilities charge user fees for treatment, with the exception of growth monitoring, immunization and community-based preventive health care services including treatment of specific communicable diseases such as tuberculosis, sexually transmitted infections (STIs) and leprosy (MoH, 2007). Eighty percent of CHAM facilities are in rural areas ((Phoya et al., 2014). The Malawi Government in 2002 embarked on an innovative health care financing mechanism called Service Level Agreement (SLA) with Christian Health Association of Malawi (CHAM) institutions that are located in areas where people with low incomes reside. The rationale of SLA was to increase access, equity and quality of health care services as well as to reduce the financial burden of health expenditure faced by poor and rural communities (GoM, 2005).

CHAM facilities were contracted by the Ministry of Health (MoH) to provide specific health care services to people within their catchment area free of charge. Out of the 172 CHAM facilities, 76 have SLAs through which the Ministry of Health (MoH) pay for maternal and neonatal health services which are then delivered free by CHAM (Phoya et al., 2014).

The ministry of health and CHAM relationship has three main features. Firstly government provides a salary grant to all 176 CHAM facilities, through the CHAM Secretariat, to pay for all agreed established staff at those facilities. This salary grant makes the Government of Malawi the largest financial contributor to CHAM services. Secondly the MOH pays bursaries for students to attend CHAM health training institutions, which train approximately 80% of Malawi's mid-level health professionals, mainly nurses and midwives and thirdly district health offices have entered into Service Level Agreements with selected CHAM facilities to provide selected services for free in their health facilities, usually maternal and neonatal health services, with the district reimbursing CHAM at an agreed rate for services provided.

Although CHAM provides services at a fee except where there are service level agreements, it is generally perceived that the quality of care in these facilities is relatively better than that of public facilities (MoH, 2007). The main argument is that the two sets have completely different financing regimes, there is bound to be differences in staff morale, availability of medical supplies and hence quality of care and eventually, technical efficiency (Pasiya, 2009). It is therefore, important that a study be done assessing the technical efficiency of CHAM facilities in Malawi whose results can be compared with similar studies that focused on government hospitals such as a study by Chapotera (Chapotera, 2006).

1.2 Problem Statement

Malawi has serious resource scarcity problem, it is therefore important that the limited country's resources, including those specifically allocated to the health sector are put to optimal use. The per capita expenditure on health (US$ 34) in Malawi falls far short of the US$ 54 per capital expenditure as recommended by WHO (GoM, 2016) for low income countries. In using meager resources it is important to avoid wastage. On the other hand inefficiency in the allocation and use of health sector resources is one of the inherent problems of the health systems in sub-Saharan Africa at large (Phoya et al, 2014). In Sub-Saharan Africa, hospitals account for the bulk of government's health sector expenditure, ranging between 45-69% (Kirigia *et al*, 1998). In Malawi two studies were conducted on technical efficiency in public health facilities by Chapotera and Malawi government and found that only 22% and 23% respectively of the sampled hospitals were efficient. The results revealed that public health care facilities are not maximizing health care outcomes from available resource endowments. It is therefore, imperative to assess the efficiency of the sector in Malawi especially in CHAM facilities, as a step towards identifying and eliminating inefficiencies. This is because unless inefficiencies are identified and eliminated, resources will keep on leaking out of the health care system, and wastage through spending more than necessary on inputs to produce health care outputs will continue in Malawi.

1.3 Study Justification

The subject of technical efficiency in the health sector is of great significance; efficiency of health facilities is a key element to health policy. Although this is the case, there is very little published research on technical efficiency that has taken place in Africa and particularly in Malawi. Since resources are limited it is wise to avoid wastage. Technical inefficiency would contribute to the resources available being inadequate to the achievement of the health goals in the Vision 2020. The vision 2020 which is a long-term development vision for Malawi prepared to serve as a base for short and medium-term plans that will lead to the vision that Malawians see for the year 2020 (NSO, 2001). It is implemented using medium term strategies such as the Malawi Growth Development Strategy (MGDS) I and II (Phoya et al, 2014). Inefficiency would adversely affect government's effort to achieve a state of health for all the people of Malawi that would enable them to lead a quality and productive life (GoM, 2011). The MGDS recognizes that a healthy and educated population is necessary if Malawi is to achieve sustainable economic growth (Phoya et al, 2014).Since resources are limited, it is important to ensure that they are used efficiently and hence the significance of this study cannot be over emphasized. There is a research gap on technical efficiency of individual hospital performance in the country and no specific study on technical efficiency on CHAM facilities. The two studies on hospital performance which had a component of CHAM facilities one conducted by Pasiya in 2009 and the other one by Ministry of Health in 2008, firstly only had mission hospitals as a component but had largely still focused on the government hospitals and that both of them used the out-put oriented approach in calculating technical efficiency. This study is therefore aimed at bridging the information gap and generating important evidence on the state of technical efficiency of CHAM facilities in the country by focusing fully on CHAM facilities and using*(output oriented approach)* in calculating technical efficiency.

The study assessed the technical efficiencies of CHAM facilities in Malawi using the data envelopment analysis and tobit regression model using cross sectional data of 2015 of CHAM facilities.

1.4 Objectives of the study

1.4.1 Main Objective

The main objective of the study was to determine the technical efficiency of CHAM facilities and some of its determinants in Malawi.

1.4.2 Specific Objectives:

i. Evaluate the technical efficiency of CHAM facilities in Malawi
ii. Evaluate the Scale efficiency of CHAM facilities in Malawi
iii. Identify factors that affect state of efficiency of CHAM facilities in Malawi

1.5 Study Hypotheses

The above objectives will be achieved by testing the following null hypotheses;

i. There is no technical efficiency in CHAM facilities in Malawi.
ii. There is no significant difference in technical and scale efficiency in CHAM facilities.
iii. The following factors, high bed occupancy rates; hospital regional location, longer average days of stay; increase in number of beds per facility; increase in number of inpatient days do not affect technical efficiency in CHAM facilities.

1.6 Uniqueness of this study

This study is different from other studies conducted in the country on same subject in a number of ways.

Chapotera in 2006 conducted a study focusing on determining factors influencing inefficiency in government public hospitals using data envelopment analysis and tobit regression but left out a very important sector in the health in the name of CHAM in Malawi and this study is different as it addresses this gap by assessing the technical efficiency of CHAM facilities in Malawi.

Pasiya in 2009 conducted a study that was comparing the two ownership regimes government and privately owned hospitals. The objective of the study was to determine technical efficiency and scale efficiency using Malmquist indices which gives total factor productivity and focused mainly on one component, namely efficiency change which was also output oriented and variable returns to scale. This study is different in that it determined the technical efficiency of CHAM facilities and used cross sectional data for 2015 and used the data envelopment analysis out-put oriented approach.

The MoH in 2008 conducted a study assessing the technical efficiency of Hospitals in Malawi; they used the data envelopment analysis output oriented model. This study is different in that it used the data envelopment analysis output oriented approach and used the cross sectional data for 2015 CHAM facilities.

1.7 Organisation of the study

The study is organized as follows: In chapter one the study introduces the subject of technical efficiency, then define the problem statement and justification. This chapter is closed with the objectives and their corresponding hypothesis. Chapter two focuses on the general macroeconomics to the health sector in Malawi. In chapter three which is literature review, the study presents the theoretical and empirical literature. In chapter four the focus is on the methodological part of the study. In chapter five, the study discusses the results and discussion. The study winds up with conclusions and recommendations in chapter 6.

1.8 Summary of Chapter

The chapter started with the background information on efficiency and CHAM facilities, then introduced the problem statement followed by justification to the study, then went on further to present the objectives of the study with their hypothesis then reviewed the uniqueness of the study visa vi other studies in Malawi. This chapter was concluded by organization of the rest of the study.

CHAPTER TWO

OVERVIEW OF THE HEALTH SECTOR IN MALAWI

2.1 Introduction

This chapter focuses on the general macroeconomics to the health sector in Malawi. This deals with health related issues and structural arrangements likely to have effect on hospital operations including efficiency in Malawi. It firstly gives the structure of Malawi's health sector, then some of the general health indicators status, then the disease burden, followed by health financing issues and finally some of the problems facing the sector.

2.2 Structure of Malawi's Health Sector

The health sector in Malawi consists of primary, secondary and tertiary levels (GoM, 2011). The health system infrastructure, consisting of dispensaries, health centres, and district and central hospitals is linked through a referral system (GoM, 2011).

Primary level services are delivered by rural hospitals, health centres, health posts, and outreach clinics (MoH, 2014). Primary level does not have admissions except in some of the health centres where they have a maternity wing. The secondary level, consisting of public district hospitals and the CHAM hospitals, mainly supports the primary level by providing surgical backup services, mostly for obstetric emergencies, and general medical and paediatric inpatient care for common acute conditions (MoH, 2014). Some of these have limited specialist functions. Tertiary hospitals provide services similar to those at the secondary level, in addition to a small range of specialist surgical and medical interventions (GoM, 2016). The district hospitals act as referral for health centres and dispensaries within their particular district while the central hospitals and specialised hospitals act as referral for the district hospitals. All the levels of provision of health care are linked through a referral system.

Malawi's health system is further classified into formal and informal aspects, besides the above classification. The main players in the informal sector are the traditional healers and traditional birth attendants. The traditional birth attendants were formerly banned in Malawi.

2.3 Ownership of Health Care Facilities in Malawi

Table 1: Ownership of Health Care Facilities in Malawi

Ownership	**Primary**	**Secondary**	**Tertiary**	**Others**	**Total**
Government (MoH)	493	53	5	5	**556 (48%)**
CHAM	112	49	1	14	**176 (15%)**
NGO	56	1	0	13	**70 (6%)**
Private for Profit	166	4	1	0	**171 (15%)**
Statutory Org	130	0	0	7	**137 (12%)**
Companies	47	0	0	0	**47 (4%)**
Total **%**	**1004** **(87%)**	**107** **(9%)**	**7** **(1%)**	**39** **(3%)**	**1,157** **(100%)**

Source: GoM (2014)

According to table 1, 48% of health facilities in Malawi is owned by the Ministry of Health,15% by CHAM which is also second largest provider of health services,15% by private for profit, 6% by NGOs, 12% by Statutory organization and 4% by companies.

CHAM has a membership of 176 health facilities (GoM, 2014). According to table 1, the largest numbers of facilities among CHAM facilities are health centres 112 providing primary health care, followed by 49 facilities proving secondary with only 1 tertiary hospital. About 90% of CHAM facilities are located in the rural areas where government facilities are not found (MoH, 2014). This makes CHAM a particularly very important provider of health services in rural areas. CHAM also offers training for nurses and other health personnel in collaboration with the government (MoH, 2014). While CHAM Provides the necessary training for nurses, medical assistants and clinicians, the government provides annual grants and employment for the same. The MOH also subsidies the CHAM Hospitals by paying salaries to some of staff employed under CHAM.

2.4 General Health Indicators for Malawi

The national life expectancy from birth was at 47 years as of 2000 and increased to 53 years in 2008 according to WHO (WHO, 2010). And increased further in2015 to be at 60.1 years (United Nations, 2015).The life expectancy is within the acceptable ranges against countries in Sub-Saharan Africa within the same year 2015, Zambia 60.79 years (United Nations, 2015) , Zimbabwe 59.16 years (United Nations, 2015), Mozambique 54.6 years (United Nation, 2015) and Tanzania 65.49 years (United Nations, 2015) .Despite that, this is significantly lower than the global average life expectancy which according to the United Nations world population prospects was at 71.5 years in 2015. This low life expectancy in Malawi can largely be attributed to malaria, HIV/AIDS, chronic malnutrition, sub-standard health services, and inadequate access to safe drinking water and proper sanitation (NSO, 2011).

Table 2 below show some of the important health indicators of Malawi between the year 2004 and 2014. There have been improvements in some of the important health indicators of Malawi. Maternal mortality rate (MMR) decrease from 984 deaths in 2004 to 675 deaths in 2010 and further to 574 in 2014, within the same period under 5 mortality rate (UMR) decreased from 133 in 2004 to 85 in 2014 (GoM, 2014). Infant mortality rate (IMR) on one hand decreased by 30% from 76 deaths for every 1,000 live births to 53 deaths for every 1,000 live births in 2014 (GoM, 2014). Even though this is the case, these rates are also on average among the lowest in Sub-Saharan Africa compared to countries within the same region for example maternal mortality rate per 100,000 live births in 2014 was at 574 in Malawi against 224 in Zambia and 382 in Tanzania, in terms of infant mortality rate per 1,000 live births in Malawi was at 85 in 2014 against 70 in Zambia, 61.8 in Zimbabwe and 70 in Tanzania WHO (2015).

Table 2: Some of the Health Indicators of Malawi

Year	**2004 (DHS, 2004)**	**2010 (DHS, 2010)**	**2014 (MDG, 2014)**
Infant Mortality Rate (per 1,000 live births)	76	66	53
Under-5 Mortality Rate (Per 1,000 live births)	133	112	85
Maternal Mortality rate (Per 100,000 live births)	984	675	574
HIV Prevalence rate (%)	11.8	10.6	9.11

Source: (GoM, 2005, 2014), (NSO, 2011)

Though there were some improvements in some of the indicators there were deterioration in others and the overall targets were not meet (GoM, 2014). The MoH (2007) study attributes the worsening in some of the indicators to deteriorating service delivery in the district hospitals (non-availability of emergency obstetric services and nurse-midwifery services), HIV/AIDS infection of mothers to children, high population growth, shortage of drugs and insufficient trained professional.

2.5 The health service delivery in Malawi

The government health services provided at the health facilities around the country are for free. This is a national healthcare service which is free to all Malawians at the point of delivery. The government services are provided at three levels firstly at health centres which is the local level then at rural hospital which is secondary level and lastly at district hospitals and central hospitals as the highest level which is the tertiary level. In most health facilities due to limited funding for thoroughly investigations, there is limited investigation done before diagnosis. This implies most patients are treated on try and error basis without properly establishing the real cause of the problem. The challenge has been lack of infrastructure and resources in most facilities as most laboratory, imaging, and testing facilities are often only available at the major district hospitals. Malawi has very few doctors, it is estimated that only one doctor for every 88,300 people in Malawi (MoH, 2005). Most hospitals are staffed by clinical officers those who are trained for a minimum of four years, and are experienced practitioners and Medical Assistants which are trained for a minimum of three years (MoH, 2005). In the work place the clinical officers and medical assistants are usually in charge. They are the ones responsible to diagnose, treat and prescribe patients. The nurses usually dispense and manage simple conditions. At the lowest level of the hierarchy we have the Health Surveillance Assistants (HSAs) whose responsibilities include the management of the community health needs, assisting in clinics, collating all records, and performing VCT (Voluntary Counselling and Testing for HIV/AIDS.)

Malawi has a defined organizational structure in place for health service delivery; even though this is the case the implementation of Essential Health Package (EHP) has been very limited. A JICA/MoH inventory in 2002 found that only about 9% of government and mission health facilities were capable of providing the EHP onsite (Calcon 2003). The situation is such that in each district, only one or two facilities had adequate EHP capacity. These service deficits arise from lack of health workers, supply stock-outs, and lack of basic utilities (water, electricity, phone or radio communication) (Calcon 2003).

2.6 Health Financing

The Ministry of Health services are entirely financed by the government and donors. It is estimated that the secondary and tertiary levels consumes up to two thirds of the Ministry's financial resources currently (GoM, 2007). The two levels are also responsible for support and guidance of the lower structures in regard to supervision, training and patient referral (GoM, 2007). Even though currently public health services provided at Government health institutions are for free, Government is in the process of exploring mechanisms for cost sharing, while maintaining free services for vulnerable citizens (GoM, 2014). The Ministry intends to explore and where feasible, introduce alternative sources of health financing in Malawi. A report of the national health accounts highlighted that 20% of total health costs in the health sector are from out of pocket expenditures (GoM, 2001). There are also other platforms put in place to increase financing in the health sector, one of the measures put in place wasto increase financing was Programme of Work (POW). The development and implementation of the Malawi Programme of Work 2004-10 (POW) through the Sector-Wide Approach (SWAp) to health financing and management; design of the Essential Health Care Package (or EHP, which provides certain basic health care services free of charge); and increased donor support through the Global Fund to Fight AIDS, Tuberculosis and Malaria, World Health Organization (WHO) 3x5 Initiative, U.K (MoH, 2007).

National Health Accounts (NHA) is a framework established to account for cash inflows and outflows in the health system. It shows where funds come from and how they are being used. It is a framework accepted and recognized internationally. For example, in the year 2004/5 donors were the major source of financing for health care services and goods, contributing an average of 56%; second was the public sector, at 28%, and third the private sector, at 16% (MoH, 2005)

The amount committed to the Health system in Malawi has been increasing over the years. In a Ministry of Health 2012, Malawi Health Sector Strategic Plan show that government of Malawi dramatically increasing its level of spending from an estimated $ US46.3 million in 2004/05 to $US134 Million in 2009/10 (GoM, 2011). It also indicate total health spending rose from $US5.3 per capita in 2009/10 − far less than the US$34 per capita per annum that the World Health Organization's Commission on Macroeconomics and Health recommended in 2001 for delivering basic essential health care interventions in developing countries.

2.7 The Disease Burden

The productivity of labour force depends upon the health status of a population. MDHS carried out a study in 2000 that revealed that Malawi had among the worst health indicators in the world. As a result of poor health indicators Malawi population remain sickly (42.7% reported sick with fever or malaria (IHS3, 2011)) and poor (52.4% headcount poverty rate, Malawi) (IHS2, 2005). It is reported that the bulk of the disease burden in the country is due to communicable (infectious) diseases such as malaria, tuberculosis (TB), HIV/AIDS and sexually transmitted infections (STIs) in addition to malnutrition (MoH, 2007).

The (WHO, 2006), states that about 3.3 billion people (half the world's population in 2006) were at risk of malaria, and that malaria kills nearly one million people worldwide every year. In Africa, one in five childhood deaths (20%) are due to the effects of the disease (WHO, 2010). Malawi is no exception: malaria is still the leading cause of death in the country. Malaria is the leading cause of morbidity and mortality especially among children under the age of five years and pregnant women (NSO, 2001). 40% of the deaths of children of less than 2years are related to malaria and it is also one of the causes of pregnancy loss, low birth weight and neonatal mortality. Malaria has become number one killer (MoH, 2005). It accounts for 40% of all outpatient visits in all health facilities (MoH, 2005).Diarrhoea diseases, cholera and acute respiratory infections also contribute significantly to outpatient visits (GoM, 2001). The vulnerability of the country to diseases such as these reduces and compromises on the country's' labour force and consequently reduces production not only by reducing number of people to be productive at a particular time but also channelling most resources to the health sector which could have been used in the production process.

HIV/AIDS is one of the deadliest diseases in the world, like many countries in Africa; the rate of people living with HIV/AIDS in Malawi is extremely high (GoM, 2005). WHO officially recognizes that as of 2015, 9.6% of the population in Malawi is HIV positive (WHO, 2015).The 2010 HIV prevalence rate of 11.6 percent of the adult population indicates a generalized epidemic (NSO, 2011).This indicates a slight decrease in number of people living with HIV compared to the 2004 of 12%. HIV/AIDS related conditions account for about 40% of all inpatient admissions (GoM, 2005) in Malawi. This epidemic has negatively affected the social and economic fabric of the nation given that it is mostly the productive age group that is infected with the virus. This slows and weakens the production process. The Joint United Nations Programme on HIV/AIDS (UNAIDS) in its 2010 global report stated that there were 920,000 adults and children living with HIV in Malawi in 2009 (UNAIDS, 2010). This is quite a large number of people living with HIV this implies more money for ARVs and other resources will have to be allocated for their drugs and care which could have been used otherwise.

However, one of the greatest obstacles to ARV use in Malawi is low percentage of people who get tested early. A majority of clients only confirm that they have the disease through testing once they have progressed to the final stages of AIDS (USAID/Malawi, 2009). There is a usually limited option when people leave their diagnoses and treatment to very end, when the infection has reached the most critical stages.

Reported cases of Tuberculosis increased from about 5000 in 1985 to 25,000 in 2002 (Conticini, 2004).The overall number of new TB cases reported in 2009 was 48,144 (UNAIDS, 2010).According to Conticini (2004) this rise was mostly due to the association between HIV/AIDS and TB.The case fatality rate for TB in Malawi is at 20 %. Tuberculosis (TB) and HIV/AIDS are closely linked in Malawi with 72 percent of all TB patients co-testing as HIV positive. This continuously increase in reported TB cases is worry some as people who are sick are a burden and a cost to the nation as they cannot actively participate in the development agenda.

According to the (WHO, 2015), Malnutrition still remains as one of the major health problems facing the developing world, and is one of the leading causes of death in Malawi. Malnutrition is in two fold lack of food and taking unbalanced diet. WHO cites malnutrition as the single greatest threat to the world's public health (WHO, 2006).The MDHS 2004 states that "malnutrition is one of the most important health and welfare problems among infants and young children in Malawi, and stems from inadequate food intake and illness— especially related to lack of sanitation—which is reflective of underlying social and economic conditions" (GoM, 2005). WHO, states that only 15.8% of all children under five in Malawi are at a balanced diet while 53.2% of children under five are identified as stunted (low height for their age) (WHO, 2006). The (NSO, 2011) identifies 4.2% of the children under five as wasting (low weight for their height) and 18.9% as critically underweight. It is also reported that 13% of all babies in Malawi are born underweight; often as a result of malnourishment present in the mother herself and that 47.3% of pregnant women and 63% of children under five have anaemia (NSO, 2011). Malnutrition is a major burden on the health sector and the nation of Malawi at large. Therefore the nation needs to have measures to ensure it is controlled and minimised as much as possible.

2.8 Challenges Facing the Health Sector

There are a number of challenges that keep dragging the performance of Malawi's health sector. Despite the notable strides made in achieving five of its eight Millennium Development Goals (MDGs) (GoM, 2014). These goals were eradicating extreme poverty and hunger; reducing child mortality; combating HIV and AIDS, malaria, and other diseases; ensuring environmental sustainability; and developing global partnerships for development (NSO, 2011). The Health Sector continues to experience a number of challenges which include but are not limited to:

- Shortage of trained health professionals is one of the main problems that the health sector faces. The health sector in the country faces a big challenge from inadequate skilled personnel. The delivery of services is severely affected by the limited number of human resources in the sector. This is contributed by the population size serviced by the government facilities as there are too many people serviced by them than their private counterparts. According to Contincini some of the contributing reasons include resignations due to poor working conditions, low salaries, migration to other sectors and other countries, and deaths of employees due to HIV and AIDS (Contincini, 2004). The intensity of the problem is more pronounced in the rural areas, for instance, over 95% of registered nurses are urban based leaving significantly higher vacancy rates in under-served rural areas where over 80% of the population resides (GoM, 2006). This skewness in employment is mainly due to the unattractive working environment in the rural areas, such as lack of social amenities and accommodation. This shortage of staff has adversely affected the coverage and quality of health care in the country in that a hospital or health facility can only be established if there are the relevant health personnel to serve the people (Conticini, 2004).

- Shortages of essential medicines and medical supplies;
- Shortages and malfunctioning of medical equipment and devices;
- Inadequate and dilapidating hospital infrastructure;
- Poor food for patients;
- Unsatisfactory ambulatory or transport services;
- Inadequate hospital operating finances
- High maternal mortality rate.
- Increased disease burden – both communicable and non-communicable

2.9 Summary of Chapter

The chapter has provided an overview of the Malawi's' health sector, ownership of health care facilities in Malawi, the general health indicators for Malawi, the health service in Malawi, health financing, the disease burden and challenges facing the health sector in Malawi. The review of Malawi's health sector has revealed thatit has an extensive and comprehensive health system infrastructure, consisting of dispensaries, health centres, and district and central hospitals linked through a referral system which is the formal sector. Despite that there are two sectors the informal and formal, services are mainly provided by the latter. The reason being there is no legal framework within which the informal can operate. The general health indicators for Malawi reveal that there has been improvements in recent years in general health indicators even though the indicators still remain among the lowest the in the world. The health financing revealed that Malawi's health services are to a greater extent financed by the government and donors. The chapter also revealed that there is a lot of pressure on the sectors resources due to the enormous disease burden. In addition to the disease burden; there are several other challenges facing the health sector in Malawi such as lack of adequate qualified personnel, shortages of essential medicines and medical supplies; shortages and malfunctioning of medical equipment and devices; inadequate and dilapidating hospital infrastructure; poor food for patients; and unsatisfactory ambulatory or transport services just to mention but a few.

The next chapter presents the literature reviewed to inform this study.

CHAPTER THREE

LITERATURE REVIEW

3.1 Theoretical literature on Efficiency

3.1.1 Definition of Efficiency

Farrell in 1957 defined the efficiency of a firm as its success in producing as large as possible an output from a given set of inputs (Farrell, 1957). Skaggs and Carlson building on Farrell's definition in 1996 defined economic efficiency as obtaining the maximum benefit from a given cost or minimizing the cost of a given benefit (Skaggs and Carlson, 1996). In other words they defined economic efficiency as maximizing the net gains from an action.

The efficiency of any production unit has two components: − technical efficiency; and − Allocative efficiency (This is inclusive of hospitals). Technical efficiency (TE) refers to the ability of a hospital to produce maximum output that is feasible from a given level of inputs (i.e. maximizing output from a given level of inputs). This is an output orientated definition. The input orientation definition on TE is defined as minimizing input/resource use for a given level of outputs (Farrell, 1957). Estimation of allocative efficiency on the other hand requires data on quantities of health service outputs, health system inputs, and input prices. Technical efficiency describes the production by a health Decision Making Unit (DMU) of the optimal/maximum quantity of outputs from the available health system inputs (Salvatore, 2008). Alternatively, technical efficiency can be said to be achieved where a DMU produces a given level of health service outputs with the least health system inputs, e.g. labor force, pharmaceutical and non-pharmaceutical supplies, capital inputs such as equipment, vehicles, beds and buildings. In order to be economically efficient, a firm must first be technically efficient (Kirigia and Asbu, 2013). To maximize profit a firm requires to maximize output produced at a given level of inputs employed (technical efficiency), use the right mix of inputs in light of the relative price of each input (input allocative efficiency) and produce the right mix of outputs given the set of prices (output allocative efficiency) (Kumbhakar and Lovell, 2000).

The technical efficiency of a health DMU can be broken down into pure technical efficiency and scale efficiency. Pure technical efficiency denotes health decision making unit technical efficiency that cannot be attributed to deviations from optimal scale (scale efficiency). Whereas scale efficiency is a measure of the extent to which a health decision making unit deviates from optimal scale (defined as the region in which there are constant returns to scale in the relationship between outputs and inputs) (Fried et al, 1993). Salvatore in his study in 2008 defines returns to scale as the extent to which health system output changes as a result of a change in the quantity of all health system inputs used in production to produce health outcomes. Palmer and Torgenson in their study in 1999 defined the health outcomes to be either intermediate outputs (number of patients treated, patient-days) or a final health outcome (lower mortality rates, longer life expectancy). Hospitals use multiple inputs to produce multiple outputs. Where the quantity of all hospital inputs is increased by same proportion as the quantity of outputs, a constant return to scale is achieved. On the other hand, an increasing return to scale is achieved if output increases by a greater proportion than the increase in inputs and a decreasing return to scale is achieved where output increases by a smaller proportion than the increase in inputs. Where a DMU has more control on inputs then an input oriented will be preferred and where a DMU has more control on outputs then an output oriented would be preferred.

Thus Technical efficiency can be illustrated graphically using either a two-input (x_1 , x_2) or a two-output (y_1, y_2) production process (Figure 1 and Figure 2). The choice on which graph to use will depend on whether CHAM facilities have more control on outputs or on inputs. Since CHAM facilities has more control on outputs as the MoH determines the number of inputs (labour) at each facility. Technical efficiency for CHAM facility will therefore be the optimal output that could be produced given a set of inputs (an output orientation definition). Technical efficiency can also be considered in terms of the optimal combination of inputs to achieve a given level of output (an input-orientation definition).

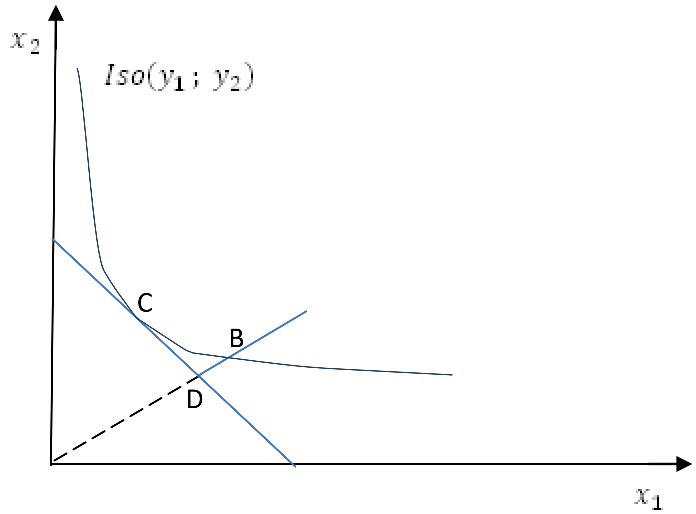

Figure 1: Input-oriented efficiency measure

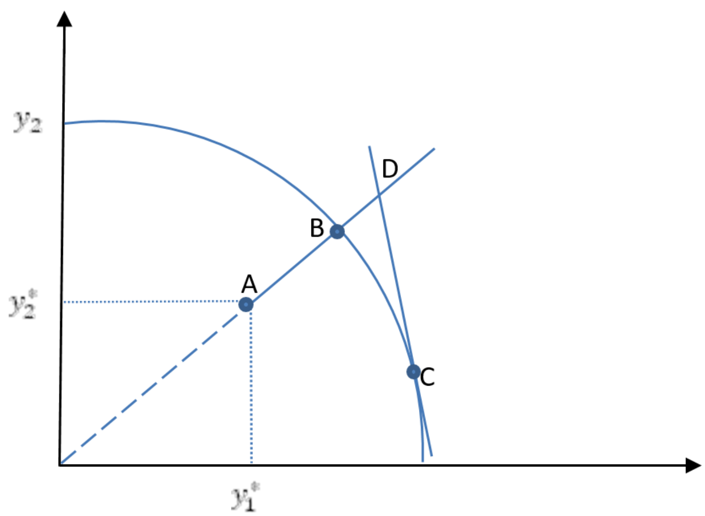

Figure 2: Output–oriented efficiency measure

In the production possibility frontier illustrated in Figure 2 above, if the inputs employed by the DMU were used efficiently the output can be expanded radially to point B. Hence, the output oriented measure of technical efficiency (TEO (y, x)), is 0A/0B. This is only equivalent to the input-oriented measure of TE under conditions of constant returns to scale. Even though point B is technically efficient, because it is on the production possibility frontier, higher revenues is achieved by producing at point C (the point where the marginal rate of transformation is equal to the price ratio ($p2/p1$). Implying, more of y1 should be produced and less of y2 in order to maximize revenue. If the firm wanted to achieve the same level of revenue, as at point C, but having same proportions of inputs and outputs then the firm would need to expand to point D. Hence, to achieve the revenue efficiency (RE (y, x, p)) is 0A/0D you would use more resources than necessary and fall outside the isoquant. Output allocative efficiency (AEO (y, w, w)) is given by RE (y, x, w)/TEI (y, x), or 0B/0D in Figure 2. TE only focuses on output and input quantities. It does not consider input and output prices. The incorporation of the analysis of price of inputs as seen above diverts attention to allocative efficiency and is beyond the scope of this study and hence not our interest. In short a hospital is technically efficient if its production is located on an isoquant or production possibility frontier as shown above.

3.1.2 Measurement of Technical Efficiency

The measurement of efficiency in healthcare is a difficult exercise for various reasons including the complex nature of the productive process and difficulty in measuring the ideal output of the sector, i.e. improved health status (Khembo, 2014). This is further complicated by the fact that health status is influenced by many factors, many of which lie outside the health sector such as the initial health status of patient, income level and others.

There are two frontier methodologies, stochastic frontier analysis (SFA) and data envelopment analysis (DEA) that are commonly used for measuring efficiency of healthcare organizations (Worthington, 2004). SFA follows a parametric approach that uses econometric techniques to estimate efficiency of Decision Making Units (DMUs). It allows for the possibility of modeling and takes into account measurement error and produces a smooth parametric frontier. SFA appeals to economic theory when considering the shape of the frontier and the statistical criteria that might be used to differentiate the appropriateness of alternative functional relationships for particular data sets (Skinner, 1994). Some argue that the problem of providing a prior specification of functional form is solved by applying a non-parametric technique a point Jacobs and Smith in their study also mentions. Consequently, DEA is highly flexible, the frontier moulding itself to the data (Jacobs, Smith & Street 2006). Guven-uslu, Osei and Valdamanis also mentioned in their studies that DEA is recommended for evaluating hospital efficiency in settings with inefficient health-sector information and particularly inappropriate data availability on prices of inputs(Guven-uslu, 2008), (Osei et al, 2005) and (Valdamanis et al, 2004). Unlike the parametric methods such as SFA, the non-parametric properties of DEA provide that required flexibility (Jacobs & Smith, 2006) to use multiple inputs for multiple outputs. DEA is a non-parametric mathematical programming approach to frontier estimation, which was first developed by Charnes (Charnes et al, 1978) to measure efficiency of production units with multiple inputs and outputs and it was extended by Banker (Banker *et al.*1984). The two built the model by building upon the work of Farrell. In the DEA model approach you use linear programming techniques to evaluate the relative efficiency of each DMU; the DMUs can either be Hospitals, nursing homes or any unit. The DMU model uses mathematical programming techniques to construct production frontiers and measures the efficiency of a DMU relative to these constructed frontiers. It use an identical set of inputs to produce a variety of identical outputs and used to evaluate performance of a group of DMUs and usually all members are fairly homogenous. This study therefore purposes to use the DEA approach which is suitable for measuring the efficiency of hospitals as it uses multiple inputs to produce multiple outputs.

The yardstick for comparing the efficiency of a particular DMU is determined by the group of DMUs included in the study sample. The inefficient DMUs are assigned a score between 1 and 0 (Coelli and Battese, 2005) where 1 represents the most efficient and anything less than 1 (or 100%) represents inefficiency and 0 (or 0%) the worst case of inefficiency. Hospitals in the same sample whose efficiency score is equal to one are said to be ‘optimally efficient’. Such hospitals lie on the efficiency frontier. Hospitals whose efficiency is less than one are perceived to be operating inefficiently. This approach is desirable because it can compute efficiency score for production functions with multiple outputs and inputs (Ozcan, 2008). DEA technique determines the ‘best practice’ frontier that is built empirically from the observed inputs and outputs and then each decision-making unit is compared with its peers. According to Coelli and others DEA is the preferred method of efficiency analysis in the non-profit sector (Coelli et al, 1998) , it is non-parametric, it does not require a specific functional form for technology or any distributional assumption about the error terms (Khembo, 2014), random noise is less of a problem; multiple outputs production is relevant; price data is difficult to find; and setting behavioral assumptions such as profit (cost) maximization (minimization) is difficult (Khembo, 2014)

DEA has got advantages in that, as an analysis tool, it has flexibility in handling multiple inputs and outputs, making it best suited for measuring the efficiency of hospitals that use multiple inputs to produce multiple outputs. However, it has some disadvantages in that DEA produces results, which are sensitive to measurement error, and it measures the efficiency relative to the best practicing DMUs within the sample of DMUs included in the study. Thus, it does not allow the comparison of the TE with DMUs outside the sample (Grosskopfs & Valdmanis, 1987). This poses as a challenge as DEA captures the best among the sample but we do not know if these best DMUs can perform better. This is because DEA estimates the relative efficiency of a DMU compared to its peers without necessarily comparing with absolute efficiency.

According to Coelli and others the SFA is likely to be more appropriate than the DEA in the agricultural applications especially in developing countries where the data is heavily influenced by measurement error and the effects of weather and diseases (Coelli et al, 1998). Pasiya noted the same in her study that the DEA is the optimal choice in the non-profit sector where random influences are less of an issue, multiple output production is important, prices are difficult to define and behavioural assumptions such as cost minimisation or profit maximisation are difficult to justify as in a hospital set up (Pasiya, 2009). In this regard this study therefore adopts the DEA method in measuring technical efficiency and determining the factors that affect the same.

3.1.3 Scale Efficiency

Scale efficiency is being efficient due to size, having the right combination of the input-output mix. This implies the hospital running number of operations that are proportional to its size. The size of a hospital may sometimes be a cause for inefficiency. A hospital may be too large for the volume of activities that it undertakes; and therefore, may experience diseconomies of scale. On the other hand, a hospital may be too small for its level of operation, and thus experience economies of scale. This point was also noted by GoM and WHO in their study in 2008; that in the presence of diseconomies of scale, a hospital is inefficiently large (GoM and WHO, 2008). Unit costs increase as the scale of production increases. Usually a hospital is inefficiently small in the presence of diseconomies of scale. In this regard unit costs decrease as the scale of production increases, thus an inefficiently small hospital may improve its efficiency by increasing its size. To achieve economies of scale, hospitals need to arrange their inputs in such a way that staff are able to specialize in their areas of expertise, obtaining discounts from bulk-buying, maximizing full capacity of expensive equipment, and being able to spread overhead costs over a larger number of output units.

This study therefore measures scale efficiency of CHAM facilities considering that the size and number of operations vary from one facility to another and determining if there is any significant difference between scale efficiency and technical efficiency.

3.1.4 Model selection and measurement of variables

DEA model's type choice usually follows the management process assumption made. The model will be either input-oriented or output-oriented (Cooper et al, 2007). The model adopted for the study will follow the management style in practice, CHAM has less control on inputs as the labour (Nurses) are determined by the Ministry of Health (GoM, 2011).Hence output oriented model is more preferred. Output models focus on how the firm can maximize the output without altering the input quantities meaning it has control on outputs while Input oriented model focus on the extent to which the firm can minimize inputs without changing output quantity; here it implies management has control on inputs only. The other model is non-oriented which assumes that managers have control over both inputs and outputs rather than giving primacy to either (Ozcan, 2008). Some studies argue that, the inputs oriented Data Envelopment Analysis (DEA) model is most useful for efficiency measurement in hospitals, because hospitals have more control on inputs rather than outputs (Ozcan, 2008). However in the case of CHAM Ministry of Health determines the labour size (number of nurses) per facility (GoM, 2011) and hence the DEA with ‘Output orientation’ is best suited considering the limited control of CHAM facilities over their inputs. This study, therefore, adopts the output oriented model to measure the CHAM facilities technical efficiency.

When measuring efficiency constant return to scale (CRS) assumption implies that the hospital is operating at an optimal scale such that its size is not relevant while variable returns to scale assumes that size affects its efficiency. The DEA model involves the assumption of constant return to scale (CRS) and variable returns to scale (VRS). The VRS model is considered as the suitable in measuring hospital efficiency (Ozcan et al, 1992). This is because in the study CHAM facilities vary by the size (number of beds). This study, therefore, adopts the variable return to scale (VRS) model with assumption that CHAM facilities in Malawi vary by size.

3.2 Empirical Literature Review

Several studies on technical efficiency of hospitals have been carried out in America and other developed countries by applying the DEA method. Ozcan in 1992 assessed the technical efficiency of hospitals from acute care general hospitals in the United States of America and found that government and non-profit hospitals were similar in that both had high inefficiency scores(Ozcan et al, 1992). In 2004, Lee and Wang assessed the technical efficiency of district hospitals in Taiwan using the semi-parametric method. They used panel data on hospital inputs and outputs. They were comparing the performance of the tobit regression to that of the Censored Least Absolute Deviations (CLAD) together with the performance of public and private owned hospitals in Taiwan. It was found that private hospitals performed better than public hospitals (Lee and Wang, 2004). The following variables were found to be significantly affecting the technical efficiency of the hospitals Ownership, firm size, bed flow, average length of stay and that the CLAD regression yielded more significant parameter estimates than the tobit regression (Lee and Wang, 2004). Even though this was the case because the CLAD has less restrictive distributional assumptions of the error term compared to the Tobit, and that the current computational programs cannot compute the CLAD in a panel setting. This study, therefore, adopts the tobit regression in spite of the short falls.

Sebastian and Lemma in 2010 carried out a study, whose objective was to evaluate the technical efficiency (TE) of the public district hospitals in Madhya Pradesh, India, with special emphasis on maternal healthcare services, using data envelopment analysis (DEA). They collected data from 40 district hospitals. The results showed that 50% of district hospitals were operating as technically inefficient hospitals (Sebastian and Lemma, 2010). This study follows a similar approach using data envelopment analysis focusing on CHAM facilities.

Tao carried out a study in china in Henan. The study not only evaluated the technical efficiency and productivity of country hospitals in Henan province, China, during the period of healthcare reform, but also explored factors impacting on technical efficiency. He used the Data envelopment Analysis and tobit regression. The result of tobit analysis indicated that government subsidy, hospital size with above 618 beds and ALoS were negatively associated with TE; while bed occupancy rate (OCCU), and bed turnover ratio (BTR) were significantly positive with TE (Tao, 2014). This study aims analyzing similar indicators on the Tobit analysis and adopts some of the variables in the study such as OCC, BTR, bed size and ALoS.

There are a few studies that have assessed the factors affecting technical efficiency in a panel setting. One such study was conducted in Thailand, Pavananunt (undated); he determined the relative efficiency of hospitals and factors that affect efficiency variations among hospitals. In his study fixed effects production function model was employed to estimate efficiency indices on hospitals and the panel model was employed to determine the factors affecting efficiency. He used both internal and external factors. The factors were as follows: Age of the hospital, size, technology, managing service, managing human resource, managing financial resource as internal factors while location, competitive environment and community demographics were external factors used. The following variables Age, size, managing human resource competitive environment and community demographics were found to be significant with a positive relationship with efficiency with the exception of competitive environment which had a negative one. This study adopts some of the environmental factors used in this research.

There are very few studies on the technical efficiency and productivity of hospitals conducted in Africa and mostly indicate pervasiveness of technical inefficiency and wastage of resources that could have been used to improve access and quality of care as a casing example studies conducted by (Kirigia et al 2000 and Zere et al 2006) in South Africa in public sector hospitals found that inefficiency levels were from 34-38%. If there were efficiency savings the money could have been adequate enough to build 50 clinics in their estimation. This implies improving technical efficiencies would lead to saving of a lot of funds within the sector and improve in the health care support system.

In Tanzania, Khembo by employing data envelopment analysis (DEA), examined the efficiency of faith-based (private not for profit-PNFP) hospitals in Tanzania. He used data from 15 hospitals, covering the year 2009- 2012 with the objective to determine technical efficiency of Volunteering Agency Hospitals (VAHs) as well as scale efficiency (Khembo, 2014). He established that average efficiency index (for all hospitals) was 0.769 (76.9%) and total number of technically efficient was 4 (26.6%) hospitals and that there was no improvement in the technical efficiency over the years but that there was increasing returns to scale (Khembo, 2014). In a similar study in Kenya, kirigia and others conducted a study to measure relative technical efficiencies of 54 public hospitals in Kenya using Data Envelopment Analysis (DEA) technique (Kiringa et al, 2002). 14 (26%) of the public hospitals were found to be technically inefficient, implying 74% of the hospitals were technically efficient (Kiringa et al, 2002). The study singled out the inefficient hospitals and provided the magnitudes of specific input reductions or output increases needed to attain technical efficiency. In another study in Ghana, Osei assessed technical efficiency of public district hospitals and health centres of seventeen hospitals and health centres (Osei et al, 2005). He found that eight (47%) of the hospitals were technically inefficient, with an average TE score of 61% and a standard deviation (STD) of 12%, Ten (59%) hospitals were scale inefficient, manifesting an average SE of 81%

(STD = 25%) (Osei et al, 2005). In a study in Ethiopia, out of the 17 health Centre's, 3 (18%) were technically inefficient, with a mean TE score of 49% (STD = 27%). Eight health Centre's (47%) were scale inefficient, with an average SE score of 84% (STD = 16%). The mean efficiency score for the hospitals was greater than that for the health centres. In another related study Akazili and others they used the VRS model of DEA to access efficiency, out of a total of 128 district hospitals, 31 (24%) were found to be efficient, 25 (19.5%) were very close to being efficient with efficiency scores ranging from 70 to 99.9% and 71 (56.2%) had efficiency scores below 50% (Akazili*et.al*, 2005). The lowest performing hospitals had efficiency scores ranging between 21 to 30% (Akazili*et.al*, 2005). This study follows a similar approach as the studies above in using the DEA to determine the technical efficiency of CHAM facilities in Malawi.

In Malawi, few studies have been conducted on technical efficiencies in Hospitals. Chapotera assessed technical efficiency in government hospitals and found that only 22% of the sampled hospitals were efficient (Chapotera, 2006). The Ministry of health and WHO assessed the technical efficiency of district and CHAM hospitals in the country using cross-sectional data. The study revealed that only 9 out of the 40 hospitals were efficient (23%) and that the mean efficiency score of the public sector district hospitals was 70.1% while that of non-government was at 45% (GoM and WHO, 2008). Pasiya compared technical efficiency changes between hospitals that are under government ownership and those that are private nonprofit using panel data. She was specifically trying to determine if there were changes in technical and scale efficiency for the hospitals under the two ownership types. She found that there was no significant difference in technical efficiencies between the governments' owned hospitals and the private owned hospitals (Pasiya, 2009). However, she found that the performance on scale efficiency was different in that it favored Nongovernmental hospitals (Pasiya, 2009).

This study envisages assessing the technical efficiencies of Mission (CHAM) facilities in Malawi using the Data envelopment theorem and tobit regression model using the cross sectional data for the year 2015.

3.3 Summary of the Chapter

The chapter has presented both theoretical and empirical literature related to the study. The chapter has presented the theory behind the premise technical efficiency and has extended to look at related studies in Malawi, Africa and across the continents of the world. The chapter has also presented some of the issues on efficiency to consider when employing this study, this includes definition of technical and scale efficiencies, measurement of efficiency, model selection and selecting variables and how they have been addressed in other related studies and how this study has addressed such issues. The next chapter presents the methodology that has been adopted in the study.

CHAPTER FOUR

METHODOLOGY

4.1 Introduction

This chapter presents the methodology employed in order to measure technical efficiency of CHAM facilities. The study mainly used data from the following sources: input variables per facility from the CHAM Secretariat and output variables per facility from HMIS (Health Management Information System) of the Ministry of Health. The data envelopment analysis was used to measure technical efficiency per CHAM facility. It also employed censored tobit regression model which regressed the environmental variables against the technical efficiencies (Inefficiencies) of hospitals. The study also made assessment of how many inputs (decreased) and outputs (increased) of inefficient facilities per hospital to make each facility technically efficient.

4.2 Data Envelopment Analysis

The DEA method has been adopted for this study being informed by the literature review from similar studies. Some of the studies reviewed were those by (Gosskopfs & Valdmanis, 1987), (Akazili *et al*, 2008), (Khembo, 2014), (Sebastian & Lemma, 2010); (Osei *et al*, 2005), (Chapotera, 2006) and several other studies. This being a linear programing methodology; it sketches a production possibilities frontier using inputs and outputs. The frontier represents the perfect input output combination. All production units lay on or below the frontier and the efficiency scores range from 0 to 1 (the lesser the score the lesser the efficient). One represents an efficient score and anything less than one as inefficient. All efficient health facilities lay on the production frontier. The algebraic formulae for Technical Efficiency (TE)

$$\text{TE score} = \frac{weighted\ sum\ of\ Outputs}{weighted\ sum\ of\ inputs} \qquad (1)$$

The technically inefficient health facilities use more weighted inputs per single unit of weighted outputs. Following Charnes, Cooper and Rhodes (CCR) (Charnes A. et al, 1978). The technical efficiency of a health decision making unit (a hospital) can be expressed as a maximum ratio of total sum of weighted outputs to total sum of weighted inputs that is expressed above.

Assuming that there are n hospitals, each with m hospital inputs and s hospital outputs, the relative efficiency score of a given hospital (TE) is obtained by solving the following out-put oriented CCR Linear Programming model

$$Max\ TE_0\ (u, v) = \left(\frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}}\right) \qquad (2)$$

$$Subject\ to: \left(\frac{\sum_{r=1}^{s} u_r\, y_{rj}}{\sum_{1=1}^{m} v_i\, x_{ij}}\right) \ll 1, j = 1,2, \dots, n$$

$$u_i \gg 0; i = 1; 2; \dots, m;$$

$$v_r \gg 0; r = 1; 2; \dots, s;$$

(Charnes A, et al, 1978)

If the denominator ($\sum_{i=1}^{m} u_i x_{io} = 1$) of the equation of the hospital is set equal to one, the transformed linear programming model for hospital o can be written as follows:

$$Max\ TE_O = \sum_{r=1}^{s} v_r y_{ro} \qquad (3)$$

$$Subject\ to: \sum_{r=1}^{s} v_r y_{rj} - \sum_{i=1}^{m} u_i x_{ij} \ll 0;\ \ j = 1,2, \dots, n$$

$$\sum_{i=1}^{m} u_i x_{io} = 1$$

$$u_i \gg 0; i = 1,2, \dots, m$$

$$v_r \gg o; r = 1,2, \dots, s$$

(Charnes A, et al, 1978)

The CCR model doesn't give room for economies or diseconomies of scale but assumes constant returns to scale meaning that all observed production combination can be scaled up or down proportionally. This model assumes that DMU are able to linearly scale the inputs and outputs without increasing or decreasing efficiency (Charnes A, et al, 1978) Practically when a hospital increases all its inputs by the same proportion, there are usually three possible scenarios. Firstly the output(s) increases in same proportion with the increase in inputs, which implies that there are constant returns to scale; secondly its output(s) increases more than the increase in inputs, implying increasing returns to scale; or thirdly its output(s) increases less than the increase in inputs, which implies decreasing returns to scale (Koutsioyiannis , 1979). In reality, a hospital can manifest constant returns to scale, increasing returns to scale or decreasing returns to scale depending on whether it is experiencing economies of scale or diseconomies of scale. Constant returns to scale occur in a situation where economies of scale are exhausted, and where health system inputs (factors of production) are perfectly divisible (Kirigia and Asbu, 2013). This imply there has to be a perfect model that will accommodate this reality beyond constant return to scale as application of CCR Model where hospitals are not operating at an optimal scale would yield technical efficiency scale results that are contaminated by scale efficiencies.

Banker, Charnes and Cooper to solve this problem introduced a modification to the CCR model and came up with a model that allows the estimation of pure technical efficiencies. The following modified model of the BCC model output oriented variable return to scale was estimated.

The BCC DEA weights model output-oriented with the assumption of variable returns to scale (VRS) adopted for the study is presented as

$$Max\ TE_0 = \textstyle\sum_r u_r\, y_{rj_o} + u_o \qquad (4)$$

$$St \sum_{r=1}^{s} u_r y_{r0} - \sum_{i=1}^{m} v_i x_{ij} + u_0 \ll 0, j = 1,2, \dots, n$$

$$\sum_{i=1}^{m} v_i x_{ij} = 1$$

$$u_r \geq \varepsilon, r = 1,2, \dots, s$$

$$v_i \geq \varepsilon, r = 1,2, \dots, m$$

u_0 Is unconstrained in sign

(Charnes A, et al, 1978)

Where:

ε= is an infinite non-Archimedean quantity greater than zero,

y_{rj} = the amount of output r produced by hospital j,

x_{ij} = the amount of input i used by hospital j,

u_r = the weight given to output r, (r =1... t and t is the number of outputs),

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

n = the number of hospital,

u_0 = weight for hospital under assessment ($u_0 > 0$ implies increasing returns to scale, $u_0 < 0$ implies decreasing returns to scale, u_0= 0 denotes return to scale).

j = any hospital in the sample,

j_0 = the hospital under assessment

An output–oriented model was more preferred in this study as CHAM facilities have more control on the outputs side than the input side. The in-put part is determined partly by the MoH of which the facility may not have control over.

The study employed non-parametric and econometric tools to test the hypotheses of the study. This study estimated technical efficiency for each CHAM facility in the sample using DEA first using the linear programs as presented in Fare (1994) focusing on output-oriented measures of TE and then determined environmental factors that contribute to (in) efficiency as a second stage by regressing the values of TE on the environmental factors. The technical efficiencies were estimated by using DEA MaxDEA Basic 6.9_64 statistical software.

4.3 Study variables

This study has selected variables inputs and outputs to be included in the analysis based on literature review and available data. Hospitals turn *inputs* (factors of production) into *outputs* (health services) in the production process. The inputs can be divided into broad categories of labour, materials and capital, each of which can be further divided into sub-divisions, for example labour inputs include skilled health personnel (doctors, nurses, paramedics) and unskilled workers (drivers, watchmen, gardeners, ward attendants, *etc.*). It is widely acknowledged that the ultimate output in the production process of health facilities is improvement in the health of the population, even though health facilities turn *inputs* (factors of production) into *outputs* (health services), it is difficult to measure improvement in population health and the data necessary for this kind of analysis is usually difficult to get, so intermediate outputs are usually employed instead. In modeling the health service production, the study used three input and five output variables.

4.3.1 Input variables

The input variables for each CHAM facility used were:

1. Doctors - Number of doctors (specialists and primary care physicians) per CHAM facility
2. Nurses - Number of nurses per CHAM facility;
3. Beds - Number of beds and cots per CHAM facility. The number of beds variable is included as a proxy indicator for capital inputs.

4.3.2 Output variables

The output variables used were:

1. ANC women - Number of women with three completed antenatal checkups per annum;

2. Deliveries - Number of deliveries per annum;

3. IPD (Inpatients Admissions) - Number of inpatient admissions per annum;
4. OPD (Outpatient Consultations Department) - Number of outpatient consultations per annum.
5. INPD (Inpatient days) – Total average number of days patients stay in a hospital per annum.

4.3.3 Environmental Variables

The following environmental variables have been used in this study. The environmental variables were computed using the input and output variables.

1. ALS (Average Length of Stay) -This is the measure of the average number of days a patient will stay in a hospital after admission. Refer to Appendix A2 for formulae.
2. OCC (Bed occupancy rate) - This is the measure of utilization of the available bed capacity. The percentage of beds occupied by patients per annum. This is defined as the number of inpatient days divided by the total number of beds. Refer to Appendix A2 for formulae
3. BTR (Bed turnover ratio) - The number of patients treated per bed per annum. (Measure of hospital productivity beds). Refer to Appendix A2 for formulae
4. Reg1 (Northern region) – Dummy variable for CHAM facility regionally located in the north where "1" if facility is located in the north and "0" otherwise
5. Reg2 (Central region) – Dummy variable for CHAM facility regionally located in the central region. Where "1" if facility falls in the central and "0" otherwise. The southern region is the base variable.

The selection of the variables for this study was guided by a review of the literature on the hospital efficiency assessment using DEA, but affected by the availability of the data. The availability of data on various indicators in the hospitals in CHAM facility in Malawi was the final determinant on the variables included in the model and analysis for this study. Some of the indicators were left out when the data was not available such as number of Health Surveillance Assistants (HSA), expenditure on drugs and salaries of staff. This study included data from 26 CHAM facilities across the country, which was randomly sampled from a list of CHAM facilities using systematic random sampling. Starting from a random number of hospital number three on the list of CHAM facilities in Malawi, every sixth hospital was included in the sample. A total of 31 hospitals were sampled but only 26 were finally incorporated as the other 5 had a lot of missing data. The main source of the data was from the health management information system (HMIS) in Ministry of Health for output variables and CHAM Secretariat for input variables.

4.4 Econometric Model

This first step employs data envelopment analysis to compute the TE scores and then later on, inefficiency scores from the DEAs are regressed upon the environmental variables by using tobit regression. The environmental variables which in this case are the independent variable include regional location of facility, average length of stay, bed turnover ratio, number of beds and bed occupancy ratio. The direction of the influence on inefficiency (dependent variable) is determined by the sign of coefficient (+/-) while the strength of the relationship is measured by the standard hypothesis tests. A positive sign on the coefficient will imply an increase in the independent variable will lead to an increase in the dependent variable and vice versa.

The tobit model was best suited for this data as the efficiency scores are bound between a minimum of 0 and a maximum of 1 and Tobit model is able to estimate linear relationships between variables when there is either left or right censoring in the dependent variable below and above, respectively, as is the case in efficiency scores of 0 (below) and 1 (above). The tobit model is also for this effect referred to as the censored regression model.

The VRS DEA efficiency scores are transformed into inefficiency scores, left censored at zero for computational convenience according to Asbu (Asbu EZ, 2000) using the formula

$$Inefficiency\ Score = \left(\frac{1}{DEA\ TE\ Score}\right) - 1 \qquad (5)$$

The Tobit model is formulated as follows (McDonald JF & Moffitt RA, 1980):

$$y^* = \beta_i x_i + \varepsilon_i \qquad (6)$$

$$y_i = y_i^* \; if \; y_i^* > 0$$

$$y_i = 0 \; if \; y_i^* \leq 0$$

$$i = 1,2, \dots, N$$

Where: N is the number of observations;

y_i is the observed inefficiency score, i.e. dependent variable;

$y^*$is the latent dependent variable;

β_i is the Kx1 vector of un-known parameters;

x_i is the kx1 vector of explanatory/independent variable; and

ε_i is an independently distributed error term assumed to be normal with zero mean and constant variance σ^2

The estimated Tobit model was as follows:

$$Ineff = \beta_0 + \beta_1 \, ALoS + \beta_2 OCC + \beta_3 BTR + \beta_4 BEDs + \beta_5 Reg + \varepsilon_i \qquad (7)$$

Where:

Ineff is the technical inefficiency score of facility

β_0 is the constant

β_{1-5} is the coefficient of variables

ALoS is the average length of stay

OCC is the bed occupancy rate

BTR is the bed turnover ratio

Reg1 is location dummy

= 1 for northern region and

= 0 otherwise

Reg2 = 1 for central region

= 0 otherwise

It is our expectation in this model that technical inefficiency decreases with the increase in the bed occupancy rate. We also expect the same for average length of stay and bed turnover ratio variables; implying that variables ALoS, OCC and BTR would have negative signs. The tobit regression was conducted using STATA / MP13.1 statistical software 64.

4.5 Summary of the Chapter

The chapter has presented the methodology employed in the study. The Chapter has outlined the data envelopment analysis approach, the study variables employed (Inputs and outputs) for the study and sources of the data. It has also mentioned on the econometric model used the censored Tobit regression model and the environmental variables on which efficiency was regressed. It has also described the analysis of the data.

The study adopted the DEA method informed by literature review which is a linear programming methodology. The study used doctors (specialists and primary care physicians), nurses, and beds as inputs and Antenatal women, deliveries, inpatient admissions, out patients and inpatient days. The study also included the environmental variables computed using inputs and outputs to regress against the inefficient scores using the tobit regression model. The next chapter presents and discusses study findings

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents research results and its' interpretation. It started with descriptive statistics, then capacity utilization, followed by technical and scale efficiency scores and finished with censored Tobit regression model results.

5.2 Descriptive Statistics

In 2015, the 26 hospitals in the sample supported with health care services a total of 14,479 women with 3 antenatal checkups; 18,313 women with deliveries; 62, 040 client's in-patients and 336,652 as out-patients. These outputs were produced employing a total of 48 medical doctors (Primary care physicians and specialists), 466 Nurses and 1,901 beds.

Table 3 presents the means, standard deviations, minimum and maximum for input and output variables of the 26 CHAM facilities. There were wide variations in both outputs and inputs across the different facilities. The outpatient department visits varied from a minimum of 2,354 (Makanjira) to a maximum of 45,514 (Daeyang Luke), and in-patients ranged between 113 (Makanjira HC) to 12,279 (Daeyang Luke) patients. Deliveries ranged from a minimum of 84 (Sister Teresa) to maximum of 2,060 (Ekwendeni). In terms of inputs there were considerable variations with the number of doctors varying between 0 and 48, nurses varying between 7 (Makanjira) and 62 (Ekwendeni), Hospital beds and cots between 6 (Makanjira) and Ekwendeni (250).

Table 3: Summary Statistics of Input and Output Variables

VARIABLE	OBS	MEAN	STD DEV	MIN	MAX
# of doctors	26	2	2.64	0	10
# of Nurses	26	18	19.54	1	61
# of beds	26	73	75.99	6	250
ANC women with 3 checkups	26	557	495.43	0	1,930
# of deliveries per annum	26	704	629.73	84	2,060
# of in-patients	26	2,386	2,966.46	113	12,279
# of out-patients	26	12,948	11,684.27	2,354	45,514

5.3 Capacity Utilization of Hospital

5.3.1 Bed Occupancy Rate

The bed occupancy ratio has a mean of 23.23 percent (STD dev = 20.41). The findings in this study range between 2 percent (Namalenga) and 85 percent (Nsamana), but under normal circumstances the occupancy rate should not exceed 100 percent. Chapotera in assessing government district hospitals in Malawi found a range of 3.83 percent to 174.64 percent (Chapotera, 2006) in another related study MoH found a mean of 49.6 percent and a range of 14.2% to 105.4% (GoM and WHO, 2008). Similar studies found a range between 18 and 35 percent in Namibia and 80 and 100 percent in South Africa. According to Barnum and Kutzin under normal circumstances the occupancy rate should not exceed 100 percent (Barnum and Kutzin, 1993). Barnum and Kutzin suggest that hospitals would be operating efficiently at an occupancy rate of 85-90 percent (Barnum and Kutzin, 1993). A rate of more than 100 percent means that they admit more patients than their bed capacity. Implying other patients sleep on the floor. This comparison shows that the Malawi rates are higher in government facilities against the CHAM facilities and this could be due to the fact that services at government facilities at the point of service delivery are for free and in cases where payments are demanded are heavily subsidized. In central hospitals for example there are paying wards while other wards have remained for free. Hence there is high demand in government facilities than there is in CHAM facilities. So it can be concluded that patients in CHAM facilities prefer to be treated as outpatients than inpatients due to high costs as all services under CHAM attract user fees except for those under service level agreements. This therefore begins to explain the reason for underutilization of bed capacity in CHAM facilities as it has an average of 23 against the standard rate of 80 to 100.

5.3.2 Average Length of Stay (ALoS)

The ALoS has a mean of 2.335 (Std dev = 0.9743603) with the minimum at 0.13 (Namulenga Health Centre) and maximum at 3.75 (Sister Teresa). This means that on average patients stay a minimum of about a day and maximum of 4 days in a hospital if admitted. It is expected that CHAM facilities should have a lower ALoS given the type of patients they treat as complicated cases are referred to the referral hospitals (district & central hospitals). Other studies in Malawi such as Chapotera found a range of 0.075 to 13.11 days (Chapotera, 2006) while MoH found a range of 1.7 to 8.1 days for government (GoM and WHO, 2008), both of which were quiet on a higher side. In Namibia the range was 3-12 days and in South Africa the range was found to be 2.6 to 10.8 days (Government of Namibia, 2004 and Zere, 2000). Hospitals with ALoS lower than that of their peers are regarded as performing well relative to those with higher ALoS as per MoH (GoM and WHO, 2008). This implies that CHAM facilities are on average performing very well than government facilities both locally and within some countries in the sub-Saharan studies cited in the study for example Namibia and South Africa. As already mentioned that the shorter average length of stay in CHAM facilities could be attributed to the type of cases treated as complicated cases are referred to government referral facilities. It is also common practice that patients in CHAM facilities prefer to be treated as outpatients as a way to minimize costs due to the high charges attached to the treatment at CHAM facilities compared to government facilities.

5.3.3 Bed Turnover Ratio

This study found the rates of Bed turnover ratio to be in the range of 7.2 percent (St. Joseph (Mitengo) HC) and 170.6 percent (Nsanama) with an average of 40.01 percent. The average of 40.01 percent for bed turnover ratio can be considered to be consistent with other studies done in other countries in Sub-Saharan Africa and in Malawi. For example in South Africa bed turnover ratio was found to have an average of 46.8 and range between 12.3 to 107 (Zere, 2000) and in Namibia's bed turnover rates interval was 3 to 34 (government of Namibia, 2004). Other studies in Malawi see for example Chapotera found a range of 15.64 to 993.31 (Chapotera, 2006), in the study by MoH they found Bed turnover ratio of 15.3 to 204.6 (GoM and WHO, 2008). Turnover ratio in acute care hospitals is expected to be higher than that of chronic hospitals. It is also expected to be higher in lower-level hospitals as compared to higher-level ones (GoM and WHO, 2008). The average turnover ratio of 40.01 percent would mean that the number of patients treated per bed in a defined period of time is lower than the capacity available. Implying some beds stay without patients for some time.
lities

5.4 Technical Efficiency

5.4.1 Efficiency Measures

The VRS model technical efficiency (TE) and scale efficiency (SE) scores for individual hospitals are contained in table 4, below. Of the 26 CHAM facilities, 18 (69%) were technically efficient since they had a relative technical efficiency (TE) score of 100%. The remaining 8 (31%) had a TE score of less than 100%, which means that they were technically inefficient. The TE score among the latter facilities ranged from 15% in St Anne's hospital to 91% in Mlanda Health Centre. This finding implies that St Anne's and Mlanda faci could potentially reduce their current input endowments by 85% and 9% respectively while leaving their output levels unchanged. The average TE score among the inefficient hospitals was 61% (standard deviation = 26%), which means that these hospitals could, on average, produce their current levels of output with 39% less inputs than they were currently using.

According to table 4, only eight (31%) of CHAM facilities had a scale efficient (SE) of 100%, implying thereby that they had the most productive scale size (MPSS) for that particular input–output mix. The remaining 18 (69%) facilities were found to be scale inefficient, manifesting a mean SE score of 75 % (SD=25%). This implies that, on average, the scale-inefficient CHAM facilities could reduce their input size by 25% without affecting their current output levels.

The result of 69% of CHAM facilities being technically efficient is consistent with some of the findings in the Sub-Saharan Africa; in a study by Kirigia and others in Kenya found that 74% of the public hospitals were found to be technically efficient (Kirigia et al, 2002). A similar study among 55 public hospitals in Kwazulu-Natal province in South Africa by Kirigia and others found 60% of the hospitals were technically efficient (Kirigia et al, 2000).These results; however, vary from results obtained by other studies in same region, for example, Chapotera assessed technical efficiency in government hospitals in Malawi and found that only 22% of the sampled hospitals were technically efficient (Chapotera, 2006). The Ministry of Health and WHO assessed the technical efficiency of hospitals in the country using cross-sectional data and found that only 23% of hospitals were efficient (GoM and MoH, 2008). There is a huge variation of results on technical efficiency in CHAM facilities and government hospitals in Malawi, the variation can be attributed to the difference in management and control systems administered in the two systems (CHAM & Government) in addition to the fact that there was a size variation as the sample of CHAM facilities included Health Centre's while the government studies focused on the district hospitals and referral hospitals only. In the literature, the evidence on the impact of ownership on efficiency is mixed. Some studies found government hospitals to be more efficient for example Kiringia (Kiringia et al, 2002) while others have found the opposite to be true such as Chapotera (Chapotera, 2006).

Table 4: Technical and Scale Efficiency Scores

No.	Name of DMU	Technical Efficiency	Scale Efficiency	Returns to Scale
1	Likuni	1.00000	0.283723096	Decreasing
2	Madisi Hospital	0.55643	0.843574474	Decreasing
3	St. Joseph (Nguludi)	0.48448	0.761039859	Decreasing
4	Daeyang Luke	1.00000	1	Constant
5	Ekwendeni	1.00000	0.372369801	Decreasing
6	St. Anne's	0.14860	0.996080948	Increasing
7	St. Joseph (Mitengo) HC	0.41682	0.967033865	Decreasing
8	Luwalika / Makanjira Health Centre	1.00000	0.633204633	Increasing
9	Nsanama Health Centre	1.00000	1	Constant
10	Chipini Health Centre	1.00000	0.934051558	Decreasing
11	Phalula Health Centre	1.00000	0.78597449	Increasing
12	Magomero Health Centre	1.00000	1	Constant
13	Nakalanzi Health Centre	0.84252	0.971912598	Increasing
14	Namulenga Health Centre	0.81674	0.981912972	Decreasing
15	Misomali Health Centre	1.00000	1	Constant
16	Gowa Health Centre	0.69126	0.448882535	Increasing
17	Mlanda Health Centre	0.91116	0.607541437	Decreasing
18	St. Andrews Health Centre	1.00000	0.86188594	Decreasing
19	Liwaladzi Health Centre	1.00000	1	Constant
20	Chididi Health Centre (NSJ)	1.00000	1	Constant
21	Nkhamenya	1.00000	0.986784141	Increasing
22	Sister Teresa (Mikoke)	1.00000	0.350750373	Increasing
23	Our Lady of Mt. Carmel (Kapiri)	1.00000	1	Constant
24	Alinafe	1.00000	0.994956266	Increasing
25	ABC	1.00000	1	Constant
26	Chingadzi	1.00000	0.772362971	Increasing

The rate of return to scale percentages are summarized in Table 5, 8 (31%) of CHAM facilities demonstrated constant return to scale (CRS), 9 (35%) manifested increasing return to scale (IRS) and the remaining 9 (35%) revealed decreasing return to scale (DRS). These findings reveal that 35% of the sampled CHAM facilities in Malawi are too small for their operations and to operate at CRS, they need to expand their scale of operation. However, 35% of the sampled CHAM facilities need to scale down their operations for achieving the CRS.

Only eight (31%) of CHAM facilities had a scale efficient (SE) of 100%, implying thereby that they had the most productive scale size (MPSS) for that particular input–output mix. In a similar study carried in Ghana 53% of hospitals were scale efficient (Republic of Ghana, 2000). Another DEA study of 155 primary health care clinics in Kwazulu-Natal province in South Africa by Zeze found that only 16% manifested some scale efficiency (Zeze, 2000). A similar study of 32 public health centers in Kenya by Kirigia and others revealed that 59% of the facilities were scale efficient (Kirigia et al, 1998). The result with the Sub-Sahara Africa varies across countries. The studies reviewed have a minimum of 16% scale efficient and a maximum of 59% and our finding is within the range with 31% scale efficient. This implies 69% of facilities in the country need to either reduce or increase their operations to operate at the most productive scale size. This means that on average, health Centre’s are using more inputs than they need to produce what they are currently producing. In other ways, health Centre’s could increase on the number of outpatients, in-patients, ANC women, and deliveries services with the resources they have currently.

Table 5: Summary of Return to Scale Results

No.	Variable Description	Frequency	Percentage
1	Constant Return to Scale (CRTS)	8	31%
2	Decreasing Return to Scale (DRTS)	9	35%
3	Increasing Return to Scale (IRTS)	9	35%
Totals		**26**	**100%**

Table 6, below, presents the total output increases and/or input reductions required for making the inefficient CHAM facilities efficient. The results show that, to become efficient, the inefficient facilities combined would have to reduce number of doctors by 6.25%, number of nurses by 22% and 23% of beds to keeping the current output levels constant. Alternatively, the inefficient hospitals could become efficient by increasing the number of cases of women who had three complete antenatal check-ups by 15%, deliveries by 12% and IPD admissions by 2% and OPD consultations by 7% with the current inputs.

Table 6: Summary of Input (Reductions) and Output (deficiencies)

No.	Valuables	Original	Projection	Difference (%)
	OUTPUTS			
1	# of women with 3 ANC checkups	14,479	16,600	15%
2	# of deliveries	18,313	20,552	12%
3	# of in-patients admissions	62,040	63,278	2%
4	# of out-patients	336,652	360,462	7%
	IN-PUTS			
5	# of beds	1,901	1,469	-23%
6	# of doctors (physicians & specialists)	48	45	-6.25%
7	# of Nurses	466	366	-21.46%

5.5 Regression Analysis

5.5.1 Regression results

By estimating equation 7, we tested two hypotheses. Firstly a test whether technical efficiency is statistically significant from zero and secondly the overall significance of the model tested by the joint null hypothesis tested using the likelihood ratio test.

First hypothesis on technical efficiency being statistically different from zero

$$H_0: TE_0 = 0$$

$$H_A: TE_0 \neq 0$$

To test the first hypothesis which stated that "There is no technical efficiency in CHAM facilities in Malawi" a one sample t test at 10% confidence level was carried out in which t value was found to be 19.5784 with a p value of 0.0000. Since p-value was less than .001 we had extremely strong evidence that the null hypothesis is not true and hence we rejected the null hypothesis and adopt the alternative hypothesis that there is technical efficiency in CHAM facilities in Malawi. The results of the one-sample t test are shown in Appendix B1

The Joint null hypothesis to test the overall significance of the model

$$H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$$

$$H_A: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 \neq 0$$

In table 7, the joint null hypotheses (H_0) is rejected at 5 percent level of significance because the computed chi-squared =14.47 df =7 is greater than the critical chi-square value of 9.49 for the four degrees of freedom. Therefore we accept the alternative hypothesis (H_A) and consequently the regression coefficients for the explanatory variables (ALoS, OCC, BTR, Region) are not equal to zero. The average length of stay (p-value=0.008); regional location in the north (Reg1) for CHAM facility (p-value=0.078) and rate of turnover ratio (p-value=0.042) in CHAM facilities, as the p values are less than 0.10 which is the confidence level and accept the alternative hypothesis that high bed turnover ratio, hospital regional location, longer average days of stay decreases technical inefficiency in CHAM facilities. This Imply that the higher the bed turnover ratio and the longer the average days of stay the lower the technical inefficiency and that hospitals located in the north are more efficient than those that are not. However we failed to reject the null hypothesis for bed occupancy ratio and number of beds as the p values are greater than the 10% confidence interval, hence the latter environmental variables have no significant influence on technical efficiency. The model variable ALoS is significant at 1 percent and bed turnover ratio at 5 percent while the variable Reg1 (hospital regional located in the north) is significant at 10 percent. The bed occupancy rate, number of beds per hospital and Reg2 (Hospital located in the central region) does not have significant contribution on inefficiency. This is because these variables are insignificant at both 10 and 5 percent.

The negative sign on the variable average length of stay is consistent with our expectations as expressed in Chapter 4. This means that the longer a patient stay at a facility is negatively associated with inefficiency. In other words, inefficiency drops as patients stay longer on a facility. This implies the longer the patients stay at a hospital facility; the more efficient a hospital would be as this would increase level of utilization. The variable Reg1, which represents facility regionally located in the north, shows that if a hospital is located in the north, the likely result is an increase in technical efficiency levels. Implying facilities that are located in the north are technically more efficient than those that are not. The variable BTR shows that it is positively associated with inefficiency. This means that inefficiency will increase with increase in number of patients treated per bed per annum. The more patients treated on a single bed per annum the less inefficient the hospital would be.

Table 7: Regression Results (Tobit Regression)

Variable (n=26)	**Coefficient**	**Standard Errors**
Average Length of Stay (ALoS)	-0.160301***	0.0552474
Bed Occupancy	0.003705	0.0034581
Bed turnover	0.0027738**	0.01394
No. of beds	0.0004456	0.0007602
Reg1 (North)	-0.3222288*	0.078
Reg2 (Central)	0.0450757	0.093581
Constant	0.9928241***	0.1318903
Pseudo R^2	-5.1225	
LR-Chi-square	14.47**	
*** , ** , and * means significant at 1%, 5% and 10% respectively		

5.6 Summary of the Chapter

This chapter has presented the study findings. Eighteen (69%) of CHAM facilities in the sample were found to be efficient and the average TE of inefficient hospitals was found to be at 61%, this implies that the inefficient CHAM facilities on average can produce current level of outputs by reducing 39% of inputs. Only 31% of facilities are scale efficient, the balance either has to scale down or up operations to be at Most Productive Scale Size (MPSS).The study revealed that the longer the patients stay at the facility the more efficient that facility, that higher bed turnover ratio decreases efficiency and that being located in northern region increase chance of being efficient but did not find sufficient evidence on whether Occupancy ratio, inpatient days and number of beds influence efficiency in CHAM facilities. This study also found that there was no significant difference between technical and scale efficiency. The next chapter concludes the study by presenting summary of results, policy implications, and limitations of the study and areas for further research.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study is the first attempt at evaluating the technical efficiencies focusing specifically on CHAM facilities in Malawi by using the DEA and Tobit regression methods.

The average pure TE score of 87.95% shows that the CHAM facilities included in the study can produce the same amount of outputs by saving 12.05% inputs. This implies that the input savings could be utilized to provide healthcare services to more people through CHAM facilities situated in rural poor areas where these services are required. The results of this study showed that only 8 (31%) of CHAM facilities are operating at optimal scale size having a scale efficient score of 100%. This finding implies that the scale inefficient facilities could significantly improve their efficiency by better input output size mix; the size of the hospital should be proportional to the size of operations and better resource management.

The regression results showed that the increase in average length of stay and regional location of a CHAM facility are important to reducing inefficiency (increase technical efficiency) while an increase in bed turnover ratio increases inefficiency. Further, the study did not find enough evidence to conclude that bed occupancy ration, and size disparities of CHAM facilities affect efficiency.

The finding of only 31% CHAM facilities operating with technical inefficient is inconsistency with studies conducted in district hospitals in Malawi by Chapotera (2006) which found out that 78% of the hospitals were operating inefficiently in 2006, Gujarat state of India (2006) also carried out a similar study whereas, a study conducted in

Tamilnadu state found that 72% of the district hospitals were operating as technically inefficient during the year 2004-2005. This could be attributed to issues of bureaucracy in government, control, monitoring and management which is strong and effective in CHAM facilities than their government counter parts.

The study has also quantified the output (increases) and input (reductions) required for making inefficient CHAM facilities efficient. The results of this analysis presented in Table 6, indicated a significant scope of increasing outputs of the inefficient hospitals. It would be important for these hospitals to ensure efficient utilization of the available resources through critical monitoring and improved management.

6.2 Study Limitations

This study has some limitations that need to be taken into account when interpreting the results. Firstly, the number of target inputs was five but the system analysis revealed that only three inputs could be located centrally from CHAM, namely, number of doctors, nurses and beds per facility were obtained and used in this study. Secondly, the output indicators were selected to represent the broad range of functions of the CHAM facilities but did not specifically bring out specific services offered per facility. Thirdly, we are aware that the inclusion of more or different output indicators and the selection of other output–input mix in the study might have influenced the results. Fourthly, the input and output data were collected for only 1 year (2015) which did not allow us to analyze and observe efficiency scores of CHAM facilities over the years. Fifthly, the information on input costs could not be collected. Therefore, it was not possible to estimate the allocative efficiency.

6.3 Conclusions and Policy Implications

The findings of our study have significant policy implications for strengthening the healthcare delivery in the CHAM facilities.

The results showed that only 31% of CHAM facilities were operating as technically inefficient hospitals. Decision makers and administrators in these facilities should identify the causes of the observed inefficiencies and take appropriate measures to increase efficiency. Considering the poor health indicators of the state and scarcity of resources, ensuring efficient functioning of these facilities will be of immense public health importance. Given that primary health care is an important driver in the health care system of most developing countries, including Malawi, efforts are needed to making CHAM facilities that are not operating on the frontier efficient.

Another recommendation for consideration would be downsizing of large scale inefficient facilities with decreasing return to scale and expanding small scale of inefficient increasing returns to scale. As results reveal that 35% of the sampled CHAM facilities in Malawi are too small for their operations and to operate at CRS, they need to expand their scale of operation and 35% of the sampled CHAM facilities need to scale down their operations for achieving the CRS.

CHAM facilities could proactively improve the efficiency and attain constant return to scale of some health facilities by transferring clinic staff from facilities with decreasing return to scale to facilities with increasing return to scale that will enhance the capacity of primary health sector to response to the needs of the people.

CHAM could also improve on the utilization of their facilities by communities in any possible way such as advertising, subsidizing of prices, offering certain services for free etc. As the results revealed that the capacity utilization ratios of the sampled CHAM facilities are below the recommended standard and that their capacity are not fully utilized.

6.4 Areas of further research

It will also be interesting to look at allocative efficiency which is closely related to technical efficiency in CHAM facilities and which warrants the collection of price data in addition. With good panel data for a sufficiently longer period of time it will be important and interesting to also do further research to estimate DEA-based Malmquist productivity index (MPI) to observe the changes in efficiency and those changes in productivity that are accounted for by technological change in CHAM facilities.

6.5 Summary of the Chapter

The Chapter concludes the study by presenting summary of results, policy implications, and limitations of the study and areas for further research. The results of the study reviewed that most CHAM facilities are technically efficient (69%) and that only 31% are scale efficient. The policy implication is that the administrators and decision makers need to identify causes of inefficiencies in inefficient facilities and put up corrective measures. The study has several limitations including the fact that changing the input output mix may change the results as such policy implications needs to be applied within the context and that it would be interesting to carry out further research looking at allocative efficiency which is closely related to technical efficiency in CHAM facilities.

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APPENDICES

APPENDIX A1: Descriptive Statistics of Environmental Variables

No.	Variable	Obs	Mean	Std. Dev.	Min	Max
1	Technical Efficiency (TE)	26	0.5239665	0.3374925	0.05958	1
2	In-patient days	26	6,471.962	9,344.006	111	41,139
3	Average Length of Stay (ALoS)	26	2.335	0.9743603	0.13	3.75
4	Bed Occupancy	26	23.23077	20.41432	2	85
5	Bed Turnover ratio	26	397	546.7069	35	2,692
6	Hospital in Northern Region	26	0.0384615	0.1961161	0	1
7	Hospital in Central Region	26	0.5	0.509902	0	1

<u>APPENDIX A2</u>: Ratio Calculation of Environmental Variables

1. Average length of stay (ALoS)

$$ALS = \frac{Inpatient\ days}{Admissions}$$

2. Bed occupancy rate (OCC)

$$OCC = \frac{Patient\ days}{Bed\ days} * 100$$

Where:

$$Patient\ days = Admissions * ALS$$

$$Bed\ days = number\ of\ beds * 365$$

3. Bed turnover ratio (BTR)

$$BTR = \frac{Total\ patient\ admissions}{Number\ of\ beds}$$

<u>APPENDIX B1</u>: One-Sample t test

<table>
<tr><th>Variable</th><th>Observations</th><th>Mean</th><th>Std. Err</th><th>Std. Dev</th><th colspan="2">[90% Conf. Interval]</th></tr>
<tr><td>Technical efficiency</td><td>26</td><td>0.8795388</td><td>0.044924</td><td>0.2290686</td><td>0.8028023</td><td>0.9562754</td></tr>
<tr><td colspan="5">Mean – mean (technical efficiency)</td><td colspan="2">t – 19.5784</td></tr>
<tr><td colspan="5">Ho: mean – 0</td><td colspan="2">Degrees of freedom-
25</td></tr>
<tr><td colspan="2">Ha: mean < 0</td><td colspan="3">Ha: mean! – 0</td><td colspan="2">Ha: mean > 0</td></tr>
<tr><td colspan="2">Pr (T < t) – 1.0000</td><td colspan="3">Pr (|T| > |t|) – 0.0000</td><td colspan="2">Pr(T > t) – 0.0000</td></tr>
</table>

<u>APPENDIX C</u>: Raw data (Input & output data)

Name in CHAM Facility	# of doctors	# of Nurses	# of beds	# of ANC Women with 3 checkups per Annum	# of Deliveries per Annum	# of inpatients per Annum	# of out patients per Annum	# of inpatients days
Likuni	6	61	231	1930	1735	4697	31233	14091
Madisi Hospital	4	31	129	541	812	4299	10060	13682
St. Joseph (Nguludi)		49	202	560	1042	4821	22844	14319
Daeyang Luke	2	57	152	930	1614	12279	45514	41139
Ekwendeni	8	57	250	1229	2060	6508	18589	18599
St. Anne's	2	45	180	84	268	1760	6343	5723
St. Joseph (Mitengo) HC	0	3	44	0	154	317	5625	610
Luwalika / Makanjira Health Centre	0	3	6	123	119	113	2354	215

Nsanama Health Centre	3	4	10	1741	1739	1706	26924	3102
Chipini Health Centre	0	7	40	565	622	2023	5648	3170
Phalula Health Centre	2	6	7	883	834	914	8580	1430
Magomero Health Centre	0	5	29	544	856	1564	5373	1117
Nakalanzi Health Centre	1	2	28	663	484	520	5924	362
Namulenga Health Centre	0	4	19	291	177	870	6037	111
Misomali Health Centre	0	2	8	259	348	483	7166	908
Gowa Health Centre	1	23	9	237	249	238	3732	676
Mlanda Health Centre	1	4	29	283	168	257	13973	498
St. Andrews Health Centre	0	15	55	426	1123	2862	9546	5723

Liwaladzi Health Centre	0	1	12	210	171	190	7163	382
Chididi Health Centre (NSJ)	0	1	14	344	232	310	2986	609
Nkhamenya	1	17	90	630	525	1899	4612	4065
Sister Teresa (Mikoke)	1	10	58	102	84	1088	5619	4080
Our Lady of Mt. Carmel (Kapiri)	1	22	160	1135	1947	8799	41665	21202
Alinafe	3	13	69	487	520	2162	10459	7382
ABC Clinic	10	17	25	160	180	450	18000	1664
Chingadzi	2	9	45	122	250	911	10683	3412