Technical Efficiency of Public Hospitals in the Provision of Maternal Health Services in Selected Zones of Oromia Regional State, Ethiopia

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Abstract

Background: Ethiopia is one of the countries in sub-Saharan Africa with markedly high maternal mortality ratio. The improvement towards achieving MDG 5 was very slow in the country. And also attaining the new SDG 3.1 is difficult if it continues at this pace. The health systems in Ethiopia faced with critical resource constraints in extending maternal health services of acceptable quality. Consequently, using the available health resources to attain maximum possible maternal health service and reduce maternal mortality is the most important activity of the health sector in the country.

Objective: To assess the technical efficiency of public hospitals in selected zones of Oromia regional state, Ethiopia, in the provision of maternal health services, 2014/2015 (2007 EFY).

Methods and Participants: Health facility based cross-sectional study was conducted. Data were collected from 14 primary and secondary hospitals from March 25 to April 18, 2016. A structured and pretested checklist based interview and document review was used to collect data. Two stage Data Envelopment Analysis was performed with input orientation and variable returns to scale assumptions. The data were entered in to Epi Data version 3.1, and transferred to SPSS version 20 software for descriptive analysis. Technical efficiency scores were computed using the Data Envelopment Analysis Programme, version 2.1 at the first stage. And at second stage predictors were determined by tobit regression using STATA version 12.0.

Result: Fourteen primary and secondary hospitals were included in the study. The assessment of maternal health service delivery efficiency among the 14 hospitals revealed that, nine (64.2%) hospitals were technically efficient with mean score of 85.1% (SD = 27.51%). Twelve (85.7%) hospitals were found to be pure technically efficient and nine hospitals were scale efficient with mean score of 99.24% (SD = 2.02%) and 85.86% (SD = 27.79%) respectively. The inefficient hospitals used excess resources like non-salary expenditure 0.97%, salary expenditures of administrative staff 2.28%, physicians 4.85%, clinical and midwife nurses 5.85%, other technical staff 4.95% and number of class rooms and beds for maternal health service 1.85% and 9.62%, respectively. Having the excess resources the hospitals could increase numbers of antenatal care users by 1.12%, deliveries by 3.22%, safe abortion service by 3.49% and post abortion service by 7.84%.The tobit regression analysis showed that average waiting time for maternal health service was negatively associated with efficiency. On the other hand, level of the hospital service years of the hospitals and catchment population of the hospitals were positively associated with efficiency of the hospitals in maternal health service.

Conclusion: Findings from this study showed that most of hospitals are technically efficient and around two third of the hospitals were operating as scale efficient in maternal health service. The inefficiency is a result of excess technical and administrative staff, beds, non-salary expenses and class rooms. Alternatively while taking the excess resources; the hospitals did not address maternal health service users. Level of the hospitals, catchment population, and service year's increase; and average waiting time reduction were determinants of technical efficiency of public hospitals.

Keywords: Maternal health services, Oromia regional state**,** Ethiopia, Data envelopment analysis, Technical efficiency, Scale efficiency

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List of Abbreviations

ANC	Antenatal Care
CEO	Chief Executive Officer
CRS	Constant Returns to Scale
CSA	Central Statistical Agency
DEA	Envelopment Analysis
DMUs	Decision Making Units
EDHS	Ethiopian Demographic and Health Survey
EFY	Ethiopian Fiscal Year
FMoH	Federal Ministry of Health
FP	Family Planning
GP	General Practitioner
HEW	Health Extension Worker
HMIS	Health Management Information System
HSDP	Health Sector Development Plan
HSTP	Health Sector Transformation Plan
MCH	Maternal and Child Health
MDGs	Millennium Development Goals
MEDHS	Mini Ethiopian Demographic and Health Survey
MMR	Maternal Mortality Ratio
NHA	National Health Account
NHE	National Health Expenditure
OPD	Outpatient Department
PNC	Postnatal Care
SBA	Skilled Birth Attendant
SD	Standard Deviation
SDGs	Sustainable Development Goals
SFA	Stochastic Frontier Analysis

SSA	sub-Saharan Africa
TE	Technical Efficiency
UN	United Nations
USD	United Stated Dollar
VRS	Variable Returns to Scale
WHO	World Health Organization

CHAPTER ONE

Introduction

1.1. Background

In economic terms, the need of human creature is unlimited; rather the resources that are required to fulfill the needs of human being are scarce (limited). That is why people struggle to have an ample of resources for themselves with the assumption that having many resources results in high level of satisfaction. But this (having sufficient resources) may not always be realized. Therefore, there should be a mechanism to use the available resources to give the maximum possible output(1,2).

Here the question of efficiency rises to attain the highest possible need using the least possible resources. As the words of Lovell, C.A.K indicate, by efficiency of a production unit we mean a comparison between observed and optimal values of its outputs and inputs. The comparison can take the form of the ratio of observed to maximum potential output obtainable from the given input, or the ratio of minimum potential to observed input required to produce the given output, or some combination of the two. In these two comparisons the optimum is defined in terms of production possibilities. It is also possible to define the optimum in terms of behavioral goal of the production unit. In this event efficiency is economic and is measured by comparing observed and optimum cost, revenue, profit, or whatever the production unit is assumed to pursue, subject to the appropriate constraints on quantities and prices(3).

Efficiency of organizations can be measured in terms of technical, allocative and productive efficiency. Technical efficiency (TE) implies the maximum possible output from a given set of inputs. Within the context of healthcare services, TE may then refer to the physical relationship between the resources used (say, capital, labor and equipment) and some health outcome. Allocative efficiency is concerned with choosing between the different technically efficient combinations of inputs used to produce the maximum possible outputs. When taken together allocative efficiency and TE determine the degree of productive efficiency (also known as total economic efficiency). Thus, if a healthcare organization uses its resources completely

allocatively and technically efficiently, then it can be said to have achieved total economic efficiency(4).

Business dictionary.com defined TE as a "Situation where it is impossible for a firm to produce, with the given know how, (1) a larger output from the same inputs or (2) the same output with less of one or more inputs without increasing the amount of other inputs." That means having the highest possible output while utilizing the least possible input(5).

TE deals with the usage of labour, capital, and machinery as inputs to produce outputs relative to best practice in a given sample of Decision Making Units (DMUs) (in our case hospitals). In other words, given same technology for all the DMUs no wastage of inputs is considered in producing the given quantity of output. An organization operating at best practice in comparison to all others in the sample is said to be totally technically efficient(6).

This concept of efficiency can also be applied to the health sector. Efficiency is the success of the hospital in using its resources to produce output – the degree to which the observed use of resources to produce output of a given quality matches the optimal use of resources to produce outputs of a given quality. This can be assessed in terms of TE or allocative efficiency. The latter type measures whether for any level of production; inputs are used in the proportion that minimizes the cost of production, given input prices. TE is concerned with the conversion of physical inputs such as labor services or raw materials into outputs. Cost efficiency refers to the combination of technical and allocative efficiency(7).

These methods of efficiency measurement are essential to measure the overall productivity of the health sector and various services in the health service organizations by taking the units as a decision making unit. Maternal health service unit's TE can also be measured using this method. Maternal health refers to the health of women during pregnancy, childbirth, and the postpartum period. The service encompasses the health care dimensions of family planning (FP), preconception, prenatal, delivery, postnatal care (PNC), abortion and post abortion services in order to reduce maternal morbidity and mortality(8,9).

1.2. Statement of the Problem

The health systems in sub-Saharan Africa (SSA) are facing with critical resource constraints in extending health services of acceptable quality to the vast majority of their people and attain health and health related targets. This is also reflected in the maternal health service delivery. A host of factors account for this include: poor macro-economic performance, conditions accompanying the demographic and epidemiological transition and increasing burden of emerging and re-emerging diseases(10).

Even though efficiency is considered a critical aspect in the health sector, the actual practice in SSA reveals the reverse. Eyob uncovered that the dearth of literatures on hospital efficiency in SSA may, perhaps, indicate that in practice not much attention is given to efficiency by health care administrators. Much of the attention of policymakers, donors and health system researchers seems to be focused on health sector reforms, prominent of which is the mobilization of additional resources for health care through user fees and other modalities of financing(11).

While it is clear that the current efforts to fill the gap in access to health care through the construction of health facilities including health centers and hospitals in Ethiopia is commendable, concurrent efforts should be enhanced to ensure that the newly constructed facilities are fully equipped with essential utilities to provide quality lifesaving maternal interventions as soon as possible. In addition, training of new staff and retraining of existing staff in basic maternal care skills is a matter of urgency in light of the massive increase in health service outlets. Financial as well as material support is required to the public sector to meet the Health Sector Transformation Plan (HSTP) as well as Sustainable Development Goal (SDG) targets in time(12).

Even though there are some increments in the National Health Expenditure (NHE) of Ethiopia in the past years, when we look at the health care financing it is one of the under financed sectors in the country. The Ethiopia's fifth National Health Account (NHA) states that; nominally, NHE in 2010/11 was Birr 26.5 billion (US$1.6 billion). Moreover, per capita NHE in that same year was US$20.77. These figures are far below the Health Sector Development Plan (HSDP-IV) per capita spending target of US$32. This signifies that there is a big gap between the actual health spending and the expected health expenditure (both nominal and per capita). The amount is also low as compared other low in-come countries; for instance, 49 low-income countries on average

spent $22 per capita in 2006 (13) and World Health Organization (WHO) recommended for these countries US$60 per capita in 2015 (14).

This expenditure for health mainly derived from households (33.7%), external funds (49.9%) and the government (15.6%). This implies that the health sector is highly dependent on the rest of the world and exposed to uncertainty. This is a signal that urges the health sector to use the available resources in an efficient manner(15). Many low income countries are below national and international health goals not only because of scarcity of resources but more painfully because available resources are not efficiently utilized(16).

Given this reality, various studies conducted in Ethiopia showed that there is big inefficiency in health facilities in using the resources availed for them. Constant Returns to Scale (CRS) Data Envelopment Analysis (DEA) model results have demonstrated that 60% are technically inefficient for 40 selected Oromia and Addis Ababa health centers.; Variable returns to scale (VRS) DEA model has shown that 24 (60%) are scale inefficient. Moreover, efficiency measure of CRSDEA model predicted that 70.6% of the hospitals were technically inefficient for 17 hospitals from Addis Ababa while the VRS DEA model predicted that 47.1% of the hospitals were technically inefficient and 70.1% of them were scale inefficient. Among the inefficient hospitals, 25% of them were operating at decreasing returns to scale(3,17).

The first study has assumed outputs of maternal health service generally as one. It had not specific figures for separated maternal health services individually as output variable. Similarly the second study considered outputs like outpatient visit, inpatient days and surgery. Moreover this study included labor and capital inputs to develop its frontier. Both studies have taken inputs and output generally that limited them to identify efficiency problems for specific inputs or outputs. This study attempted to consider specific output and input variables that were not included in the former studies to identify specific excess inputs and undressed outputs.

There was promising progress to achieve the Millennium Development Goals (MDGs) along the past years except the fifth MDG; that is, improve maternal health. This goal has showed a slow progress. WHO in 2015 indicated that annually, 303,000 women die globally during and following complications of pregnancy and child birth. Over 99% of these deaths occur in low-resource settings 66% (201 000) in SSA, and most are preventable through provision of quality essential maternal health services. The Maternal Mortality Ratio (MMR) in Ethiopia has become

353 per 100,000 live births in 2015. There is sufficient evidence to suggest that high maternal mortality is associated with inadequate and poor-quality maternal health care. Now, building on the momentum generated by MDG 5, the SDGs establish a transformative new agenda for maternal health towards ending preventable maternal mortality; target 3.1 of SDG 3 is to reduce the global MMR to less than 70 per 100 000 live births by 2030(12,18,19).

Even if there is reduction in MMR (420 in 2013 to 353 in 2015 estimate of WHO) the maternal mortality in Ethiopia is among the highest in the world. This problem with the low level of health expenditure hinders the country from the way to achieve the Health Sector Transformation Plan (HSTP) 2015/16 to 2019/2020 and SDGs at 2030. To reduce this problem maximum effort should be exerted through utilizing the existing resources in a way that gives maximum output. To examine the efficiency and operate in line with maximum efficient manner there should be sufficient data and/or information about inputs, outputs and efficiency. But there is big problem in having data and/or information regarding efficiency of health care facilities specifically in their maternal health service unit(18,20,21).

In addition to the existing gaps in information on TE of health care facilities, DEA has recently gained currency in assessing the efficiency and productivity of hospitals in the public sector. However, its use in developing countries, particularly SSA has been very limited. This is witnessed by the dearth of published information(10).

It has been found that there are several compelling methodological and practical advantages for using DEA over other models. DEA accommodates multiple inputs and multiple outputs to measure technical efficiency of DMUs. Therefore, it is appropriate for various services giving as well as good producing organizations. As one of service giving organizations, hospitals specifically maternal health service unit uses several inputs to give various kinds of services. Moreover, unlike the parametric frontier models, DEA does not suffer from the problem of model miss-specification, which has the potential of providing misleading results(22,23).

All the preceding reasons initiated the researchers to study the TE of hospitals in the provision of maternal health service. Moreover, as far as the researcher investigated there is no any study conducted in hospitals of Oromia regional state regarding TE. This is particularly true for the provision of maternal health services in hospitals of the region where a lot of resources are being directed. Therefore, the aim of this study is to assess the TE of selected hospitals in selected

zones of Oromia regional state, Ethiopia in the provision of maternal health services, 2014/2015 (2007 Ethiopia Fiscal Year (EFY)).

Significance of the Study

Understanding of the level of inefficiencies and availing the unavailable information of the maternal health care provision in the study area would enable policy makers at national, regional and local levels to design and implement efficient strategies of health care resource utilization so as to improve the maternal health status. This is particularly important since maternal health services are believed to be high impact interventions for which huge amounts of resources are committed to provide services free of charge to all women. The results from this study could also help the health program managers in the study hospitals to identify efficiency problems in providing maternal health service in the future. Furthermore, this study may ignite the initiative to draw attention towards close follow up for efficient use of resources in public health facilities especially when users are indiscriminately waived from payment. This could mobilize health program managers, policy makers and researchers in Ethiopia and other similar settings to reconsider the importance of efficient use of available resources.

CHAPTER TWO

Literature Review

2.1. Overview

The government of Ethiopia is committed to improve maternal health. MMR is expected to reduce from 420/100,000 live births in 2014 to 177/100,000 live births by the year 2020. Improving access and strengthening facility-based maternal services is one of the approaches the Federal Ministry of Health (FMoH) is using to reduce maternal morbidity and mortality. According to Mini Ethiopian Demographic and Health Survey (MEDHS) 2014, only 16% of births in Ethiopia are delivered in health facilities (15% in a public facility and 1% in a private facility). The proportion of home deliveries could be reduced if women could more easily access antenatal and postnatal services, as well as skilled attendance of deliveries and FP services(21,24,25).

When we come to specific figures of maternal health service in Ethiopia over the last years; 41% of pregnant women who gave birth in the five years preceding 2014 received Antenatal Care (ANC) from a skilled provider, that is, from a physician, nurse, or midwife, for their most recent birth 35% from a nurse or midwife, and 6% from a physician. Another 17% of women received ANC from a health extension worker (HEW). Trend data on the percentage receiving antenatal care from a skilled health provider shows that there was an impressive 52% increase in skilled ANC over the last fifteen years(24).

In particular, delivery assisted by skilled providers is the most important proven intervention in reducing maternal mortality and one of the MDG indicators to track national effort towards safe motherhood. A remarkable progress was observed from 10% in Ethiopian Demographic and Health Survey (EDHS) 2011 to 14.5% in EMDHS 2014, with a 45% increase in only three years; however, despite this progress, the percentage of Skilled Birth Attendant (SBA) is still too low in Ethiopia, even when compared with the average estimate for SSA countries (40%) published in the United Nations (UN) MDG Report 2014. the consistent upward trend in SBA from as low as 5.6% in EDHS 2000 and 5.7% in EDHS 2005 up to 14.5% in EMDHS 2014. Similarly, 15.4% of births were delivered at a health facility according to EMDHS 2014 (14.0% in a public facility

and 1.4% in a private facility). Urban births were six times more likely than rural births to be delivered in a health facility (63.0% versus 10.4%) (26).

The level of PNC coverage is extremely low in Ethiopia. Only 13 percent of women received PNC within two days, as recommended. Nevertheless, this is an improvement from fifteen years ago when only 2 percent received PNC during the first two days of delivery. The great majority of women (82 percent) with a live birth in the preceding five years did not receive a postnatal check-up at all. Among women who received a postnatal check-up, 8 percent were examined within 4 hours of delivery, 3 percent within 4-23 hours, 2 percent within 1-2 days, and 5 percent within 3-41 days of delivery(24).

According to the fifth round of NHA, total reproductive health spending in 2010/11 is Birr 3.6 billion (US$224 million), which represents 14 percent of the total NHE. From this more than 23% has consumed by public hospitals. Spending per woman of reproductive age (15–49 years) increased to $12.12 from $8.00 in 2007/08 and $3.60 in 2004/05(14).

2.2. Technical Efficiency

2.2.1. Input and Output Measures

A result of a study conducted in 19 hospitals of Eritrea using two stage DEA by measuring number of physicians (physicians), number of nurses and midwives, number of laboratory technicians, number of operational beds and costs as inputs; and number of outpatient department (OPD) visits, and number of inpatient department discharges as output, revealed that the average CRS TE score was 0.90; the average VRS TE score was 0.97; and the average scale efficiency score was 0.93. In 2007, the inefficient hospitals could have become more efficient by either increasing their outputs by 20,611 outpatient visits and 1,806 hospital discharges, or by transferring the excess 2.478 physicians (2.85%), 9.914(%) nurses and midwives (0.98%), 9.774 (9.68%) laboratory technicians, and 195 beds (10.42%) to primary care facilities such as health centers, health stations, and maternal and child health (MCH) clinics. In the second stage analysis outpatient visits as a proportion of inpatient days and average length of stay were significantly correlated with efficiency score(27).

Study on the TE was conducted in 459 Australian acute private and public hospitals using stochastic distance function.The result gives average efficiency score of 0.899 and concluded that they are required to improve their efficiency by about 10 per cent in the existing policy environment. On average, for-profit and public contract hospitals were estimated to be more efficient than public and not-for-profit private hospitals, in terms of their potential to increase output for a given set of inputs. However, for-profit, not-for-profit and public hospitals were found to be similarly efficient with respect to their potential to economise on input use for a given level of output(28).

A study in Ghana in 17 district hospitals and 17 health centers using outputs of number of child deliveries; the number of fully immunized children under the age of 5 years; the number of other maternal (ANC, PNC and family planning services) and childcare (nutritional/child growth monitoring) visits. And inputs of the number of outpatient curative visits; and input variables of number of technical staff (this included medical assistants, nurses and paramedical staff); and the number of support or subordinate staff (including cleaners, drivers, gardeners, watchmen and others was conducted using DEA approach. The result shows that eight (47%) hospitals were technically inefficient, with an average TE score of 0.61 and a standard deviation (SD_ 0.12). Ten (59%) hospitals were scale inefficient, manifesting an average SE of 81% (SD_25%). Out of the 17 health centers, 3 (18%) were technically inefficient, with a mean TE score of 0.49 (SD_0.27). Eight health centers (47%) were scale inefficient, with an average SE score of 0.84 (STD_0.16)(29).

To investigate TE of 40 Indian district hospitals on maternal health service, the researchers used number of physicians, number of nurses; and number of beds as input variables and number of women with three completed antenatal check-ups; number of deliveries; number of caesarean-section deliveries; number of women receiving post-natal care within 48 hours of delivery; number of medical terminations of pregnancy; number of male and female sterilizations; number of inpatient admissions; and number of outpatient consultations as an output variables. Finally they came up with TE and scale efficiency scores of the district hospitals 0.90 (SD_0.14) and 0.88 (SD_0.15), respectively. Of the total district hospitals in the study, 20 (50%) were technically efficient constituting the ‘best practice frontier’. The other half were technically inefficient, with an average TE score of 0.79 (SD_0.12) meaning that these hospitals could

produce the same outputs by using 21% less inputs from current input levels. Twenty-six (65%) district hospitals were found to be scale inefficient, manifesting a mean score of 0.81 (SD_0.16)(30).

A study on Kenyan public hospitals has measured medical officers/pharmacists/dentists, clinic officers, nurses (including enrolled, registered, and community nurses), administrative staff, technicians/technologists, other staff, subordinate staff, pharmaceuticals, non-pharmaceutical supplies, maintenance of equipment, vehicles, and buildings, and food and rations as input variables. And OPD casualty visits, special clinic visits, MCH/ FP visits, dental care visits, general medical admissions, paediatric admissions, maternity admissions, and amenity ward admissions as output variables. The DEA result found out that: 40 (74%) hospitals from 54 district hospitals included in the analysis were technically efficient, whilst the remaining 14 (26%) were technically inefficient. The inefficient hospitals had an average TE score of 0.84 (SD_0.16). This implies that on average, they could reduce their utilization of all inputs by about 16% without reducing output. On the other hand, out of the 54 hospitals analyzed, 38 (70.5%) are scale efficient. Sixteen (29.6%) of the hospitals were scale inefficient; meaning their scale efficiency score was less than unity. The average scale efficiency score in the whole sample was 0.90 (SD_9.7); implying that there is room to increase total outputs about 10%(31).

A study conducted in 17 selected hospitals in Addis Ababa. Results of the CRS DEA model using outputs of outpatient visit, inpatient days and number of both minor and major surgery as outputs; and labor input (yearly salary of personnel) and capital as input variables, uncover that: Overall average TE score is 0.776 (SD_0.26). Five (29.4%) hospitals were found technically efficient, while 12(70.6%) were inefficient. The VRS DEA model indicated 9(52.9%) hospitals were pure technically efficient and 8(47.1%) hospitals were pure technically inefficient with average efficiency score of 0.912 (SD_0.14). Out of the sampled hospitals, 5(29.4%) hospitals were found scale efficient, while 12 (70.6%) were scale inefficient with average efficiency score of 0.849 (SD_0.23). Factors including years of service, number of beds, level, average bed occupancy rate, and proportion of physicians to staff were found statistically significant (17).

A study in 40 public health centers of Addis Ababa and selected health centers of Oromia regional state that considered three outputs. Outpatient casual visits, MCH visits, and delivery services and five inputs: physicians and/or health officers, nurses of all categories, health

assistants, other technical staff and administrative staff. DEA result indicated that 60% of health centers have some degree of technical inefficiency and about 60% were scale inefficient. Has average overall TE score of 0.811, pure TE score of 0.936 and scale efficiency of 0.864. In the analysis, the input reduction required to make the inefficient health centers technically efficient is also identified. From the OLS and Logit results, location and availability of public health care providing unit (hospital) in the area are significantly associated with efficiency(3).

2.2.2. Methods of Measuring Technical Efficiency

Measurement of efficiency of any organization (e.g., hospital, bank etc.) that uses multiple inputs and generates multiple outputs is complex and comparisons across units are difficult. The empirical measurement of economic efficiency centers on determining the extent of either allocative efficiency or TE or both in a given organization or a given industry. Most recently, economists have employed frontier efficiency measurement techniques to measure the productive performance of healthcare services. Frontier efficiency measurement techniques use a production possibility frontier to map a locus of potentially technically efficient output combinations an organization is capable of producing at a point in time. To the extent an organization fails to achieve an output combination on its production possibility frontier, and falls beneath this frontier, it can be said to be technically inefficient(4,6).

Over the past years efficiency of service organizations like health institutions has been measured by various techniques. The two principal methods that were used are DEA and Stochastic Frontier Analysis (SFA), which involve mathematical programming and econometric methods, respectively(32,33).

Data envelopment analysis

After the work of Charnes and Cooper in 1985 that is the excellent methods to measure efficiency of organizations that use multiple inputs and output, measurement of efficiency became simpler and more scientific. DEA is a non-parametric approach that uses mathematical programming model applied to observed data that provides a way for the construction of production frontiers as well as for the calculus of efficiency scores relative to those constructed frontiers(32).

This approach is a non-statistical approach to the problem of efficiency measurement. It takes data on organizations' outputs and inputs, and measures the efficiency of a particular organization by its distance from the 'outer envelope' of the data. With this technique, all deviations from the efficient frontier are classed entirely as inefficiency. This method determines the relative efficiency measure for a DMU. It conducts its operation by maximizing the ratio of weighted outputs to inputs subject to the condition that similar ratios for every DMU are not larger than one. The organization that produces the most will find itself on the efficient frontier simply because there is no larger organization with which to compare it(34,35).

Stochastic frontier analysis

SFA uses statistical methods to fit a frontier. The idea is to identify the relationship between output and input(s) whilst allowing for two types of deviation from this relationship. One is statistical 'noise' in other words, random variations in the data caused by inaccuracy in the measurement of output and by other errors. The second type of deviation is a measure of inefficiency. The extent to which an organization's total deviation from the frontier is designated to be noise versus inefficiency depends on the choices made about the joint distributions of the two components(34).

The nonparametric frontier approach, based on envelopment techniques (DEA FDH), has been extensively used for estimating efficiency of organizations as it relays only on very few assumptions. On the contrary, the SFA allows the presence of noise but it demands parametric restrictions on the shape of the frontier and on the data generating process in order to permit the identification of noise from inefficiency and the estimation of the frontier(36).

Studies were conducted to compare the two frontier efficiency measurement techniques (DEA and SFA) so far. ValcarcelG. L. and Perez B.in 1996 in a sample of Spanish general hospitals, and Linna (1998) in Finnish acute care hospitals found that the choice of approach did not significantly influence the results(4).

SFA requires a great deal of knowledge, both about the shape of the frontier and the distributions of the two types of deviation. The choice that is made about the shape of the frontier and the distributions of the deviation components can have significant effects on the efficiency rankings and absolute efficiency measures generated. This economic theory often provides little

information about the shape of the frontier, and the data can be uninformative about the distributions of the two types of deviation. Failing to measure the inputs accurately can further complicate the task of correctly identifying organizations' relative efficiency. On the other hand, DEA does not require any assumptions about the shape of the frontier or about statistical distributions. But as the whole approach, by definition, focuses on extreme observations, it is very sensitive to miss-measurement(34).

DEA has been found that there are several compelling methodological and practical advantages for using DEA over the stochastic frontier models. DEA accommodates multiple inputs and multiple outputs in a single measure of efficiency than the SFA and has become the dominant approach to efficiency measurement in health care and in many other sectors of the economy(22). As the work of Charnes and Cooper implies DEA does not impose a specified functional form to model and calculate the efficiency of a DMU. Unlike the parametric frontier models therefore, DEA does not suffer from the problem of model miss-specification, which has the potential of providing misleading results. In addition, unlike SFA, DEA does not suffer from the problems of multicollinearity and heteroscedasticity. DEA gives a measure of efficiency that is empirically obtainable in a given scenario (given available resources, institutional set-up, etc). Hence we can compare the efficiency of individual DMUs realistic benchmarks(23).

2.3. Conceptual Framework

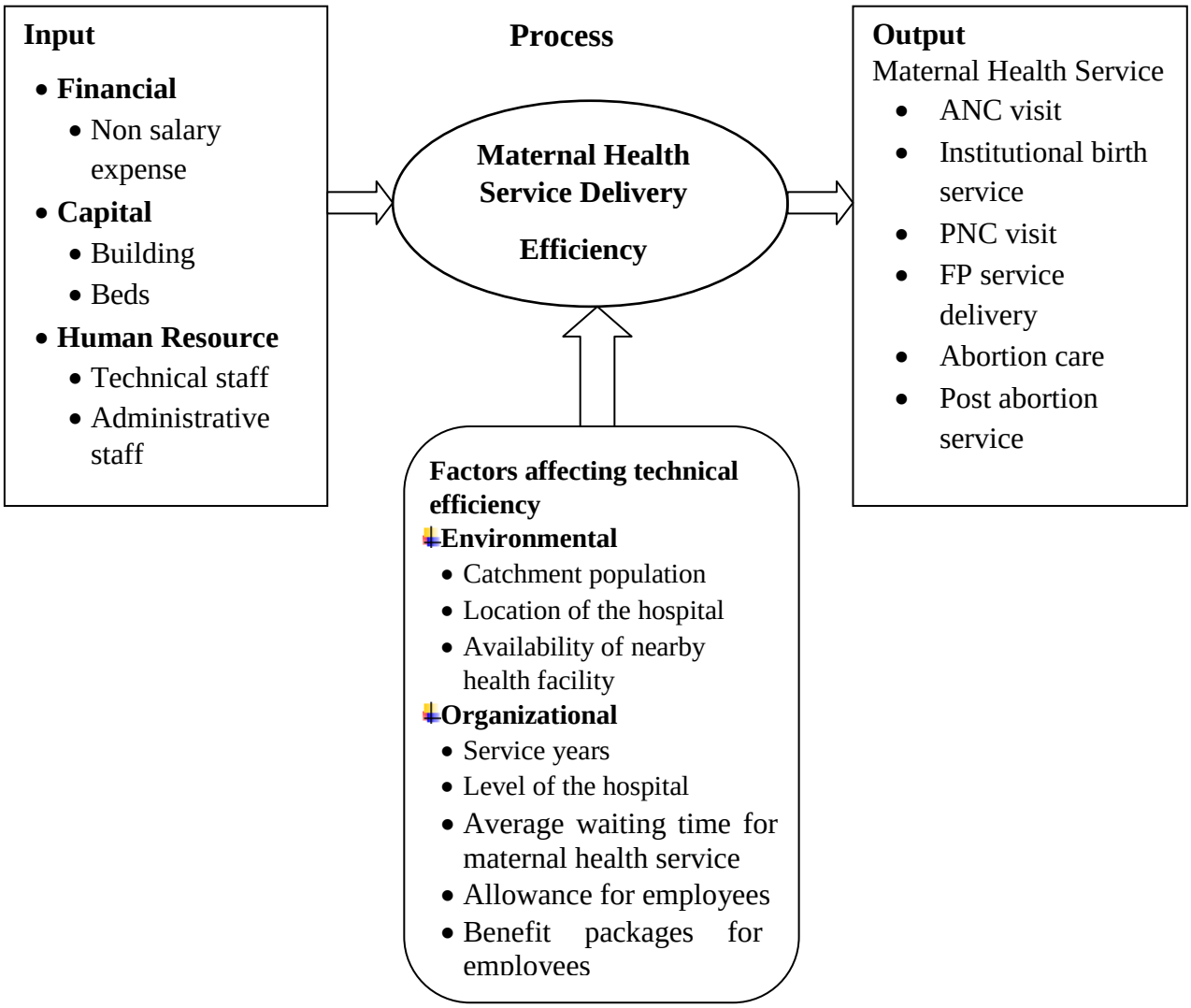

Figure 1: Conceptual Framework of the study

CHAPTER THREE

Objectives of the Study

3.1. General Objective

The general objective of this study is to assess the technical efficiency of public hospitals in the provision of maternal health services in selected zones of Oromia regional state, 2014/2015 (2007 EFY).

3.2. Specific Objectives

- To determine the pure technical efficiency of public hospitals in selected zones of Oromia regional state
- To determine the scale efficiency of public hospitals in selected zones of Oromia regional state
- To verify if there is a need for increasing output or decreasing input to improve efficiency of the public hospitals
- To identify determinants that affect technical efficiency of public hospitals in selected zones of Oromia regional state

CHAPTER FOUR

Methods and Participants

4.1. Study Area and Period

This study was carried out from March 25 to April18, 2016 in primary and secondary hospitals of selected zones of Oromia Regional State. The region is divided into 1 special zone and 17 administrative zones. According to Central statistical agency (CSA) census 2007 the population of the region was 27,158,471; (49.6 female) constituting 36.7% of the total population of Ethiopia(37). Currently there are 50 (12 secondary and 38 primary) hospitals accountable to the health bureau of the region. This study attempted to address the technical efficacy of hospitals maternal health service in East Shoa, Jimma, West Shoa, Ilubabur, North Shoa, and North West Shoa zones. These hospitals put in place various resources to deliver service for maternal health service clients including financial, human and capital.

4.2. Study Design

Health facility based cross sectional study design using two stages DEA was employed in this study.

4.3. Population

4.3.1. Source Population

The source populations of this study included all the maternal health units of all public primary and secondary hospitals in Jimma, Ilubabur, North Shoa, East Shoa, West Shoa and South West Shoa zones in the Oromia Regional State.

4.3.2. Study Population

The study populations of this study included all the maternal health units of all public primary and secondary hospitals in Jimma, Ilubabur, North Shoa, East Shoa, West Shoa and South West Shoa zones in the Oromia Regional State.

4.4. Sample Size and Sampling Technique

There are 15 public hospitals in the six zones which are accountable to Oromia regional state health bureau that became operational in and/or before 2014/15(2007 EFY). Fourteen of the hospitals were included in this study.

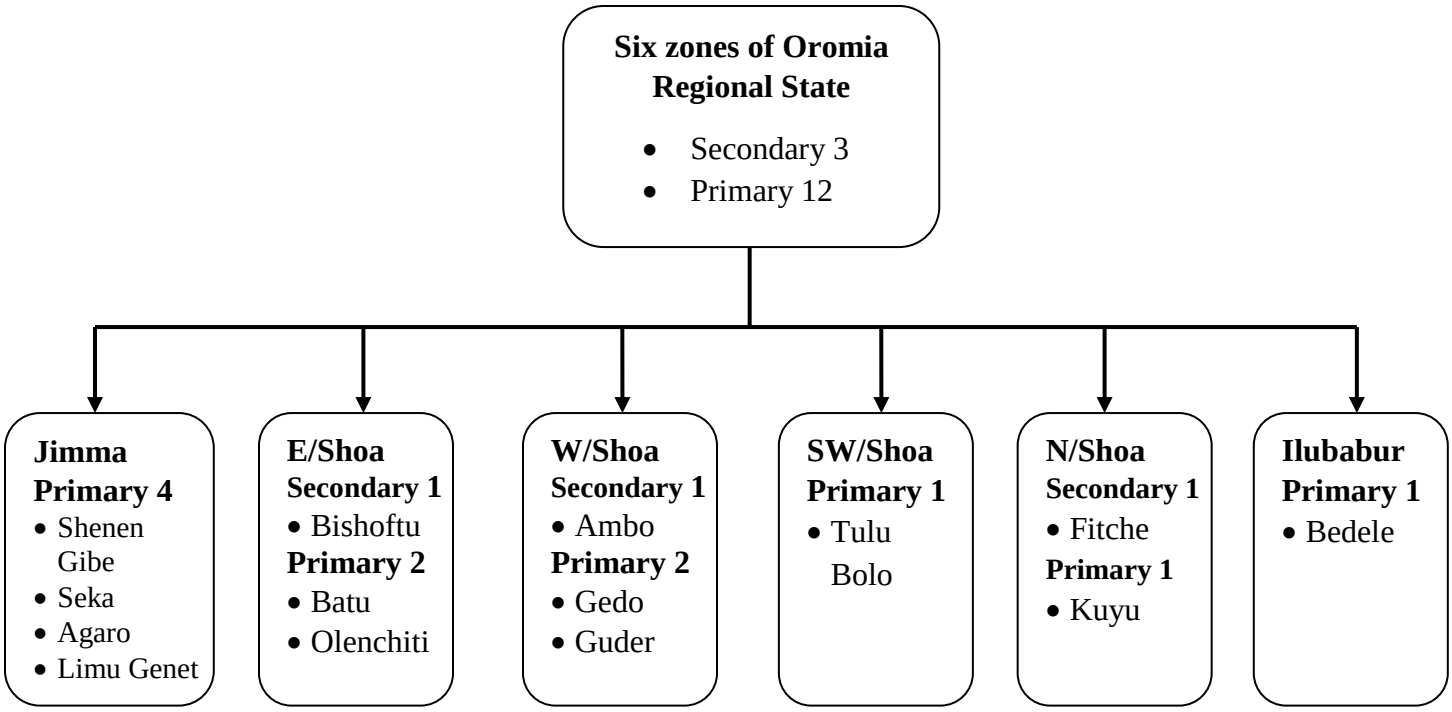

Figure 2: Schematic presentation of the studied hospitals

4.5. Inclusion and Exclusion Criteria

4.5.1. Inclusion Criteria

Hospitals having complete data of inputs and outputs for the year of 2014/2015 (2007 EFY) were included as part of the analysis.

4.5.2. Exclusion Criteria

Hospitals that started working after 2014/2015 (2007 EFY) were not included in the study.

4.6. Study Variables

Variables to Measure Technical Efficiency

Input

Financial

- Total expenditure for maternal health service excluding salary

Capital

- Buildings for maternal health services
- Number of maternal services unit beds

Human resource

- Number of administrative staff
- Number of physicians (GP, Specialists)
- Number of Nurses: clinical and midwives
- Number of laboratory technicians and technologist
- Number of pharmacy technicians and pharmacists
- Number of emergency surgical officer
- Number of Anastasia professionals

Output

- No. of ANC visits
- No. of institutional delivery
- No. of PNC service
- No. of FP services
- No. of abortion service
- No. of post abortion service

Measurement of Input and Output Variables

This study was intended to measure the TE of 14 hospitals in the provision of maternal service. The variables specifically the inputs of the hospital were not directed to maternal service only. Almost all of the resources were allocated to the entire hospital. Therefore should be a mechanism to identify the inputs specifically for maternal health service. So as have this specific figure a proportion for all the hospitals computed by dividing the total of maternal health service users (including, ANC, delivery, PNC, FP, abortion and post service users) in 2014/15 (2007 EFY) by the overall client flow of each hospital in the same Then after all the resources except midwife nurses, class rooms and beds for maternal service multiplied by the proportion and the expected specific figure for maternal health identified (

Table 1).

Table 1: Proportion of maternal health service users in hospitals of six zones of the Oromia Regional State, Ethiopia (2016)

Name of Hospital	**Proportion**
Fitche	0.11
Shenen Gibe	0.16
Bedele	0.15
Ambo	0.09
Gedo	0.06
Guder	0.02
Olenchiti	0.08
Bishoftu	0.06
Batu	0.19
Tulu Bolo	0.09
Kuyu	0.16
Seka	0.06
Limu Genet	0.11
Agaro	0.11

4.6.1. Dependent Variable

Technical efficiency scores of hospitals

4.6.2. Independent Variables

Organizational

- Number of years since the hospital started service delivery
- Level of the hospital (secondary or primary)
- Qualification of the Chief Executive Officer (CEO) of the hospital
- Average waiting time for maternal health service
- Benefit packages for the employees of the organization

Environmental

- Catchment population
- Availability of nearby public health facility that give maternal health service
- Location of the hospital (urban or rural)

4.7. Operational definitions

- Administrative staff: This implies all staff of the hospital involved in supporting maternal health service delivery other than health professionals.
- Complete data: having data about human resource, medical equipment, financial resources, capital, FP service users, ANC visit, delivery in the hospital, PNC service, abortion and post abortion services.
- Inputs: are financial, capital, medical equipment and human resources used for the provision of maternal health services.
- Maternal health service: in this study includes ANC, institutional delivery, PNC, abortion service, post abortion care and FP service.
- Other technical staff: includes laboratory technician and technologist, pharmacy technician and pharmacist, emergency surgery officer and Anastasia professional.
- Output: are numbers of ANC, institutional delivery, PNC, abortion services, post abortion services and FP service users served by the hospitals included in the study.
- Technical staff: This implies all health professionals working in the hospitals who are directly and/or indirectly engaged in the provision of maternal health services.

4.8. Data Collection Instruments/Procedures

Data were collected using structured and pretested checklist developed after consulting relevant literatures and the Ethiopian standard for primary and secondary hospitals requirement(38,39). The checklist included three sections and 42 items. Data on inputs used by the hospital for provision of maternal health services and outputs produced in the year 2014/2015 (from July 2014 to June 2015) (2007 EFY) were collected. Most of the responses were pre-coded and few were coded after data collection. Data were collected by 8 trained diploma/BSc nurses and 4 supervisors; three were BSc nurse and one was health officer.

The required input/output data were collected from the MCH and Delivery units, human resource department, finance department, the CEOs and the records in health management information system (HMIS) unit of the hospitals using check list based interview and document review.

4.9. Data Processing and Analysis

During and after data collection, the checklists were checked for completeness consistency. The data were entered into Epi Data version 3.1, and transferred to SPSS version 20 software for descriptive analysis, exported to Microsoft Excel 2013 for DEA and exported to STATA version 12 for further analysis. Hospitals characteristics were summarized using proportions for categorical variables and measures of central tendency, and dispersion for continuous variables. Two stage DEA was conducted. The first stage DEA conducted to identify TE scores which were computed using the DEA Programme, version 2.1 (DEAP 2.1) developed by Tim Coelli(40). This analysis was conducted by VRS input oriented DEA assumption.

After the TE scores were determined the second stage analysis was conducted by fitting tobit regression model using STATA version 12.0. The tobit regression model was employed while taking CRSTE score as a dependant variable and other environmental and organizational factors as determinants. Considering that the efficiency scores fall between 0 and 1, and several scores tend to concentrate on these boundary values (censored at 1). That means the efficiency scores are below some threshold 1. For this reason tobit regression is good estimator of explanatory variables(41,42). Significant independent determinants were identified at 95% confidence interval and P-value of less than 0.05. Findings were finally presented in narrations, tables and figures.

4.9.1. Data Envelopment Analysis Conceptual Framework

DEA is basically a linear programming based technique used for measuring the relative performance of organizational units where the presence of multiple inputs and outputs makes comparisons difficult. It involves identification of units, which in relative sense use the inputs for the given outputs in most optimal manner. DEA uses this information to construct efficiency frontier over the data of available organization units. DEA uses this efficient frontier to calculate the efficiencies of the other organization units that do not fall on efficient frontier and provide information on which units are not using inputs efficiently(6).

There are many important DEA extensions. Amongst others, one-stage DEA, which only involve standard DEA analysis, was broadened by a second stage, in which regression technique is used to explain the efficiency scores, which were measured at the first stage(43).

4.9.1.1. Input and Output Orientation

TE attempts to address two questions depending on whether it has input- or output-orientation. Input-orientated TE measure addresses the question: "By how much can input quantities be proportionally reduced without changing the output quantities produced?" On the other hand, output-orientated measure addresses "By how much can output quantities be proportionally expanded without altering the input quantities used?" The choice of the approach is recommended to be based on which side of the orientation (input or outputs) the decision makers in the health facility have more control over(44).

4.9.1.2. Model specification

a) The Constant Returns to Scale (CRS) Model

The constant returns to scale model assumes a production process in which the optimal mix of inputs and outputs is independent of the scale of operation. Many studies have decomposed the TE scores obtained from a CRS DEA into two components, one due to scale inefficiency and one due to "pure" technical inefficiency. This may be done by conducting both a CRS and a VRS DEA upon the same data. If there is a difference in the two TE scores for a particular DMU, then this indicates that the DMU has scale inefficiency, and that the scale inefficiency can be calculated from the difference between the VRS TE score and the CRS TE score(23,40).

$$Technical \quad Efficiency \quad Score = \frac{Weighted \quad sum \quad of \quad outputs}{Weighted \quad sum \quad of \quad inputs}$$

The CRS DEA model is used to measures overall efficiency for each of the selected hospitals. The objective function is to maximize the efficiency of a hospital's subject to the constraints that no hospitals will be more than 100% efficient. Furthermore, the coefficient values are assumed to be positive and non- zero, when the same set of coefficients (weights) are applied to all other hospitals being compared. Maximize the efficiency of hospital j under the restriction that the efficiency of all units ≤ 1. The algebraic model is(3):

$$\text{Eff} = \max_{u_r, v_i} \sum_r u_r y_{rj_0}$$

s.t.

$$\sum_r u_r y_{rj} - \sum_i v_i x_{ij} \le 0 \quad ; \forall j$$

$$\sum_i v_i x_{ij_0} = 1$$

$$u_r, v_i \ge 0 \quad ; \forall r, \forall i.$$

Where:

Yrj = the amount of output r produced by hospital j,

Xij = the amount of input I used by hospital j,

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

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

j_0 = the hospital under assessment

b) The Variable Returns to Scale (VRS) Model

It is already stated that the CRS assumption is appropriate only to hospitals operating at an optimal scale. In a situation where hospitals are not operating at an optimal scale, the TE measure will be mixed with scale efficiency. Hence, to separate the two efficiency scores VRS model is considered. VRS is an extension of equation 1 of the CRS model after imposing a convexity constraint on it. This means that the data are enveloped more closely than the CRS model. The main advantage of the VRS model is that it enables an inefficient firm to be relatively compared with efficient firms of the same size only. Thus, the relative efficiency score of hospital p can be obtained by solving the following equation(17).

$$\text{Eff} = \max_{u_r, v_i} \sum_r u_r y_{rj_0} + u_0$$

s.t.

$$\sum_r u_r y_{rj} - \sum_i v_i x_{ij} + u_0 \le 0 \quad ; \forall j$$

$$\sum_i v_i x_{ij_0} = 1$$

$$u_r, v_i \ge 0 \quad ; \forall r, \forall i.$$

Where:

Yrj = the amount of output r produced by hospital j,
Xij = the amount of input I used by hospital j,
Ur = the weight given to output r, (r = 1... t and t is the number of outputs),
Vi = the weight given to input I, (I = 1... m and m is the number of inputs),
j_0 = the hospital under assessment

In this study input oriented DEA was employed. Input oriented approach is appropriate for hospitals which have less flexibility to change their output, but can alter their use of inputs. This is more likely to be the case for public hospitals, which operate under a capped budget (28). The selection of input orientation is also conformed to the character of the non-profit organization, which focuses on the minimization of inputs with given outputs(41). Moreover, since the recommendation and the policy implication provided to Oromia regional state health bureau, they are expected to know how much resources are spent inefficiently. This enables them to decide how to use these excess resources efficiently in other setting.

The study has also employed VRS model of TE. VRS might be preferred if the interest is on the extent to which the scale of operations affects productivity or when not all units of analysis are considered to be operating at an optimal scale. Inappropriate size of a health facility (too large or too small) may sometimes be a cause for technical inefficiency. This is referred to as scale inefficiency and takes two forms – decreasing returns to scale (DRS) and increasing returns to scale (IRS). DRS implies that a health facility is too large for the volume of activities that it conducts. In order to operate at the most productive scale size, a health facility exhibiting DRS should scale down its scale of operation. In contrast, a health facility with IRS is too small for its

scale of operation. If a health facility is exhibiting IRS, it should expand its scale of operation in order to become scale efficient(45,46).

4.10. Data Quality Assurance

One day training was given to data collectors and supervisors on the objectives of the study, data collection tools and research ethics. This enabled the data collectors and supervisors to collect the required data effectively. The data collectors and supervisors were not the employees of the selected hospitals. Supervisors' control the overall field work and check each tool for consistency and completeness during and after data collection. Data collection instruments were pretested in Jimma University Specialized hospital.

4.11. Ethical Considerations

The proposal of this study was reviewed and approved by Institutional Review Board (IRB) of Jimma University. Letter of ethical clearance was assured. The proposal and ethical clearance were submitted to Oromia Regional health bureau to receive letter of support to run the study and facilitate the data collection. Research ethics training on basic concepts and principles of ethics was given to data collectors and supervisors. The purpose of the study was explained and oral informed consent was obtained from the CEO of hospitals on the behalf of the hospital.

4.12. Dissemination Plan

The findings will be presented during Jimma University annual research conference. The document will also be submitted to governmental and non-governmental stakeholders and policy makers. Finally, it will be submitted for publication on a peer reviewed journal.

CHAPTER FIVE

Results

5.1. Basic Characteristics of Hospitals

To conduct this study, 15 primary and secondary hospitals that started operation before and in the year 2014/15 (2007 EFY) were selected. Data were collected from 14 of these hospitals.

All the selected hospitals were public hospitals and accountable to Oromia regional health bureau. Among them three were secondary and the remaining eleven were primary hospitals. All these hospitals were located in urban centers. There was health center that provided maternal health service around in almost all of the hospitals with in at most three kilo meters radius. Seventy nine percent of the hospitals provided allowances for their employees like top up. And 50 % of the hospitals had additional benefit for their employees like provision of housing facility for physicians, and cleaning materials. Majority of the hospital's (64.3%) CEOs were BSc. holders in Nursing, HO, and Environmental health. All the hospitals received their internal revenue and financial resource from the government in their budget; 28.6% of hospitals got support from non-governmental organizations (Table 2).

Table 2: Characteristics of hospitals in six zones of Oromia Regional State, Ethiopia (2016)

Variables	**Category**	**Frequency**	**Percent**
Level (type) of hospital	Secondary hospital	3	21.4
	Primary hospital	11	78.6
Availability of health facility that gives maternal health service around	Yes	13	92.9
	No	1	7.1
Type of the nearest health facility	Health post	1	7.7
	Health center	12	92.3
Distance to the nearest HC/HP in kilo meters	1km	3	23.1
	2km	6	46.2
	3km	4	30.8

Variables	Category	Frequency	Percent
Availability of allowance (additional payment) for the employees	Yes	11	78.6
	No	3	21.4
Availability of facilities (benefits other than money) for the employees	Yes	11	78.6
	No	3	21.4
Qualification of the CEO	BSc	9	64.3
	BA*	1	7.1
	MHA	2	14.3
	MPH	2	14.3
Source of budget for the hospital	Government	14	100
	Internal revenue	14	100
	NGO**	4	28.6

*Bachelor of Arts
** Non-governmental Organizations

The mean service year of the 14 hospitals was around 13 years and three months; the mean catchment population and waiting time for maternal health service was 695,424 and 29 minutes and 34 seconds, respectively (Table 3).

Table 3: Summary of characteristics of hospitals in six zones of the Oromia Regional State, Ethiopia (2016)

Variable	No. of Hospitals	Mean	SD	Min	Max
Service years of the hospital	14	13.29	20.35	1	60
Catchment population in 2007 EFY	14	695424.1	466502.5	154945	1500000
Average waiting time for maternal health service in minutes	14	29.57	8.94	15	45

5.2. Description of Input and Output Variables

In 2007 EFY, the 14 hospitals served 17334 ANC visits, 18180 deliveries, 14468 PNC services, 21410 first and repeated family planning services, 1807 abortion cases and 2143 post abortion care clients with an average of 1238, 1299, 1033, 1529, 129, and 153 respectively (Table 4). Those outputs were produced using as many as 18 physicians, 77 nurses and midwives, 35 other staffs including laboratory technicians and technologists, pharmacists and druggists, emergency surgery officers and Anastasia professionals. The average salary expenditure for administrative staff was Birr 169058.3, for physicians Birr 101627.9, for nurses and midwives Birr 516988.6, and for other technical staffs Birr 128290.3. In addition to these 108 rooms (on average 8) and 208 beds (on average 15) were used as inputs (Table 5).

Table 4: Outputs in maternal health service provision in public hospitals of six zones in the Oromia Regional State, Ethiopia (2016)

Zones	**Hospital**	**Antenatal Care**	**Delivery service**	**Postnatal Care**	**Family Planning**	**Abortion**	**Post abortion service**
North shoa	Fitche	1720	1701	1733	2520	0	134
	Kuyu	2642	960	930	4667	22	157
Ilubabur	Bedele	976	1278	1085	1206	82	72
West shoa	Ambo	995	2401	2006	794	266	167
	Gedo	1167	1001	0	807	17	94
	Guder	82	24	0	56	0	0
East shoa	Olenchiti	118	38	38	50	4	0
	Bishoftu	2956	3449	2648	4197	629	260
	Batu	1838	2256	2256	474	84	539
South west shoa	Tulu Bolo	588	1154	692	1680	243	185
Jimma	Shenen Gibe	1376	1053	1053	2173	35	113
	Seka	134	56	14	16	0	0
	Limu Genet	1500	1345	895	2462	270	260
	Agaro	1242	1464	1118	308	155	162
Total		17334	17334	18180	14468	21410	1807
Mean		1238	1238.14	1298.57	1033.43	1529.29	129.07
SD		876	875.63	960.38	870.88	1510.77	176.49

Table 5: Inputs used for maternal health service provision in public hospitals of six zones in the Oromia Regional State, Ethiopia (2016)

Zones	Hospitals	Expenditure excluding salary	Administrative staffs' salary expenditure	Physicians' 'salary expenditure	Nurses' salary expenditure	Others'* salary expenditure	Class rooms	Bed
North shoa	Fitche	725494.7	232566.7	191788.3	925781.2	205625.6	12	36
	Kuyu	817260.6	244536.3	74977.63	299391.1	135878.6	5	14
Ilubabur	Bedele	1336068	208836.6	152674.8	590278.1	168136.2	3	5
West shoa	Ambo	1412139	218536.1	161408	774257.6	151344.3	6	24
	Gedo	405768.9	36839.13	37769.04	378558.4	71671.44	11	11
	Guder	30030.27	12455.74	8099.516	297757.5	16474.13	3	16
East shoa	Biishoftu	88184.39	79860.51	46508.07	370405.5	71607.27	6	8
	Olenchiti	436730.3	113250.5	158134.9	778874.9	127287.8	29	24
	Batu	498250.4	448754.3	196925	659131	218601.2	5	11
South west shoa	Tulu Bolo	431944	102167.3	78035.64	440028.1	146985.6	5	9
Jimma	Shenen Gibe	988985.2	253061.4	130626.1	577371.4	196431.1	5	9
	Seka	51576.85	62889.33	31612.05	276638	52090.1	7	12
	Limu Genet	909176.9	204818.1	73095.09	458936.3	120083.9	6	20
	Agaro	814243.5	148244.8	81136.92	410431.7	113847.1	5	9
Total		8945853	2366817	1422791	7237841	1796064	108	208
Mean		638989.5	169058.3	101627.9	516988.6	128290.3	8	15
SD		440838.5	114213.8	62444.18	204860.4	59685.84	7	9

* Expenditure for laboratory technician and technologists, pharmacy technician and technologists, and emergency surgery officers

5.3. Technical and Scale Efficiency Scores

To measure the efficiency, all the 14 hospitals were included in the analysis. The result showed that 9 (64.29%) of the 14 hospitals were CRS technically efficient. The VRS model showed that 11 (78.57%) of the hospitals were pure technically efficient and 9 (64.29%) hospitals were scale efficient (Figure 3).

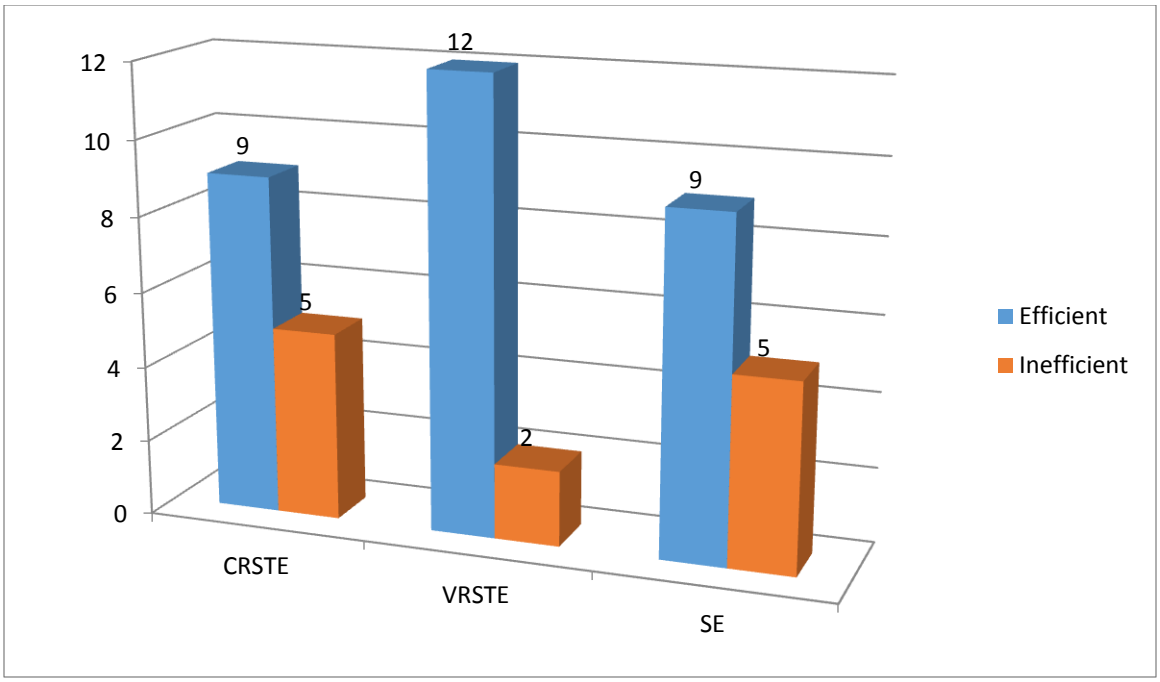

Figure 3: Efficiency of hospitals in maternal health service provision in six zones of the Oromia Regional State, Ethiopia (2016)

The study revealed that there are nine efficient and five inefficient hospitals in the provision of maternal health service. When we look at the average inputs used along efficient and in-efficient hospitals, it has shown some variation as seen in Figure 4. Even if, the in-efficient hospitals' inputs are less than the efficient ones, the difference is not comparable to the outputs' differences between the two extremes. The inputs' differences are by far less than the outputs' differences.

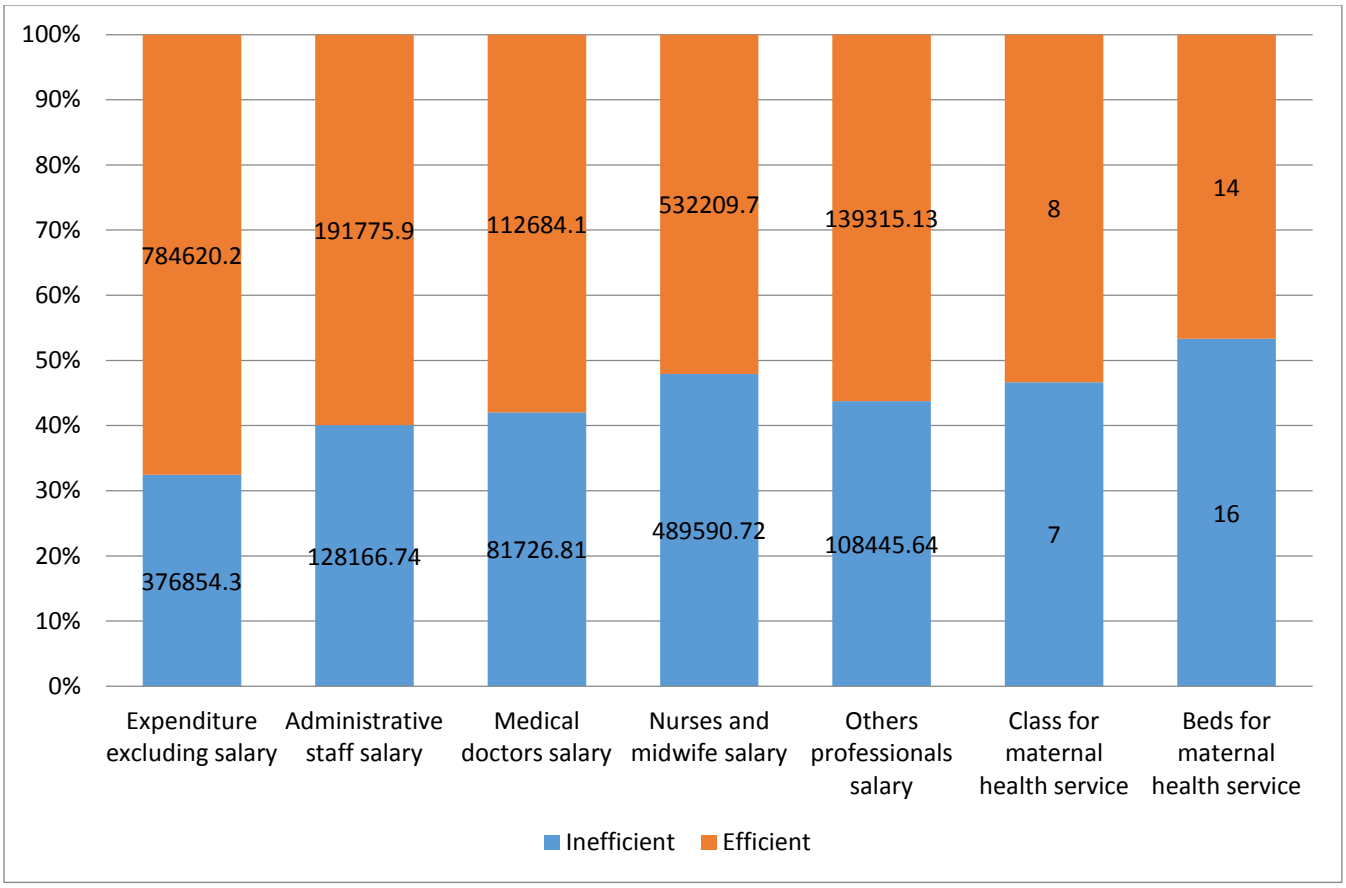

Figure 4: Mean inputs used by efficient and inefficient hospitals, in six zones of Oromia regional state, Ethiopia (2016)

Similarly the outputs produced (clients served) by efficient and inefficient public hospitals also have differences. However, the differences are by far greater than that of the inputs' differences as seen in Figure 5. The inefficient hospital's outputs are by much less than that of the efficient hospitals outputs.

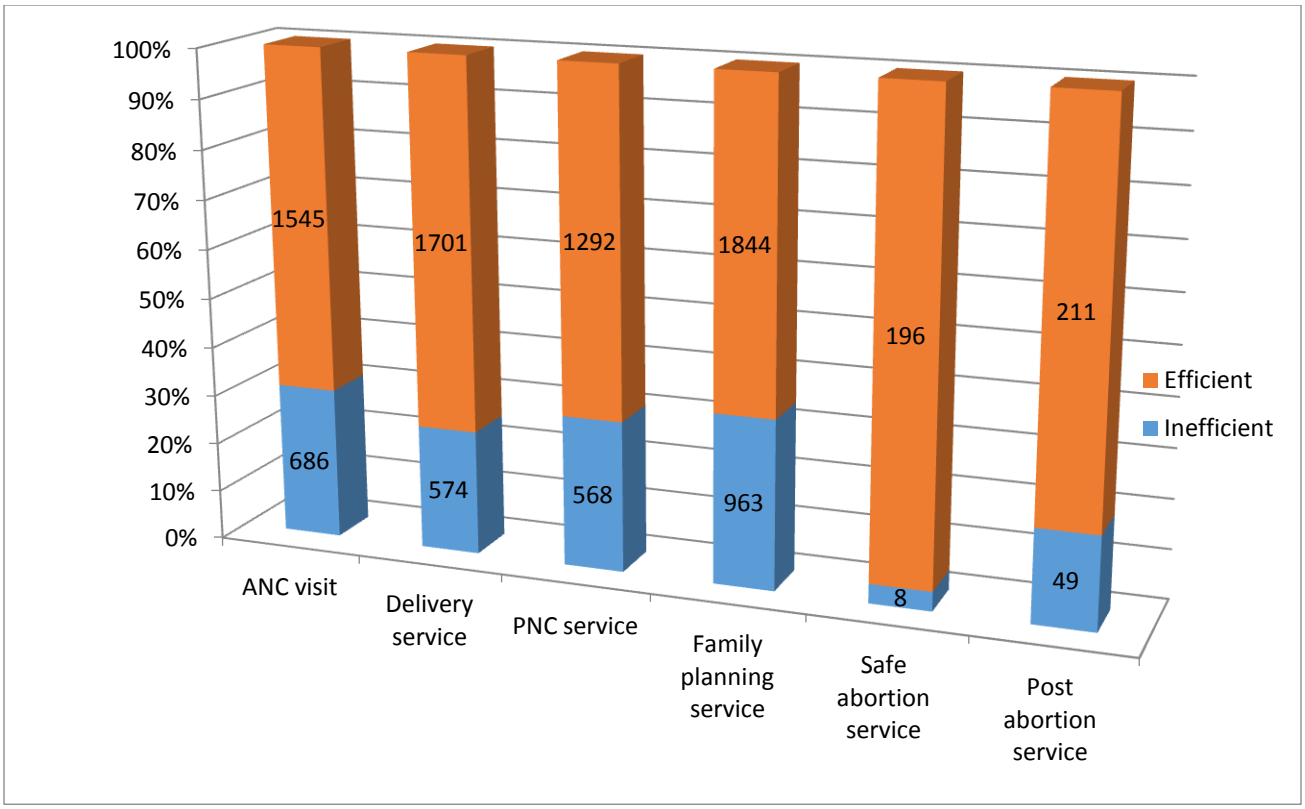

Figure 5: Mean outputs produced by efficient and inefficient hospitals, in six zones of Oromia regional state, Ethiopia (2016)

Table 6 shows scores for CRS TE, VRS TE, scale efficiency, and returns to scale. Nine (64.29%) hospitals were constant return to scale technically efficient, and the remaining 5 (35.71%) were relatively inefficient. Among the inefficient ones, 2 hospitals had a constant return to scale TE score greater than 0.75, the remaining three scored less than 0.5. The mean constant return to scale TE was 0.85, with a standard deviation of 0.28. The average constant return to scale TE score varied from 0.20 in Olenchiti hospital to 1 in 9 hospitals.

Twelve (85.71%) hospitals were VRS technically efficient, scoring 1, and the remaining 2 (14.29%) hospitals were VRS technically inefficient. The inefficient hospital had VRS TE scores more than 0.75. The overall mean VRS TE score was 0.99 (SD_0.03). Fitche and Shenen Gibe hospitals had VRS TE score less than 1. Moreover, the mean inefficiency score for pure technically inefficient hospitals was 0.93 (SD_ 0.04).

Nine (64.29%) hospitals had a SE score of 1. The remaining 5 (35.71%) hospitals had scale efficiency scores of less than 1 and were thus considered scale inefficient. The distribution shows

that: 3 hospitals had a scale efficiency score of less than 0.5; the remaining 2 hospital scored scale efficiency score more than 0.75. The average scale efficiency score was 0.86 (SD_0.28). Among the scale inefficient hospitals the mean SE score was 0.60 (SD_0.35). All the inefficient hospitals were operating at an increasing return to scale.

Table 6: Efficiency scores of public hospitals in maternal health service provision in six zones of the Oromia Regional State, Ethiopia (2016)

Hospital	**CRSTE**	**VRSTE**	**Scale efficiency**	**Returns to scale**
Fitche	0.89	0.90	0.99	IRS
Shenen Gibe	0.90	0.95	0.95	IRS
Bedele	1	1	1	-
Ambo	1	1	1	-
Gedo	1	1	1	-
Guder	0.46	1	0.46	IRS
Olenchiti	0.20	1	0.20	IRS
Biishoftu	1	1	1	-
Batu	1	1	1	-
Tulu Bolo	1	1	1	-
Kuyu	1	1	1	-
Seka	0.38	1	0.38	IRS
Limu Genet	1	1	1	-
Agaro	1	1	1	-
Mean	**0.85**	**0.99**	**0.86**	

Table 7: Summary of efficiency scores of public hospitals in maternal health service provision in six zones of the Oromia Regional State, Ethiopia (2016)

Variable	**Mean**	**SD**	**Min**	**Max**
CRSTE	0.85	0.28	0.20	1
VRSTE	0.99	0.03	0.90	1
scale	0.86	0.28	0.20	1

As the figures of overall TE score along secondary and primary hospitals showed, the secondary hospitals have greater average efficiency score 0.96 (SD_0.01). On the other hand the primary hospitals were taken the highest proportion of inefficient hospitals with the lowest efficiency score 0.81 (SD_0.31) (Table 8).

Table 8: Technical efficiency of hospitals among secondary and primary hospitals in maternal health service provision in six zones of the Oromia Regional State, Ethiopia (2016)

Level of the hospital	**Frequency**	**Efficient**		**Inefficient**		**Mean efficiency score**	**SD**
		No.	%	No.	%		
Secondary	3	2	66.67	1	33.33	0.96	0.01
Primary	11	7	63.64	4	36.36	0.81	0.31
Total	14	9	64.29	5	35.71	0.85	0.28

DEA has demonstrated that 35.71% of hospitals are run inefficiently; and they need to either reduce their inputs or increase their outputs in order to become efficient. Total input reductions and/or output increases needed to make inefficient public hospitals efficient are presented as follows.

5.4. Input Reduction or Output Increase Needed to Improve Efficiency

As presented in

Table 9 below, to make inefficient hospitals efficient the hospitals should deduct the non-salary expenditure by 0.98%, administrative staff salary expenditure by 2.33%, general practitioners and specialists salary expenditure by 5.09%, clinical and midwife nurses salary expenditure by 6.22%, other technical staff including laboratory technician and technologists, pharmacists and druggists, emergency surgery officers and anesthetists salary expenditure by 5.20% and number of class rooms for maternal health service by 1.63% and number of beds by 10.55%. As an alternative the inefficient hospitals to become efficient they could increase number of ANC service users by 1.11%, number of deliveries by 3.12%, number of safe abortion services by 3.39% and number of post abortion service by 7.28%.

Table 9: Input reduction or output increases needed improve efficiency in maternal health service provision in six zones of the Oromia Regional State, Ethiopia (2016)

Variables	**Input reduction and output increase**			
	Projected	**Actual**	**Difference**	
Inputs reduction			**Quantity**	**%**
Expenditure of the hospital excluding salary	8859386	8945853	-86467	0.98
Administrative staff salary	2312878	2366817	-53938.7	2.33
Physicians salary	1353860	1422791	-68930.6	5.09
Nurses and midwife salary	6814346	7237841	-423494	6.22
Others technical staff salary	1707222	1796064	-88842.4	5.20
Class for maternal health service	106.264	108	-1.74	1.63
Bed for maternal health services	188.152	208	-19.85	10.55
Outputs increase				
ANC visits	17527.83	17334	193.83	1.11
Deliveries	18766.04	18180	586.04	3.12
PNC service	14468	14468	0	0
FP service	21410	21410	0	0
Abortion service	1870.4	1807	63.40	3.39
Post abortion services	2311.29	2143	168.29	7.28

Specifically input reduction and/or output increase is required for pure technically inefficient hospitals that are Fitche hospital and Shenen Gibe hospitals. The remaining hospitals are not

expected to increase their output or decrease their input to be pure technically efficient (Table 10).

Table 10: Input reduction or output increases needed to make Fitche and Shenen Gibe hospitals efficient in maternal health service provision, Oromia Regional State, Ethiopia (2016)

Variables	**Input reduction and output increase**			
	Fitche		**Shenen Gibe**	
Inputs reduction	**Quantity**	**%**	**Quantity**	**%**
Expenditure of the hospital excluding salary	49846.02	6.87	36620.99	3.7
Administrative staff salary	15978.79	6.87	37959.94	15
Physicians salary	58525.11	30.52	10405.52	7.97
Nurses and midwife salary	333518.7	36.03	89975.45	15.58
Others technical staff salary	51470.88	25.03	37372.48	19.03
Class for maternal health service	1	6.87	1	18.24
Bed for maternal health services	20	54.21	0.333	3.7
Outputs increase				
ANC visits	160	9.32	34	2.43
Deliveries	397	23.36	189	17.93
PNC service	0	0	0	0
FP service	0	0	0	0
Abortion service	0	0	63	181.13
Post abortion services	129	95.96	40	35.14

5.5. Determinants of Hospital Maternal Health Services' Efficiency

The results of the Tobit model for examining determinants of hospitals' efficiency are given in Table 11. The variable average waiting time for maternal health service was negatively associated with efficiency ($p < 0.05$). As the average waiting time for maternal health service increased by one minute, the TE of the hospital for maternal health service decreases by 0.03 [-0.05, -0.01]. On the other hand, level of the hospital ($p < 0.05$), service years of the hospitals ($p <$

0.05), and catchment population of the hospitals ($p < 0.05$) were positively associated with efficiency of the hospitals. That means, when the service years of the hospital shows a unit increase, the TE score raises by 0.02 [0.003, 0.03]. Similarly a unit increase in the catchment population results in, 0.000000558 [0.0000000295, 0.00000109] increase in TE score of the hospitals. In addition to this, being secondary hospital increases technical efficiency by 1.17 [0.16, 2.18] as compared to primary hospital.

Table 11: Factors affecting hospitals efficiency in maternal health service provision in six zones of the Oromia Regional State, Ethiopia (2016)

Variables	**Coefficient**	**t**	**P-value**	**[95% CI]**	
Level of the hospital (Secondary hospital)	1.17	2.75	0.03*	0.16	2.18
Service years of the hospital	0.02	2.89	0.02*	0.003	0.03
Catchment population of the hospital	5.58E-07	2.5	0.04*	2.95e-08	1.09e-06
Availability of nearby health facility	0.14	0.78	0.459	-0.29	0.57
Availability of allowance for the employees	0.14	0.94	0.378	-0.21	0.48
Benefits packages for the employees of the organization	0.31	1.69	0.135	-0.12	.74
Average waiting time for maternal health service	-0.03	-3.33	0.01*	-0.05	-0.01
constant	-1.74	-1.96	0.09	-3.85	0.36

*significant at $p< 0.05$

CHAPTER SIX

Discussion

Technical efficiency is determined by comparing the difference between the observed ratio of combined quantities of an organization's output to input and the ratio achieved by best practice. Producing the maximum output or consuming the minimum inputs, as compared to what is technically feasible, is an essential step for service providers to be able to meet their objectives best. According to this concept the hospital's maternal health services providing unit (decision making unit) is efficient, if it operates on its corresponding production possibilities frontier. Inefficient producers operate below it.

This investigation found that more than one third of hospitals in six zones of Oromia regional state were technically in-efficient in maternal health service provision in the year 2014/15(2007 EFY) with mean TE score of 0.85 (SD_0.28). A study done among Indian district hospitals on TE, that give special emphasis to maternal health service, found more technical inefficiency as compared to this study. According to the study, one half of the hospitals in Gujarat state of India in 2010 operating with technical inefficiency with an average TE score of 0.79 (SD_0.12) (30). Another study in Ethiopia conducted in 17 hospitals of Addis Ababa investigated that 70.6% were overall technically inefficient with average technical efficiency score is 0.776 (SD_0.26)(17). There is deviation in the TE of hospitals in this study and similar studies in other setting.

The overall technical efficiency (inefficiency) of a decision making unit, in our case the maternal health service department/unit of hospitals, resulted from both pure technical and scale efficiency (inefficiency). The overall TE score (0.85) split in to pure TE and scale efficiency. The VRS assumption supposed the hospitals included in the study are not operating at the optimal level. This assumption resulted in 35.71% hospitals were scale inefficient. Among the scale inefficient 5 hospitals the mean SE score was 0.60 (SD_0.35); they were inefficient due to inappropriate scale. And all were operating at increasing returns to scale. Therefore, the scale inefficient hospitals required to increase their particular input–output mix to be scale efficient. On the other hand, 14.29% of the hospitals were pure technically inefficient and specifically mean inefficiency score for pure technically inefficient hospitals was 0.93 (SD_0.04) implied that the

inefficient hospitals included in the study can produce the same amount of outputs by reducing 7% of the inputs they were using.

In Eritrea, a study found 32% hospitals to be technically inefficient with mean score of 0.97 and 58% scale inefficient with mean score of 0.93 (27). A study in 37 health units of Sierra Leone found that 59% were pure technically inefficient, and 65% were scale inefficient with mean score of 0.63 (SD_ 0.18) and 0.72 (SD_17%) respectively(47). Another study in Ghana reported that 47% hospitals were technically inefficient, 59% hospitals were scale inefficient (29). Thirty three per cent of health centers in Addis Ababa and selected Oromia health centers were found to be technically inefficient with mean score of 0.94 (SD_0.12) and 60% scale inefficient with mean score of 0.86 (SD_0.18) (3). The mean pure TE score is almost similar to this study.

Almost all of efficiency results, overall efficiency, pure TE and scale efficiency results of the above studies are different from this study. This might be for the reason that the study was conducted for maternal health service that has more client flow, and currently government and other concerned bodies have given concern for maternal health service utilization. The variations in inputs and outputs used to calculate the efficiency and the hospitals included in this study are few in number.

This study has also quantified the output increases or the input reductions required for making inefficient primary and secondary hospitals efficient. The results of this analysis indicated a significant scope of input saving or rising 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. The excess use of inputs and/or the unaddressed maternal health service users using these excess resources made the hospitals to function out of efficiency.

There are resources that hinder the inefficient hospitals to be efficient. In other words, the excess amounts of resources make the hospitals to operate out of the efficiency frontier. These inputs include the non-salary expenditure, administrative staff salary expenditure, GPs and specialists salary expenditure, clinical and midwife nurses salary expenditure, other technical staff including laboratory technician and technologists, pharmacists and druggists, emergency surgery officers

and Anesthetist salary expenditure, number of class rooms for maternal health service and number of beds for maternal health service.

On the other hand having the existing resource, serving additional maternal health service users can make the hospitals operate at the efficiency frontier. The additional users required in the specific services like antenatal care service users, deliveries service users, safe abortion service and post abortion service.

So far, there were various studies that measure the TE of hospitals using first stage DEA. But many of them do not identify the explanatory variables for the technical efficiency/inefficiency DMUs. The Second stage DEA was an additional extension to the first stage efficiency measure to identify those determinants for the efficiency or the inefficiency of the DMUs, maternal health service in hospitals in this case. Both environmental and organizational factors were found significantly associated with the TE of the hospitals maternal health service.

Level of the hospital that means being secondary level hospital increases the technical efficiency. More over the increase in catchment population and service years were factors that possibly raise the efficiency of maternal health service of the hospitals. On the other hand, an increase in the average waiting time for maternal health service in the studied hospitals results in lower technical efficiency.

In this study being secondary level hospital and service years increase, were determinants for TE of maternal health service. This is similar with a study conducted in Addis Ababa found years in operation and teaching status were found significantly associated with efficiency(17). This investigation identified four variables that significantly affected efficiency of hospitals both positively and negatively. Two of them were also common in the above discussed studies. But catchment population and average waiting time for maternal health service were found different for this study.

Finally, it has to be noted that there were some limitations in the conduct of this study. First of all, the study did not investigate social, cultural and behavioral inputs, which can strongly influence the outputs of health systems. The findings from this study cannot also be generalized for all hospitals in Oromia National Regional State because of the purposive sample. Moreover, given the general inputs, to get a specific perspective of the outputs, since the inputs used

(physicians, nurses) work for providing services on maternal health as well as other services leads to estimating the resources proportionally. These proportions were developed while taking all the services equal. This may have resulted in under or over estimation the input shared by maternal health services.

CHAPTER SEVEN

Conclusion and Recommendation

7.1. Conclusion

This study was conducted in 11 primary and 3 secondary hospitals in six zones of Oromia regional state. The findings from the first-stage analysis indicated that more than one third of the hospitals were operating as technically inefficient hospitals in maternal health service. This inefficiency is a result of both pure technical and scale inefficiency. Most of the hospitals were found pure technically efficient in providing maternal health service. However, around one third of the hospitals were scale inefficient.

The inefficient hospitals became inefficient because they have excess resources or they did not serve the required number of maternal health service users having the existing resources. The inefficient hospitals collectively were operating while using extra resources above the efficiency frontier. The inputs that were used excess were like technical and administrative staff, beds, non-salary expenses and class rooms for maternal health service. Alternatively while taking the existing resources, the hospitals have unaddressed maternal health service users like antenatal care service users, deliveries service users, safe abortion service users and post abortion service users.

The second-stage analysis showed that efficiency of hospital's maternal health service in the frontier could be affected by various environmental and organizational factors. Level of the hospital; catchment population and service years of the hospital were positively associated. On the other hand, average waiting time for maternal health service was negatively affecting the hospitals efficiency in the provision of maternal health service.

7.2. Recommendations

To regional health bureau

- The regional health bureau is required to facilitate demand raising activities for the reproductive age group women to raise the number of maternal health service users that improve the output of the services.
- The regional health bureau is required to transfer and use the excess health professionals in the inefficient hospitals to other health institution in the health care system
- The regional health bureau and ministry of health should examine the catchment population of the hospitals and service years before sending the available health professionals to hospitals.

To the hospitals' administration

- The hospital administration has to transfer the excess professionals and administrative staff to other units of the hospital with highest client flow.
- The hospital administration should investigate the reason for long waiting time for maternal health service, give solution and follow up the progress.
- The hospital ought to use the excess beds in the maternal health service units of inefficient hospitals for other units with shortage of beds.
- The hospital has to use the excess class rooms in the maternal health service units of inefficient hospitals for other units with shortage of class rooms.

To other researchers

- It is good to study the quality of hospitals service and its relation with efficiency/ inefficiency.

Reference

1. Bourchtein V. The Principles of Economics Textbook : An Analysis of Its Past , Present & Future. New York; 2011.
2. Kakeman E, Forushani AR, Dargahi H. Technical Efficiency of Hospitals in Tehran , Iran. Iran J Public Heal. 2016;45(4):494–502.
3. Balcha T. Technical Efficiency of Publec Health Centers: the Case of Addis Ababa and Selected Health Centers of Oromia. 2002;(Addis Ababa).
4. Worthington AC. Frontier Efficiency Measurement in Healthcare : A Review of Empirical Techniques and Selected Applications. Med Care Res Rev. 2004;61(2):135–70.
5. Business Dictionary.com. Technical Efficiency [Internet]. Business Dictionary. [cited 2016 Feb 16]. Available from: http://www.businessdictionary.com/definition/technical-efficiency.html
6. Bhat R, Bhushan BV, Reuben E. Hospital Effiviency and Data Envelopment Analysis (DEA): An empirical analysis of district hospitals and grant-in-aid hospitals in Gujarat state of India. Ahmedabad; 2001.
7. Gannon B. " Technical Efficiency of Hospitals in Ireland ." 2004. Report No.: 18.
8. Karim AM, Betemariam W. Equity of Maternal, Newborn and Child Health Services in Rural Ethiopia. Addis Ababa, Ethiopia: JSI Research & Training, Inc; 2012.
9. Farlex. The Free Dictionary [Internet]. [cited 2016 Feb 20]. Available from: http://encyclopedia.thefreedictionary.com/Maternal+health
10. Lilongwe. Technical efficiency of district hospitals in Malawi An exploratory assessment using data envelopment analysis. 2008.
11. Zere E. Hospital Efficiency in Sub-Saharan Africa. Helsinki, Finland; 2000. Report No.: 187.
12. UNICEF MoH & EU. Ethiopian Maternal Health Brief: Trend of progress towards MDG 5 in Ethiopia. 2013.
13. Edejer TT-T. Constraints to Scaling Up Health Related MDGs : Costing and Financial Gap analysis. WHO. 2009;(September):1–63.
14. Ethiopia Federal Ministry of Health. Fifth National Health Accounts 2010/2011. Addis Ababa, Ethiopia; 2014.
15. Ethiopia Federal Ministry of Health. Ethiopia's fifth national health accounts highlight of major findings. Addis Ababa, Ethiopia; 2014.
16. Ichoku HE, Fonta WM, Onwujekwe OE, Kirigia JM. Evaluating the Technical Efficiency of Hospitals in Southeastern Nigeria. Eur J Bus Manag. 2011;2(3):24–37.
17. Seid AK. Technical efficiency of selected hopitals in addis ababa: data envelopment analysis approach. 1st ed. Addis Ababa, Ethiopia; 2006.

18. World Health Organization. Trends in Maternal Mortality : 1990 to 2015. Geneva, Switzerland; 2015.

19. UNFPA. Trends in Maternal Health in Ethiopia: Challenges in achieving the MDG for maternal mortality. Addis Ababa, Ethiopia; 2012.

20. United Nations General assembly. Transforming the World: the 2030 Agenda for Sustainable Development. New York; 2015.

21. Federal Democratic Republic of Ethiopia Ministry of Health. Health Sector Transformation Plan. Addis Ababa, Ethiopia; 2015.

22. Giuffrida A, Gravelle H. Measuring performance in primary care: econometric analysis and DEA. Appl Econ. 2001;33(2):163–75.

23. Akazili J, Adjuik M, Jehu-appiah C, Zere E. Using data envelopment analysis to measure the extent of technical efficiency of public health centres in Ghana. Int Heal Hum Rights [Internet]. 2008;8(11). Available from: http://www.biomedcentral.com/1472-698X/8/11

24. Central Statistical Agency. Ethiopia Mini Demographic and Health Survey. Addis Ababa, Ethiopia, Ethiopia; 2014.

25. Federal Democratic Republic of Ethiopia Ministry of Health. Health Sector Development Program IV. Addis Ababa, Ethiopia; 2010.

26. Federal Democratic Republic of Ethiopia Ministry of Health. HSDP IV: Annual Performance Report. 2014.

27. Kirigia JM, Asbu EZ. Technical and scale efficiency of public community hospitals in Eritrea : an exploratory study. Health Econ Rev. Health Economics Review; 2013;3(6).

28. Forbes M, Harslett P, Mastoris I, Risse L. Measuring the technical efficiency of public and private hospitals in Australia. Product Comm Rep Public Priv Hosp. 2010;1–36.

29. Osei D, Almeida S, George MO, Kirigia JM, Mensah AO, Kainyu LH. Cost Effectiveness and Resource Technical efficiency of public district hospitals and health centres in Ghana : a pilot study. Cost Eff Resour Alloc. 2005;3(9).

30. Jat TR, Sebastian MS. Technical efficiency of public district hospitals in Madhya Pradesh, India: a data envelopment analysis. Glob Health Action. 2013;2(25).

31. Kirigia JM, Emrouznejad A, Sambo LG. Measurement of Technical Efficiency of Public Hospitals in Kenya : Using Data Envelopment Analysis. J Med Syst. 2002;26(1):39–45.

32. Murillo-zamorano LR. Economic Efficiency and Frontier Technicues. J Econ Surv. 2004;18(1):33–77.

33. Coelli TJ, Rao DSP, O'Donnell CJ, Battese GE. An Introduction to Efficiency and Productivity Analysis. 2nd editio. New York: Springer Science and Business Media; 2005.

34. Ian Crawford AK and HS. Measuring public sector efficiency. Green Budget. 2003. p. 105–11.

35. Frei FX, Harker PT. Measuring the Efficiency of Service Delivery Processes: With

Application to Retail Banking. J Serv Res. Philadelphia: University of Pennsylvania; 1996;1(4):300–12.

36. Daraio, C.; Simar L. The Measurement of Efficiency. Advanced Robust and Nonparametric Methods in Efficiency Analysis: Methodology and Application. Springer Science & Business Media; 2007. p. 248.

37. FDRE Population Census Commision. Summary and Statistical Report of the 2007 Population and Housing Census. Addis Ababa, Ethiopia; 2008.

38. Ethiopian Standards Agency. Ethiopian Standard Primary Hospital - Requirements. 1st ed. 2012.

39. Ethiopian Standards Agency. Ethiopian Standard: General Hospital - Requirements. 1st ed. 2012.

40. Coelli T. A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program. Australia; 2008.

41. Cheng Z, Tao H, Cai M, Lin H, Lin X, Shu Q, et al. Technical efficiency and productivity of Chinese county hospitals: an exploratory study in Henan province, China. Health Serv Res. 2015;5(9).

42. Tobin J. Estimation of Relationships for Limited Dependent Variables. Econom J Econom Soc. 2007;26(1):24–36.

43. Marschall P, Flessa S. Efficiency of primary care in rural Burkina Faso. A two-stage DEA analysis. Health Econ Rev. 2011;1(5).

44. Bhagavath V. Technical Efficiency Measurement by Data Envelopment Analysis : An Application in Transportation. Alliance J Bus Res. 2006;2(1):60–72.

45. Sebastian MS, Lemma H. Efficiency of the health extension programme in Tigray , Ethiopia : a data envelopment analysis. Int Heal Hum Rights. 2010;10(16).

46. Jehu-appiah C, Sekidde S, Adjuik M, Akazili J, Almeida SD, Nyonator F, et al. Ownership and technical efficiency of hospitals: evidence from Ghana using data envelopment analysis. Cost Eff Resour Alloc. BioMed central; 2014;12(9).

47. Renner A, Kirigia JM, Zere EA, Barry SP, Kirigia DG, Kamara C, et al. Technical efficiency of peripheral health units in Pujehun district of Sierra Leone: a DEA application. Health Serv Res. 2005;5(77).

Annex

Annex I

Data Collection Tools

Jimma University

College of Health Science

Department of Health Economics, Management and Policy

Good morning/ Good after noon!

I am _____ who came from _____; I am a data collector of a research project by the title "**Technical Efficiency of Public Hospitals in the Provision of Maternal Health Services in Selected Zones of Oromia Regional State**". I expect that you will freely give me whatever information available in your hospital according to the checklist. The information that you give me will be very useful for the study. This information will help policy makers to design how to allocate resources and measure the performance of the facilities based on research findings. I thank you for your voluntary participation. Are you voluntary to participate in the study on the behalf of your hospital?

A. Yes
B. No

Section I: General information about the hospital

There are various questions that need your response listed here under. I kindly ask you to circle the choices for questions with choices and to feel the respective answers for the open ended questions.

Code	Questions	Response
101	Name of the hospital	
102	Level (type) of hospital	1. Secondary hospital 2. Primary hospital
103	How many years since establishment? (years of service)	
104	Location of the hospital	1. Urban 2. Semi urban 3. Rural

105	Catchment population (2007 EFY)	
106	Is there health facility that gives maternal health service around?	1. Yes 2. No
107	If yes for 106 What type?	1. Health Post 2. Health center 3. Primary Hospital 4. Secondary Hospital 5. Specialized Hospital 6. Other, Specify_____
108	If yes for 106 in what distance?	
109	Is there allowance (additional) payment for the employees of the hospital?	1. Yes 2. No
110	Are there facilities (benefits other than money) for the employees of the hospital?	1. Yes 2. No
111	If yes for question no. 110 what facilities are there?	
112	What is the qualification of the CEO?	
113	How much is the average waiting time for maternal health service?	
114	How many departments do the hospital has?	
115	What are the departments?	

Section II: Inputs used by the hospitals

1. **Financial resources**

There are various questions that need your response listed here under. I kindly ask you to circle the choices for questions with choices and to feel the respective answers for the open ended questions.

Code	Questions	Response
201	What is the main source of budget?	1. Government 2. Internal revenue 3. NGO 4. Other(specify) _____
202	How much was the total budget in birr (2007EFY)?	
203	How much was the total budget of the hospital excluding salary in birr (2007 EFY)?	
204	How much was the total expenditure of the hospital in birr (2007 EFY)?	
205	How much was the expenditure of the hospital excluding salary in birr (2007 EFY)?	

2. Human Resources

There are various questions that need your response listed here under. I kindly ask you to feel the respective answers for the questions.

Code	Employees		Quantity	Total salary
211	Administrative staff			
212	Physicians	GP		
		Specialist		
213	Clinical Nurse (MCH)			
214	Midwife(MCH)			
215	Laboratory technician			
216	Laboratory technologist			
217	Pharmacy technician/druggist			
218	Pharmacist			
219	Emergency surgery officer(MCH)			
220	Anastasia Professional			
221	Other specify _____ _____ _____ _____ _____			

3. Capital

There are various questions that need your response listed here under. I kindly ask you to feel the respective answers for the questions.

Code	Items	Quantity
231	How many classes are there in the hospital?	
232	How many classes used for maternal health service?	
233	How many beds are there in the hospital?	
234	How many of them used for maternal health service?	

Section III: Output in the Hospitals

There are various questions that need your response listed here under. I kindly ask you to feel the respective answers for the questions.

Code	Type of Output (2007 EFY)	Quantity (2007 EFY)
301	Patient flow in each of the department in 2007 EFY	
302	Number of ANC visit in 2007 EFY	
303	Number of deliveries in the hospital in 2007 EFY	
304	Number of women who got PNC in 2007 EFY	
305	Number of FP service visit in 2007 EFY	
306	Number of abortion service users in 2007 EFY	
307	Number of post abortion service users in 2007 EFY	

Annex II

Characteristics of the hospitals

Name of the hospital	Level	Service years	Catchment population	Health facility availability around the hospital	Distance of the facility around the hospital (KMs)	Availability of allowance for the employees of the hospital	Benefit package for the employee of the hospital	Qualification of the CEO of the hospital	Waiting time for maternal health service
Fitche	Secondary	17	1500000	Yes	2	No	Yes	BSc	15
Shenen Gibe	Primary	5	1200000	Yes	2	Yes	No	BSc	45
Bedele	Primary	6	750464	Yes	1	No	No	BA	45
Ambo	Secondary	60	1500000	Yes	2	Yes	Yes	MPH	34
Gedo	Primary	5	657332	Yes	3	Yes	Yes	MPH	24
Guder	Primary	1	154945	Yes	3	No	Yes	BSc	30
Olenchiti	Primary	1	185000	Yes	3	Yes	Yes	BSc	30
Bishoftu	Secondary	60	1060000	Yes	3	Yes	Yes	MHA	25
Batu	Primary	2	250000	Yes	2	Yes	Yes	BSc	30
Tulu Bolo	Primary	6	426091	No		Yes	Yes	MHA	24
Kuyu	Primary	6	252105	Yes	1	Yes	Yes	BSc	15
Seka	Primary	1	350000	Yes	2	Yes	Yes	BSc	35
Limu Genet	Primary	14	750000	Yes	1	Yes	Yes	BSc	30
Agaro	Primary	2	700000	Yes	2	Yes	No	BSc	32

Medical Equipments used for maternal health service in 2014/15

Equipment	**Mean**	**Minimum**	**Maximum**
Examination coaches	3.64	1	14
Delivery coaches	2.79	0	5
Stethoscope	4.21	1	18
Sphygmomanometer	4.14	1	20
Thermometer	4.50	0	22
Weighing scale, Adult	2.57	1	11

Specula of different size	4.43	1	10
Infant meter and height scale	1.29	0	5
Otoscope	1.07	0	4
Fetoscope	3.14	1	7
Stand lamp	2.29	0	15
Refrigerator	2.14	1	8
Cold chain boxes	2.14	0	5
Vacuum	1.85	1	4
Forceps	8.43	0	80

Summary of Output Targets:

Hospitals	**Antenatal Care**	**Delivery service**	**Postnatal Care**	**Family Planning**	**Abortion**	**Post abortion service**
Fitche	1880.347	2098.281	1733	2520	0	262.586
Shenen Gibe	1409.479	1241.76	1053	2173	98.395	152.707
Bedele	976	1278	1085	1206	82	72
Ambo	995	2401	2006	794	266	167
Gedo	1167	1001	0	807	17	94
Guder	82	24	0	56	0	0
Olenchiti	118	38	38	50	4	0
Biishoftu	2956	3449	2648	4197	629	260
Batu	1838	2256	2256	474	84	539
Tulu Bolo	588	1154	692	1680	243	185
Kuyu	2642	960	930	4667	22	157
Seka	134	56	14	16	0	0
Limu Genet	1500	1345	895	2462	270	260
Agaro	1242	1464	1118	308	155	162

Summary of actual Outputs

Hospital	Antenatal Care	Delivery service	Postnatal Care	Family Planning	Abortion	Post abortion service
Fitche	1720	1701	1733	2520	0	134
Shenen Gibe	1376	1053	1053	2173	35	113
Bedele	976	1278	1085	1206	82	72
Ambo	995	2401	2006	794	266	167
Gedo	1167	1001	0	807	17	94
Guder	82	24	0	56	0	0
Olenchiti	118	38	38	50	4	0
Biishoftu	2956	3449	2648	4197	629	260
Batu	1838	2256	2256	474	84	539
Tulu Bolo	588	1154	692	1680	243	185
Kuyu	2642	960	930	4667	22	157
Seka	134	56	14	16	0	0
Limu Genet	1500	1345	895	2462	270	260
Agaro	1242	1464	1118	308	155	162

Summary of Input Targets:

Hospitals	Expenditure excluding salary	Administrative staff salary expense	Physicians salary expense	Clinical & midwife Nurses salary expense	Others technical staff salary expense	Class rooms for maternal health service	Beds for maternal health service
Fitche	675648.7	216587.9	133263.2	592262.5	154154.7	11.176	16.485
Shenen Gibe	952364.2	215101.4	120220.5	487396	159059.6	4.088	8.667
Bedele	1336068	208836.6	152674.8	590278.1	168136.2	3	5
Ambo	1412139	218536.1	161408	774257.6	151344.3	6	24
Gedo	405768.9	36839.13	37769.04	378558.4	71671.44	11	11
Guder	30030.27	12455.75	8099.516	297757.5	16474.13	3	16
Olenchiti	88184.39	79860.51	46508.07	370405.5	71607.27	6	8
Biishoftu	436730.3	113250.5	158134.9	778874.9	127287.8	29	24
Batu	498250.4	448754.3	196925	659131	218601.2	5	11

Tulu Bolo	431944	102167.3	78035.64	440028.1	146985.6	5	9
Kuyu	817260.6	244536.3	74977.63	299391.1	135878.6	5	14
Seka	51576.85	62889.33	31612.05	276638	52090.1	7	12
Limu Genet	909176.9	204818.1	73095.09	458936.3	120083.9	6	20
Agaro	814243.5	148244.8	81136.92	410431.7	113847.1	5	9

Summary of actual inputs

Hospitals	**Expenditure excluding salary**	**Administrative staff salary expense**	**Physicians' salary expense**	**Clinical & midwife Nurses salary expense**	**Others technical staff salary expense**	**Class rooms for maternal health service**	**Beds for maternal health service**
Fitche	725494.7	232566.7	191788.3	925781.2	205625.6	12	36
Shenen Gibe	988985.2	253061.4	130626.1	577371.4	196431.1	5	9
Bedele	1336068	208836.6	152674.8	590278.1	168136.2	3	5
Ambo	1412139	218536.1	161408	774257.6	151344.3	6	24
Gedo	405768.9	36839.13	37769.04	378558.4	71671.44	11	11
Guder	30030.27	12455.74	8099.516	297757.5	16474.13	3	16
Olenchiti	88184.39	79860.51	46508.07	370405.5	71607.27	6	8
Biishoftu	436730.3	113250.5	158134.9	778874.9	127287.8	29	24
Batu	498250.4	448754.3	196925	659131	218601.2	5	11
Tulu Bolo	431944	102167.3	78035.63	440028.1	146985.6	5	9
Kuyu	817260.6	244536.3	74977.63	299391.1	135878.6	5	14
Seka	51576.85	62889.33	31612.05	276638	52090.1	7	12
Limu Genet	909176.9	204818.1	73095.09	458936.3	120083.9	6	20
Agaro	814243.5	148244.8	81136.92	410431.7	113847.1	5	9

Annex III

Map of Oromia Regional State