ประสิทธิภาพทางเทคนิคและประสิทธิภาพต่อขนาดของโรงพยาบาลชุมชนใน
ประเทศเนปาล: การวิเคราะห์ DEA

นางประภา บารัล

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ปีการศึกษา 2553

TECHNICAL AND SCALE EFFICIENCY OF DISTRICT HOSPITALS IN NEPAL: A DATA ENVELOPMENT ANALYSIS APPROACH

Mrs. Prabha Baral

A Thesis Submitted in Partial Fulfillment of the Requirements

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ประภา บารัล: ประสิทธิภาพทางเทคนิคและประสิทธิภาพต่อขนาดของโรงพยาบาลชุมชนในประเทศเนปาล: การวิเคราะห์ DEA. (TECHNICAL AND SCALE EFFICIENCY OF DISTRICT HOSPITALS IN NEPAL: A DATA ENVELOPMENT ANALYSIS APPROACH) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: รศ. ดร.โสตถิธร มัลลิกะมาส, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม : นพ.พิรัส ประดิษฐวณิช, 70 หน้า.

การศึกษานี้มีวัตถุประสงค์เพื่อวัดประสิทธิภาพทางเทคนิคและประสิทธิภาพขนาดของโรงพยาบาลชุมชนในประเทศเนปาล จำนวน 56 แห่ง ในปี 2552 และ 2553 และศึกษาปัจจัยที่มีผลต่อประสิทธิภาพ โดยการวิเคราะห์ระดับประสิทธิภาพทางเทคนิคใช้แบบจำลอง Input oriented DEA และการวิเคราะห์ปัจจัยกำหนดประสิทธิภาพใช้แบบจำลองโทบิท

จากแบบจำลอง DEA พบว่ามี 29 โรงพยาบาล (51.79%) และ 30 โรงพยาบาล (53.57%)ที่มีค่าต่ำกว่าค่าประสิทธิภาพสูงสุดในปี 2552 และ 2553 ตามลำดับ ค่าเฉลี่ยของประสิทธิภาพทางเทคนิคภายใต้ข้อสมมติ variable return to scale มีค่าเท่ากับ 89% และ 90% ในปี 2552 และ 2553 ตามลำดับนอกจากนี้ โรงพยาบาลส่วนใหญ่มีขนาดเล็กเกินไป พบว่าโรงพยาบาลมีลักษณะเป็น increasing return to scale ซึ่งแสดงถึงแบบจำลองโทบิทโรงพยาบาลที่มีอัตราการเข้าพักสูง (occupancy rate) ดำเนินงานดีกว่าโรงพยาบาลที่มีอัตราการเข้าพักต่ำ การเพิ่มสัดส่วนผู้ป่วยนอกต่อแพทย์และเพิ่มจำนวนเตียงต่อแพทย์มีผลต่อการเพิ่มค่าประสิทธิภาพทางเทคนิค ขณะที่อัตราการครองเตียง, จำนวนเตียง, และอัตราส่วนเตียงต่อแพทย์มีผลต่อประสิทธิภาพขนาด นอกจากนี้ยังพบว่าโรงพยาบาลที่อยู่บนภูเขามีค่าประสิทธิภาพทางขนาดต่ำกว่าเขตพื้นที่อื่นๆ

สาขาวิชา เศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ ลายมือชื่อนิสิต.............................

ปีการศึกษา 2553 ลายมือชื่อ อ. ที่ปรึกษาวิทยานิพนธ์หลัก.............................

ลายมือชื่อ อ. ที่ปรึกษาวิทยานิพนธ์ร่วม.............................

##5385616329: MAJOR HEALTH ECONOMICS AND HEALTH CARE MANAGEMENT
KEY WORDS: DATA ENVELOPMENT ANALYSIS/ HOSPITAL EFFICIENCY/ TECHNICAL/ SCALE EFFICIENCY/ DISTRICT HOSPITALS

PRABHA BARAL: TECHNICAL AND SCALE EFFICIENCY OF DISTRICT HOSPITALS IN NEPAL: A DATA ENVELOPMENT ANALYSIS APPROACH. THESIS ADVISOR: ASSOC. PROF SOTHITORN MALLIKAMAS. Ph.D., CO-ADVISOR: PIRUS PRADITHAVANIJ, M.D, 70pp

The study aimed to measure technical and scale efficiency of district hospitals and to estimate the possible factors affecting on the efficiency of district hospitals in Nepal. Input oriented Data Envelopment Analysis (DEA) was employed to measure technical and scale efficiency of 56 district hospitals in the year 2009 and 2010. In the second stage, Tobit regression model was used to determine the factors that affect on efficiency.

The DEA analysis revealed that 29 (51.79%) and 30 (53.57%) of the hospitals were run inefficiently in 2009, and 2010 respectively. The average variable returns to scale (VRS) technical efficiency scores were 89% and 90% respectively during two years. Most of the patterns of scale inefficiency were increasing return to scale. The result of Tobit regression revealed that hospitals with higher occupancy rates and higher outpatient per physician perform better than those with lower occupancy rates. The bed physician ratio is positively and nurse physician ratio is negatively significant. Similarly bed occupancy rates, no. of beds, outpatient physician ratio are associated with scale efficiency. Hospitals in mountain region are significantly less scale efficient than others.

Field of Study: Health Economics and Health Care Management Student's Signature........................
Academic Year 2010 Advisor's Signature........................
Co-Advisor's Signature........................

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Abbreviations

DEA	Data Envelopment Analysis
DMU	Decision Making Unit
TE	Technical Efficiency
SE	Scale Efficiency
CRS	Constant Return to Scale
VRS	Variables Return to Scale
IRS	Increasing Return to Scale
DRS	Decreasing Return to Scale
MPSS	Marginal Productive Scale Size
DEAP	Data Envelopment Analysis Programme
WHO	World Health Organization
MoHP	Ministry of Health and Population
DoHS	Department of Health Services
HMIS	Health Management Information System

CHAPTER I
INTRODUCTION

1.1 Problem and significance:

Hospitals are an important part of any health system and the major health care outlets, both in developed as well as in developing countries of the world. Building and running hospitals absorb a major share of health expenditure in any country. The production of health care services requires inputs from wide variety of sources including health care professionals, other staff, capital and materials. The right combination of inputs should produce optimum outputs. Increasing efficiency by reducing costs or increasing outputs are often desired by the policy makers, responsible for health sector reform.

Health care system of Nepal is in tremendous pressure because of the triple burden caused by increasing demand of services for communicable diseases, increasing non-communicable diseases, and poverty. Health care costs are constantly rising due to the changing life style, new technologies, and high expectations. Nepal spent over 5% of GDP on health sector. The Government contribution to total health expenditure is increasing continuously. Despite an increase in the public funds allocated to health, the supply of health care insufficient to address the need and demand. As demand for health care increases and the cost for service provision rises, it is essential to make more efficient use of the resources already devoted to hospitals.

The public health delivery system in Nepal is organized under three levels of health care: primary, secondary, and tertiary. The primary level of care consists of district hospitals, primary health care centers (PHCCs), health posts (HPs), and sub-health posts (SHPs). The secondary level consists of zonal to regional hospitals and the tertiary level includes all referral and specialized hospitals. There are 3314 sub-health posts, 679 health posts, 214 primary health care centers 61 district hospitals, 13 zonal hospitals, 5 regional hospitals and 8 central hospitals (DoHS, 2009). Different levels of public hospitals represent important health care outlets in Nepalese context. As an important part of the public health system, Government of Nepal has given first priority for availability of primary-level health services at the local level (WHO, 2007).

District Hospitals play the key role in providing preventative as well as curative service and serve as the first referral point for health post, sub-health posts and primary health care centers. The districts hospitals are small scaled hospital located in district headquarters and remain a safeguard for resident who live in remote area. One of the most important functions of the DHs is to serve the needs of the poor and disadvantaged. However essentials components of curative services at each level of care not available or not carried out as defined.

District hospitals suffer from persistent weakness such as there is shortage of adequately trained health personnel especially technical staff. There are extensive staff vacancies in hospitals with unfilled posts and posts that are filled but unmanned. The supply of health personnel does not correspond to need. There is persistent mismatch between the skills personnel (MoHP, 2007). Mal-distribution of health staff in urban and rural and inadequate management control results to the poor quality of services, high personnel expenses and low staff productivity. Since, health service delivery is so particularly labor intensive, mismatches between needs and the use of available HRH may cause great negative impact on service performance (MoHP, 2007).

Government strategic plan for human resource for health (2003-2017) has identified the available beds for population 1/ 5434 is low. So it was recommended to increase the beds in all level hospitals including district hospitals. However, the situation with regard to available beds, and other equipments are reported under utilization due to understaffing (MoHP, 2003). Moreover, scattered population, geographical situation, peoples growing expectations of access to quality care are other external factors affecting on the efficiency of health service delivery in Nepal.

Public health service providers in Nepal receive state budget allocations to deliver services and to pay salaries to health care workers. Hospitals are still largely financed by global line item budget, and labour (health personnel and others) are paid by salary. These payment methods do not appear to encourage an increase in efficiency and productivity of both hospitals and personnel. Hospitals consume a significant share of resources to provide various types of services. There is still lack of cost containment mechanism for improving provider performance in terms of efficiency and quality of service (MoHP and GTZ, 2010). It has brought up the need for efficiency measurement and regular monitoring of the system. Comparative efficiency assessment of how well inputs are used to produce these services is an important issue to control excessive health care expenses and force hospitals to search for better resource utilization.

The Second Long-Term Health Plan (1997-2017) of Nepal focus to improve the management and organization of the public health sector and to increase the efficiency and effectiveness of health care system (DoHS, 2009) however few attempt has been made to evaluate the technical efficiency in resource use among government hospitals. A comparative study of hospital efficiency (Somananthan et al 2008) among Srilanka, Bangladesh and Nepal found that Nepalese district hospitals are less technically efficient and are not operating at scale economies in comparison to other two countries. The results suggest that there is considerable room for improvement in the system efficiency of hospital services in Nepal and Bangladesh.

Hence, it is vital to assess the technical efficiency of district hospitals in order to be able to utilize the available resources optimally and expedite the move towards achieving health and development goals. From a managerial perspective, understanding hospitals efficiency is crucial for utilizing resources and making health care policies and budgeting decisions. Higher operational efficiency of hospitals is likely to help control the cost of medical services, and consequently to provide more affordable care and improved access to the public.

1.1 Research Question

1. What are the relative technical efficiency and scale efficiency of district hospitals in Nepal?
2. What are the factors affecting on the efficiency of District hospitals in Nepal?

1.2 Research Objective

General Objective:

The general objective of this study is to measure the relative efficiency of district hospitals and to explore the factors affecting on the variation of hospital efficiency in Nepal.

Specific Objectives:

- To measure the technical efficiency of district hospitals in Nepal
- To measure the scale efficiency of district hospitals in Nepal
- To identify some factors that can affect on technical and scale efficiency of district hospitals in Nepal.

1.4 Scope of the study:

There are 61 district hospitals and located in different region across the country. The sample consisted of all public sector district hospitals however complete inputs and outputs data was available only 56 of those hospitals so the final sample consists of 56 district hospitals. Secondary panel data of the fiscal year 2009 and 2010 was used in this study.

1.5 Possible benefits:

This study provides information of technical and scale efficiency level of district hospitals in Nepal. It reveals the profile of relatively efficient and inefficient hospital as well as factors affecting on the efficiency of district hospitals. The information will sensitize policy makers and planners about rational use of available resources to improve the efficiency of hospitals. In addition, the study will create awareness among hospital managers and planners for further study and analysis of hospital efficiency in future. The information of scale efficiency score can be helpful for policy maker in decision making about which district hospital should be downsized or upsized. Measuring performance will enables the inefficient hospitals to be monitored and opportunities for specific areas of improvement in future.

CHAPTER II

COUNTRY HEALTH SYSTEM IN NEPAL

2.1 Country Profile

Nepal is a land-locked country nestled in the foothills of the Himalayas, wedge between the two most populous countries of the world, India to the east, south, and west and China to the north. The total land area of the country is 147,181 square kilometers with 29 million projected populations in 2009. Geographically, Nepal is divided into three distinct ecological regions; the mountains in the north, the hills in the middle and terai (or plains) to the south. Administratively, Nepal is divided into five development regions, 14 zones, 75 districts, 58 municipalities, 3912 village development committees (VDC).

Nepal is one of the least developed countries and ranked 138th in Human Development Index with per capita GDP US$ 536, life expectancy at birth of 68 years and adult literacy rate of 60% in the year 2010 (UNDP, 2010). About 80% of Nepalese rely on agriculture for their livelihood. The decade long civil conflict (arising from persistent poverty and inequality) took a great toll on people's lives, destabilizing political and economic structures, resulting in country's increased dependency on foreign aid for its development needs.

2.2 Country health Profile:

Nepal's National Health Policy 1991 aims at addressing the health need of the people through primary health care (PHC) approach. With the objective of providing essential PHC services to the people, the Ministry of Health and Population (MoHP) has extended basic health infrastructure under the aegis of Department of Health Services (DoHS) at four levels i.e. central, regional, district and periphery levels. The district health service consists of district hospital, Primary Health Care Center (PHC), Health Post (HP) and Sub-Health Post (SHP) with about 48,000 village-based Female

Community Health Volunteers (FCHVs). At the district level each of the departmental or ministry offices oversees the plans and programs for that sector. The district health office is responsible for all health activities of the district including the organization and management of district hospital, primary health care centers, health posts and sub health posts. The district health system is a self contained segment of the national health system comprising well defined population living within a clearly defined administrative and geographic area. Table 3.4 gives a scenario about the distribution of public health facilities by the region across the country.

Table 2.1 Distribution of health facilities in the public sector by geographic region

Geographical region	Central Hospitals	Regional Hospitals	Zonal Hospitals	District Hospitals	PHCC	Health Post	Sub Health post
Mountain	0	0	0	16	20	148	383
Hill	8	2	1	32	103	364	1517
Flat (Terai)	0	3	9	13	84	166	1005
Total	8	5	10	61	207	678	2905

Sources: Annual Reports, DoHS, 2009

Despite health inequalities and poverty coupled with civil conflict, the country has made significant improvements in health indicators over the last decade. People's average span of life is now 68 years and the Maternal Mortality Rate (MMR) has decreased from 850 per 100,000 live births in 1991 to 231 in 2008. The major health indicators are presented in Table 2.2

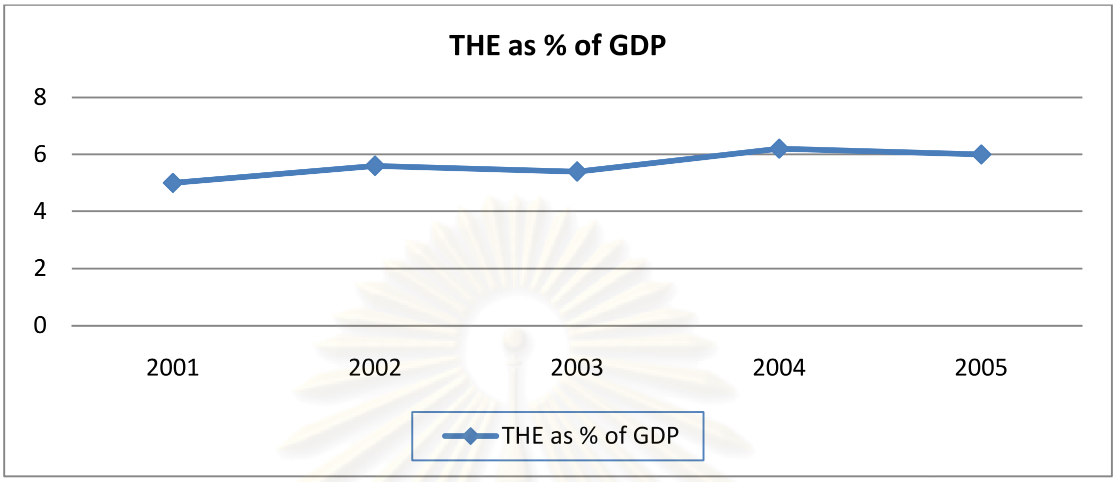
Table 2.2 Nepal's Key Health Indicator

Indicator	1991	2001	2006
IMR	97	64	48
Under five MR	162	91	61
MMR	539	415	281
Population Growth Rate	2.7	2.4	2.15
LER	55	60.4	63
Adult Literacy rate	36.7	53.74	66.6
Total fertility rate	5.3	4.1	3.1

Source: NHSP-IP 2010

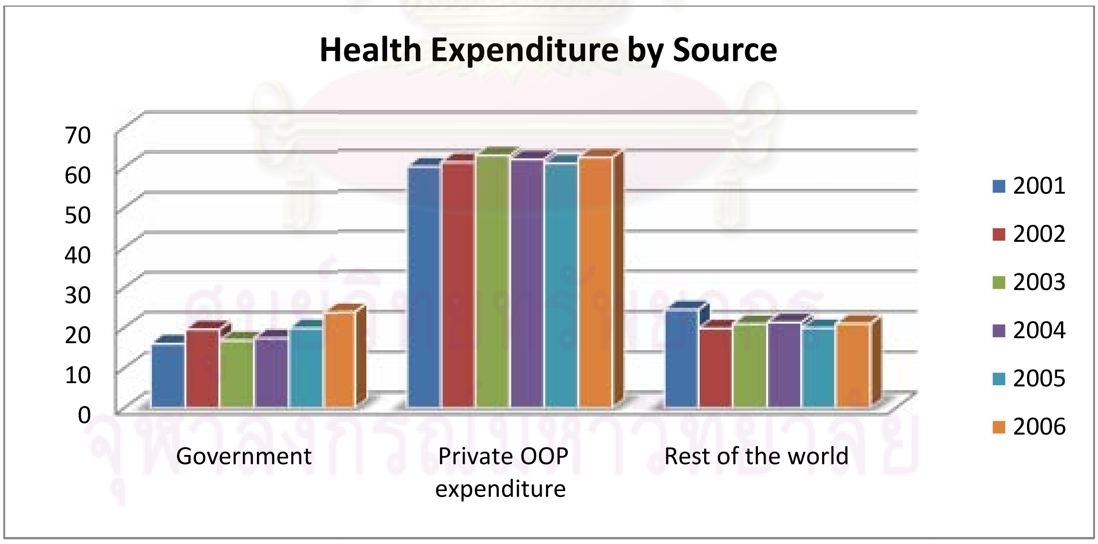
There has been an increasing trend in the allocation of financial resources for health sector development as part of the government's Poverty Reduction Strategy. Nepal spent over 5% of GDP in health expenditure resulting in per capita health expenditure of US $ 18 in 2006. Of the total public financing for health, the share of the government has shown an increasing trend, household (out of pocket) expenditure for health is the biggest source of funding in Nepal: it account for 62%of the total health expenditure. The government is the second biggest source of funding 24% followed by international donors (10%) and international not for profit agencies (11%). As per the NNHA findings, the private sector plays a key role in Nepal's health care system (NNHA, 2006). See the figure 2.1 and 2.2.

Figure2.1 Total Health expenditure as% of GDP, 2001-2005



Source: WHO estimates for country NHA data

Figure 2.2: Health expenditure by Source of funding, 2001-2006



Source; Nepal national Health Account 2006

Communicable diseases account for the greatest proportion of the disease burden. However, as concomitants of the demographic and epidemiological transition, non communicable diseases are also on the increase. Mortality and morbidity rates especially among women and children are alarmingly high. Acute preventable childhood diseases, complications of child birth, nutritional disorders and endemic disease such as malaria, tuberculosis, leprosy, STDs, vector borne disease continue to prevail at a high rate. Determinants of such conditions are associated with pervasive poverty, low literacy rates, poor mass education, rough terrain and difficult communication, low levels of hygiene and sanitary facilities and limited availability of safe drinking water. These problems are further exacerbated by under-utilization of resources, shortages of adequately- trained personnel, under developed infrastructure, poor public sector management and weak intra-and inter-sectoral coordination (MoHP, 2007).

The Ministry provides a wide coverage in its primary and secondary health care services. However there is a general problem of under-staffing in all those institutions, particularly in rural areas. This has been a long-standing problem. The increasing limitations of public health sector resources to meet public demand will require greater efficiency in the operation of the service. At the same time, a more skilled workforce will be needed to meet the aspirations of the public for better and more comprehensive care. The human resources, which are the major determinants of the quality, character and recurrent cost of health care provision. Since, health service delivery is so particularly labor intensive, mismatches between needs and the use of available HRH may cause great negative impact on service performance (MoHP, 2007). A strategic human resource (HR) plan of action for the health sector for fourteen years (2003-2017) was developed to manage future staff requirements and supply and their allocation on the efficient manner.

The overall work force density and category wise densities according to the Nepal's Strategic Plan for Human Resource in Health (2003-2017) is given below in table 2.3. The total no. of staff (34912) in proportion to the population (1 health staff to 694 people in 2003) is very low to meet the health care demand. Primary health care facilities to population are 1/5981 and population per bed 1/5435(public sector) in 2003.

Table 2.3 Workforce per population

Occupations	Supply in 2003	% FTE in public sector	FTEs in Public	FTEs in Private	Population per worker
Medical Specialist	1544	24	363	181	14997
Medical Officer	1186	63	753	433	19521
Integrated medical officer	30	98	29	1	771714
Dental Surgeon/ Dentist	236	16	37	199	98099
Pharmacist	38	37	14	24	609248
Asst. Pharmacist	69	58	40	29	335528
Nurse (certificate)	1585	61	967	618	14607
ANM	1820	75	1358	462	12721
Graduate nurse	264	73	193	71	87695
Medical Technologist	42	83	35	7	551224
Lab technician/ Ass.	543	65	353	190	42636
Radiographer	48	29	14	34	482321
Asst. radiographer	158	39	61	97	146528
VHW/MCHW	5221	98	5132	89	4434
AAW/AHW	4334	98	4231	103	5342
Health Asst./Kaviraj	1558	90	1397	161	14860
Allied health occup.	556	64	358	198	41639
Allied non-med.	594	70	414	180	38975
Manager	240	99	238	2	95425
Skilled support staff	2384	57	1367	1017	9711
Other support staff	12462	75	9362	3100	1858

Total	**34912**	**77%**	**6716**	**8196**	**694**

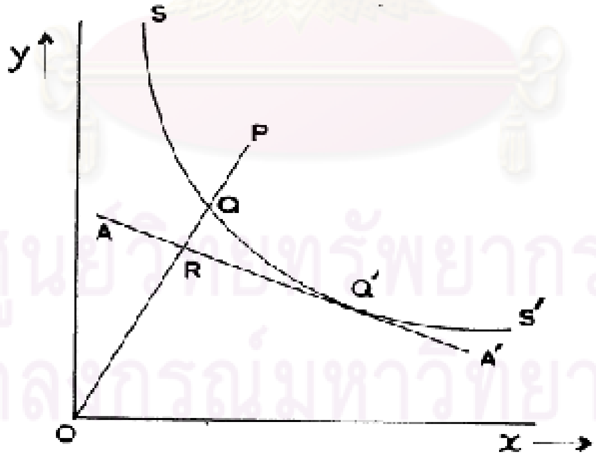
Source: Nepal's Strategic plan for Human Resource in Health (2003-201)

According to WHO, The population per doctor is 18,439, per nurse 4,145 and per paramedical 3443 and per hospital bed is 3510 in 2006. At present, there is an imbalance between supply and demand in human resource in the health sector and there is mal-distribution of health staff. The World Health Organization has categorized Nepal as a country with critical shortage of human resources in the health sector.

Given the absolute resource constraints faced by HMG/N, the government supports the development of private facilities to meet demand for both the delivery of health services and the production of trained human resources. There has been a rapid expansion of the number of private hospital, medical college and nursing homes offering secondary and tertiary care since the mid-1980s. We have very limited data on private providers however facility-based private initiatives are focused in the urban areas, almost 47% of them based in the district of Kathmandu.

Due to economic and other barriers, a significant proportion of the poor in Nepal do not use public health services. The results of the most recent Nepal Living Standard Survey (2003– 04) reported that 43 percent of the poorest quintile of the population did not consult any type of health service provider (RTI, 2009). In order to increase the use of public health services by the poor and marginalized people, Government of Nepal has established free essential health services at the sub-health post and health post levels in 2007. The government has also introduced free essential health care to targeted group and free essential drug to all citizens in Primary Health Centers and District Hospitals since 2009 (DoHS, 2009).

Provision of equitable access to health and better quality of life by creating more equitable distribution of resources is the dominant concern of Nepal, today. In accordance with achieving this objective, several analytical works were undertaken to reform the national health system during the last several years. Against this background, there is a need that the government increase resources in the sector. At the same time, there is also a need to look how far the public spending on health is made from the perspective of efficiency, social equity and reducing poverty.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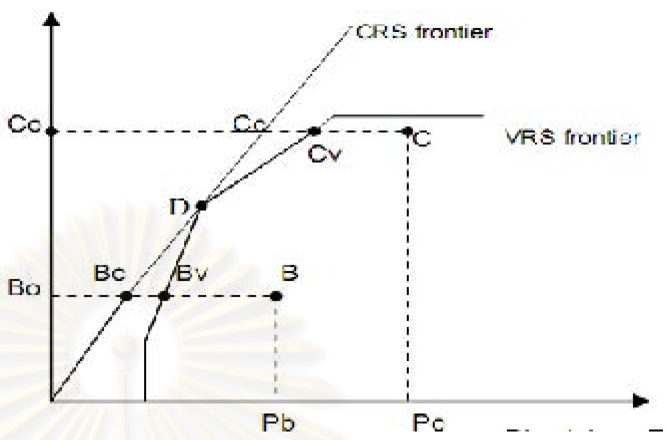
output that the firm is observed to use. The isoquant SS' represents the various combination of the two factors, that a perfectly efficient firm might use to produce unit output. A ray joining the the origin with P intersects SS" at Q.
Hence, Technical Efficiency: TE ═ OQ/OP
Price ratio line intersects OP at R. Hence allocative Efficiency: AE = OR/OQ.
Economic Efficiency: EE = OR/OP or EE = AE x TE

Technical efficiency attempts to address two questions depending on whether it has input or output orientation. In output oriented technical efficiency the focus is on expanding output quantities without changing the quantity of inputs used. On the other hand, input oriented technical efficiency focuses on reducing input quantities used without changing the quantity of outputs produced (Zere et al, 2006).

The overall efficiency also includes scale and scope phenomena. Scale efficiency can be accessed in term of production correspondence by referring to the notion of returns to scale. Increasing returns to scale or economies of scale are said to exist when a proportional increase in inputs causes outputs to increase by a greater proportion, whereas decreasing returns to scale also called diseconomies of scale is the situation in which an increase in inputs causes output to increase by a smaller proportion (Aletras et al, 2007).

Figure 3.2 shows a production function where some single input produces an output generically called hospital services. Two production frontiers are shown, one assuming constant returns to scale (labeled "CRS Frontier") and one assuming variable returns to scale (labeled "VRS Frontier"). Scale efficiencies are found by comparing efficiency on the variable returns to scale frontier to efficiency on a constant returns to scale frontier. For example, if a hospital is producing at point B (output B_O with P_b physician) it is technically inefficient assuming either constant returns to scale or VRS. If there are constant returns to scale, technical efficiency is given by the ratio $TE_{CRS} = B_OB_C / B_OB$. Technical efficiency assuming variable returns to scale is measured as $TE_{VRS} = B_O B_V / B_OB$. Scale efficiency calculated as the ratio of these two measures: $SE = B_OB_C / B_OB_V = {}_{CRS}TE / {}_{VRS}TE$.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Cv
C
VRS frontier
D
Bo
Bc
Bv
B
Pb
Pc

Inappropriate size of a hospital (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 and increasing returns to scale. Decreasing returns to scale implies that a hospital is too large for the volume of activities that it conducts. Unit costs increase as outputs increases. In contrast, a hospital with increasing returns to scale is too small for its scale of operation. Unit costs decrease as outputs increase. A hospital that is scale-efficient is said to operate under constant returns to scale (Zere et al, 2006).

It is often argued that health care institutions are not expected to be efficient, as they do not adhere to neo-classical firm optimization behavior. However given the vast amount of resources that go towards funding such institutions, there is a great and growing interest in examining efficiency in hospitals with the driving force for such concern being value for money.

3.3 Method to access efficiency:

Comparative performance analysis can be undertaken by various methods, including:

- Ratio Analysis,
- Least- Square econometrics model
- Total factor Productivity
- Stochastic frontier model
- Data envelopment analysis (DEA)

Ratio analysis is the simplest of the methods for calculating performances especially productivity/efficiency. It produces information on relationship between one input and one output. That is efficiency is defined as the number of output units per unit of input: Productivity = Output / Input

The technical efficiency of hospitals can be measured by parametric and non-parametric evaluation methods that permit simultaneous comparison of the inputs and outputs of a hospital's production process and produce concise indicators of efficiency.

The Parametric Approach consists:

- Least- Square econometrics model
- Stochastic frontier model

Non-Parametric Approach consists:

- Total factor productivity(TFP indices)
- Data envelopment analysis (DEA)

Parametric methods assume a particular functional form such as Cobb-Douglas production function or translog function, whereas the non-parametric analyses determine the relative efficiency scores by means of linear programming techniques, without detailed descriptions of their production processes.

Least square and total factor productivity are most often applied to aggregate time-series data and to measure technical change or total factor production. Both of these methods assume all firms are technically efficient. While stochastic frontier and DEA are most often applied to data on a sample of firms and provide measures of relative efficiency among those firms.

DEA and Stochastic frontier technique have primarily been used to measure efficiency of healthcare institutions. Moreover, DEA is likely to be more appropriate than stochastic frontiers in the non-profit service sectors where prices are difficult to define (Coelli, Rao D.S. & Battese G 1998). Given the multi-output nature of the hospital production process, we will focus on a particular non-parametric method, Data Envelopment Analysis (DEA), which is encountering growing consensus as a powerful tool to measure hospital productivity.

3.4 Data Envelopment Analysis (DEA):

DEA was first introduced by Charness et al in 1978 for measuring the relative efficiency of organizations such as hospitals and schools that lack the profit maximization motive. Researchers in a number of fields have quickly recognized that it is an excellent and easily used methodology for modeling operational processes for performance evaluations (Das, Vaishnavi and Muralidharan, 2010; Zere et al 2006). In health care, the first application of DEA dates to 1983, in the work of Nunamaker and Lewin (1983), who measured routine nursing service efficiency. Since then DEA has been used widely in the assessment of hospital technical efficiency in the United States as well as around the world at different levels of DMUs. For example, Sherman (1984) was first in using DEA to evaluate overall hospital efficiency. Data Envelopment analysis (DEA) is the non-parametric mathematical linear programming approach to frontier estimation that compares a set of organization's actual inputs used to produce their actual output levels during a common time period (Coelli,1996).

DEA begins with the definition of the unit of assessment, which is typically called the decision making unit (DMU). In each DMU various resources, called inputs, are converted into outcomes, called outputs. DEA constructs a piece-wise linear-segmented efficiency frontier based on best practice, using combinations of inputs and outputs from best performing Decision Making Units (DMU) and computes comparative ratios of outputs to inputs for each unit, which is reported as the relative efficiency score. The efficiency score is usually expressed as either a number between 0-1 or 0-100%. DMUs that have score 100% or 1 are referred to as efficient given the required inputs and produced outputs. A decision-making unit with a score less than 100% or less than 1 is deemed inefficient relative to other units. Unit with an efficiency ratio of 1 (E = 1) are not necessarily absolutely efficient but rather represent the "best practice" group of units, which means that they are not clearly inefficient compared with other units in the set. This situation arises because the identity of the absolutely efficient hospitals is not known because of lack of knowledge of the efficient input-output relationships. Hence a hospital that is found to be relatively efficient may also be able to improve its operating efficiency. An inefficient hospital, as identified by DEA, is defined to have the ability to produce its same level of outputs (patient care, teaching) with fewer inputs based on the actual output-input levels of hospitals that were compared with the inefficient hospital(Sherman, 1984).

st $\quad u'y_j/v'x_j \le 1, \; j=1,2,\ldots,N,$

$u, v \ge 0.$

$\max_{u,v} \, (u'y_i/v'x_i),$

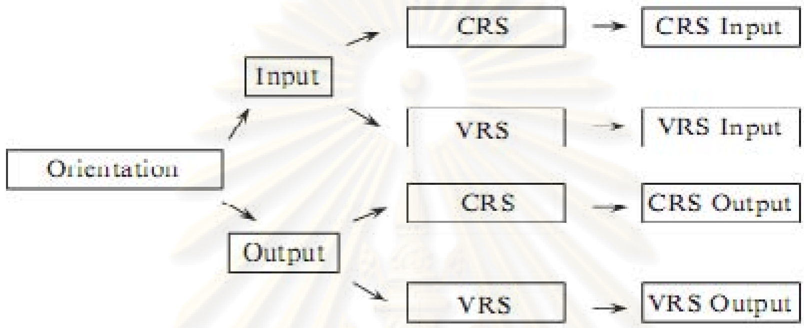
st $\quad u'y_j/v'x_j \le 1, \; j=1,2,\ldots,N,$

$u, v \ge 0.$

$$
\begin{aligned}
&\max_{\mu,\nu} (\mu' y_i), \\
&\text{st} \quad \nu' x_i = 1, \\
&\qquad \mu' y_j - \nu' x_j \leq 0, \; j=1,2,\ldots,N, \\
&\qquad \mu, \nu \geq 0,
\end{aligned}
$$

$$
\begin{aligned}
&\min_{\theta,\lambda} \theta, \\
&\text{st} \quad -y_i + Y\lambda \geq 0, \\
&\qquad \theta x_i - X\lambda \geq 0, \\
&\qquad \lambda \geq 0,
\end{aligned}
$$

$$TE_{I,CRS} = TE_{I,VRS} \times SE_{I}$$



Orientation
Input
Output
CRS
VRS
CRS
VRS
CRS Input
VRS Input
CRS Output
VRS Output

Sherman (1984) tested the new technique (DEA) for identifying inefficient hospitals, by application to a group of teaching hospitals. He found that DEA provides insights about hospital efficiency not available from the widely used efficiency evaluation techniques of ratio analysis and econometric-regression analysis. DEA is, therefore, suggested as a means to help identify and measure hospital inefficiency as a basis for directing management efforts toward increasing efficiency and reducing health care costs.

Chang (1998) used Data Envelopment Analysis and regression analysis to evaluate the efficiency of central government-owned hospitals in Taiwan, over the fiscal year between 1990 and 1994 by adapting output based approach. A multiple regression model is employed, in which the efficiency score obtained from the DEA computations is used as the dependent variable, and a number of hospital operating characteristics are chosen as the independent variables. The results indicate that the scope of services and proportion of retired veteran patients are negatively and significantly associated with efficiency, whereas occupancy is positively and significantly associated with efficiency. Furthermore, the results also show that hospital efficiency has improved over time during the periods studied.

The cost, technical, allocative and scale efficiencies of Rural U.S. hospital are calculated through linear programming model. Tobit analysis is used to assess possible correlates of each of the efficiency measures. Demand characteristics, quality of care, size of mix of services offered are found to influence hospital performance. Furthermore, for- profit hospitals were found to be more efficient then their public or nonprofits counterparts. A large amount of dispersion in operating efficiency was found due to technical inefficiency. The average technical efficiency was 78% allocative efficiency was 86% and scale efficiency 89% found for the sample hospitals (Ferrier &Valdmines 1996).

Zere et al. (2006) measured technical efficiency of district hospitals in Namibia. All public sector hospitals (30) were included and the data for four financial years (1997/

98 to 2000/2001) was used for the analysis. The DEA model used three inputs (total recurrent expenditure, beds and nursing staff) and two outputs (total outpatient visits and inpatient days) on the assumption of input-oriented approach. The average technical efficiency level during the given period was less than 75%. Less than half of the hospitals included in the study were located on the technically efficient frontier. Increasing returns to scale is observed to be the predominant form of scale inefficiency.

A study on technical and scale efficiency of district hospitals in India was done by using the data collected from the Directorate of Medical and Rural Health Services (DMRHS) for 29 districts of Tamil Nadu in 2004–05. The output data included are outpatient visits, number of inpatients, and number of surgeries undertaken, number of deliveries and number of emergency cases. The numbers of staff members and bed strength were used as input. Of the 29 hospitals, it was found that 52 per cent were technically efficient as they had relative efficiency score 1.00 and lie on the efficiency frontier, while the remaining 48 per cent were technically inefficient. Further, the average scale efficiency among the inefficient hospitals was 81 per cent, which implies that the scale inefficient hospitals could reduce their size by 19 per cent without reducing their current output levels (Das, Vaishnavi and Muraleedharan, 2006).

Kiriga et al (2006) used DEA to analyze the technical efficiency among a sample of 23 zonal hospitals in the Republic of Benin over a period of five years, i.e. 2003 to 2007. The yearly analysis revealed that 20 (87%), 20 (87%), 14 (61%), 12 (52%) and 8 (35%) of the hospitals were run inefficiently in 2003, 2004, 2005, 2006 and 2007 respectively; and they needed to either increase their outputs or reduce their inputs in order to become efficient. The average variable returns to scale (VRS) technical efficiency scores were 63%, 64%, 78%, 78% and 86% respectively during the years under consideration. They pointed out that there is some scope for providing outpatient curative and preventive care and inpatient care to extra patients without additional investment into the above mentioned health services.

A pilot study in Ghana estimates the technical efficiency of 17 public district hospitals and 17 health centers through DEA approach based on the data of 2000. Eight (47%) hospitals were technically inefficient, with an average TE score of 61%. Ten (59%) hospitals were scale inefficient, manifesting an average SE of 81%. Out of the 17 health centers, 3 (18%) were technically inefficient, with a mean TE score of 49%. Eight health centers (47%) were scale inefficient with an average SE score of 84% (Osei et al, 2005).

DEA was used to investigate the efficiency of a set of hospitals health centers (HHCS) located in remote rural area of Greece and serve relatively small local populations. The study used the data of 2003 and sample consisted 17 among 18 units existing in the Greek NHS. Variable chosen to characterize production were numbers of doctors, nurses and beds as inputs and admissions, outpatient visits and preventative medical services as outputs. The DEA model input oriented allowed for constant return to scale and units were ranked according to benchmarking approach. Analysis was performed with and without the preventative medicine variable and the result demonstrated technical inefficiencies 26.77 and 25.13 % respectively. Location appeared to effect performance, with remote units, e.g. on small islands, more inefficient. (Kontodimopoulos, Nanos and Niakas, 2006)

R.R. Donna et al (2003) analyzes technical efficiency in the production of aggregate health outcomes of reduced infant mortality and increased life expectancy, using Organization for Economic Cooperation and Development (OECD) health data. Application of data envelopment analysis (DEA) reveals that some countries achieve relative efficiency advantages, including those with good health outcomes (Japan, Sweden, Norway, and Canada) and those with modest health outcomes (Mexico and Turkey). They conclude that, USA may learn from countries more economical in their allocation of health care resources that more is not necessarily better. Specifically, they found that the USA can substantially reduce inputs while maintaining the current level of life expectancy.

Puenpatom R. &Rosenman R. (2006) investigates the short-term effect of the new national health insurance known as Universal Coverage on hospital efficiency by comparing the technical efficiencies of public hospitals among 92 Thai provincial public hospitals before and after the transition period during which universal coverage was implemented (1999 to 2002). They studied the efficiency differences using a two-stage analysis, including the Data Envelopment Analysis, bootstrapping DEA, and a censored Tobit model. Five inputs (no. of beds, no. of physicians, no. of nurses,no. of dentist and pharmacists, no. of other personnels) and five outputs (adjusted no. inpatient visits in acute surgical, adjusted no. of inpatient visits in primary care, adjusted no. of inpatient visits in other, no. of surgical outpatient visits, no. of non-surgical outpatient visits) were selected for the study . The DEA result indicates overall, mean efficiencies in all types of hospitals slightly decreased from 0.83 in 2000 to 0.78 in 2001 immediately after the UC program was introduced, and rebounded to a higher level of efficiency in 2002 (0.86). The average efficiency score was 0.82, that UC improved efficiency across the country. The Tobit regression shows that the reform is a source of efficiency, which is consistent with the DEA result.

Rebba and Rizzi (2006) measure the efficiency of 85(public and private) Italian hospitals operating within National Health Service (NHS). They showed how both the choice of specific constraints on input and output weights (in accordance with health care policy-makers' preferences) and the consideration of exogenous variables outside the control of hospital management (and linked to past policy-makers' decisions) can affect the measurement of hospital technical efficiency using DEA. They found that the imposition of a lower bound on the virtual weight of acute care discharges weighted by case-mix (in order to consider policy-maker objectives) reduces average hospital efficiency. Low efficiency scores are attributable to external factors, which are not fully controlled by the hospital management; especially for public hospitals low total efficiency scores can be mainly explained by past policy-makers' decisions on the size of the hospitals or their role within the regional health care service. Finally, non-profit private hospitals exhibit a higher total inefficiency while both non-profit and for-profit hospitals are characterized by higher levels of scale inefficiency than public ones.

A study in Greece compares technical and scale efficiency of 103 primary care centers from national health system(NHS) and 91 primary care centers from the social security foundation(IKS) to determine how efficiency affected by various exogenous factors such as catchment population and location. Efficiency was measured with DEA and in the second stage efficiency score were regressed against facility type size (NHS or IKA) and location using multivariate Tobit regression. The results shows that, regarding technical efficiency, IKA performed better than NHS, smaller units better than medium seized and larger ones and remote island units better than urban centers. For scale efficiency, larger units performed better and urban units showed higher scale efficiency than remote ones. 755 of facilities appeared to be functioning under increasing returns to scale. Tobit regression model showed that facility type, size and location were significant explanatory variables of technical and scale efficiency.

CHAPTER IV

RESEARCH METHODOLOY

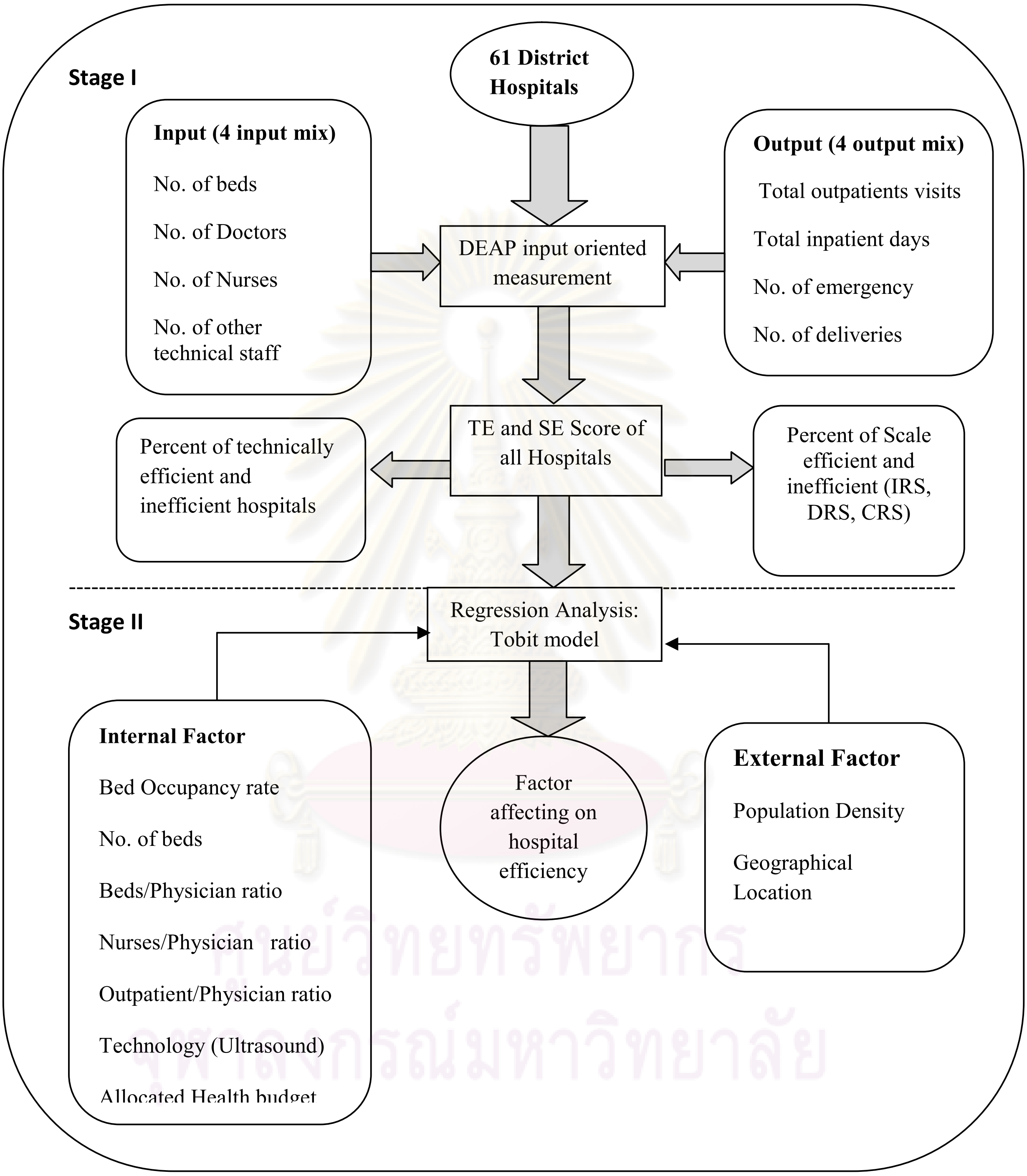
4.1 Study Design: This is a descriptive study using Data Envelopment Analysis (DEA), a non-parametric approach based on linear programming to measure technical and scale efficiency of district hospitals. A cross sectional secondary panel data for the year 2009 and 2010 was used for the analysis. Tobit regression method was applied to find the factors that affect on hospital efficiency.

4.2 Study population: All the district hospitals in Nepal are the study population for this study. There are 61 district hospitals according to the annual report of department of health services in the year 2009 and their size varied from 15 beds to 50 beds. The sample consisted of all public sector district hospitals however complete inputs and outputs data was available only for 56 hospitals so the final sample consists of 56 district hospitals.

4.3 Type and sources of data: Secondary panel data for the year 2009 and 2010 was collected from Human Resource Development Information System (HuRDIS) of Ministry of Health, administration section of Department of Health Services and Regional Health Directorate offices. Some district hospitals input data were collected by contact through telephone and email as well, whose data was not available in center level. Service utilization data were collected from Health Management Information System (HMIS).

4.4. Conceptual Framework: The study applied two stages. The technical and scale efficiency of all district hospitals in Nepal was measured through DEA input-oriented method under VRS assumption. It gives the score of efficient and inefficient hospitals. The Tobit regression model was used to determine the factors that affect on efficiency. The TE and SE score were used as the dependent variable and seven internal and two external factors were estimated. The overall conceptual framework is concluded in the following figure.

Figure 4.1 Conceptual Framework



4.5 Analysis Technique : The analysis technique carried out in two parts i.e. input oriented model under VRS assumption to evaluate technical and scale efficiency and Tobit regression model to identify the factor affecting on efficiency.

4.5.1 Data Envelopment Analysis (DEA) Model:

Data envelopment analysis has been widely used to analyze the efficiency of health sector in most countries. In this study Data Envelopment Analysis (computer) program (DEAP version 2.1) was used to estimate the efficiency of district hospitals. In DEA, the efficiency of an organization (district hospitals in this case) is measured relative to a group's observed best practice. This implies that the benchmark against which to compare the efficiency of a particular district hospital is determined by the group of district hospitals in the study. The motivation for the use of DEA in the health sector is twofold: 1. Multiple input and output in health sector. The alternative techniques are less reliable and definitive in their ability to identify hospital inefficiencies.

In general, hospital management has greater control over inputs than over outputs. As we think that the decision to use or not to use district hospital services is at the discretion of the consumer/patient therefore an input oriented DEA model was adopted. Health services production process are not linear, and thus it may be more appropriate to assume variable returns to scale (VRS) input oriented model. The VRS model was discussed in chapter III, section 3.4.

Prior research on hospital efficiency has used several measures of hospital inputs and outputs. Given the constraints of the available data, we consider four inputs and four outputs for the estimation of the DEA model. These input and output variables were chosen after a review of hospital management literature and health information management system database of Nepal**.**

Input Variables:

The classical economics focuses on physical resources in defining its factors of production which are land, labor and capital. In this study, inputs of district hospitals considered the number of beds as the proxy of hospital size as capital input and no. of doctors, nurses and other medical staff as labor input. The input categories are defined as follows;

No of doctors: Total no. doctors (including temporary, contracted) working in district hospitals for the year 2009 and 2010.

No. of nurses: Total no. of nurses (all levels including Auxiliary Nursing Midwife) working in district hospitals for the year 2009 and 2010

No. of other technical staff: No. of other technical staff (including Health Assistant/Auxiliary Health Workers /Lab technician. /lab assistant./ Radiographer) working in district hospitals for the year 2009 and 2010

No. of beds: No. of functioning beds in district hospitals for the year 2009 and 2010.

Output Variables:

Although there is a general consensus that the ultimate measure of output should be an improvement in the quantity and quality of life, practical difficulties limit the use of the outcomes approach. Changes in health outcome cannot be entirely attributed to health care. Health is multi-dimensional and affected significantly by a host of other socio-economic factors. So output is measured as an array of intermediate outputs (health services) that supposedly improve health status. It is easier to measure and define processes (services) in health care than changes in health status.

In this study total outpatient visits, total inpatient days, total emergency cases and no. of deliveries are identified as output for the DEA model because out-patient, in-patient and emergency services are highly demanded component of district hospital services by the people and delivery remains the most common cause for hospitalization (DoHS, 2009) in district hospitals in Nepal. The operational definition of output variables is as follows.
Outpatient visits: No. of total visit recorded in outpatient department of each district hospitals in the year 2009-2010.

Total inpatient days: Total no. of inpatient stay days in inpatient care unit of district hospitals for the year 2009- 2010.

No. of emergency: Total no. of emergency cases recorded in emergency unit of each district hospitals in the year 2009- 2010

No. of Deliveries: Total no. of deliveries conducted in each district hospitals in the year 2009- 2010.

4.5.2 Regression Analysis:

In the second part of the study the estimated efficiency scores were analyzed by regressing them against a set of observed explanatory variables. A Tobit regression model (through Eviews computer program) used to identify and evaluate factors affecting on efficiency because the efficiency scores are bounded by zero and one. Since, the efficiency score computed from DEA model are censored at zero and one, an OLS regression that assumes a normal and homoscedastic distribution of the disturbance and the dependent variable would produce biased and inconsistent parameter estimates because the expected error will not equal to zero. Therefore, a Tobit model is more appropriate for the analysis of efficiency correlates.

The efficiency score for each hospital, calculated using DEA, was used as the dependent variable in regression model and bed occupancy rate, beds/physician ratio, nurses/physician ratio, population density of districts, geographical location, no. of beds (hospital size) and allocated budget for district hospitals were used as independent variables representing the factors likely to effect on efficiency of district hospital in Nepal. As we are estimating the efficiency of two years (2009 and 2010), Year was included in the model to control the yearly effect. To move to a one-sided truncation the DEA scores were transformed into the reciprocal form (1/eff). The reciprocal of the efficiency score unbounded above though it does have a lower bound of 1. Tobit analysis of reciprocals of the efficiency scores is therefore an appropriate tool for analyzing the factors of efficiency (Ferrier and Valdmanis, 1996).

4.5.3 Rational for the explanatory variable of hospital efficiency:

Bed Occupancy rate: The occupancy rate can be assume as a measure of the demand for hospitals services. It is reasonable to assume that hospital with greater occupancy rate means better utilization of resources according to their capacity. It indicates that hospital is producing highest output from available inputs. Under using service capacity increases the costs per case of hospital care and reduces efficiency. As a result, occupancy rate is expected to be positively associated with efficiency. This assumption is supported from (Chang 1998, Ferrier &Valdmanis, 1996).

No. of beds: No. of beds is taken as the proxy for hospital size. The inappropriate size of a hospital (too large or too small) may sometimes be a cause for technical and scale inefficiency. Patient have tendency to choose larger hospitals that have advanced technology and better facilities. Currently, District hospitals in Nepal have facilities of 15 to 50 beds. There is discussion about the available no. of bed is insufficient for district hospital and need to increase. Hence, no. of bed is expected to have positive relationship with efficiency.

Bed/physician ratio: This proportion shows the combination of capital and labor input. One physician can manage more in-patient visits or more beds mean more hospitals efficiency but it may be problem for quality. The sign of bed-physician ratio can be positive or negative depending on the situation of hospital. We assume that no. of bed per physician ratio may have negative effect on efficiency. This assumption was supported from the finding of wichian Thianjaruwatthana (2009).

Nurse/Physician ratio: This proportion is taken as an indicator of the health worker skills mix which shows the combination of labor input between physician and nurses. Nurses were complimentary unit of physicians in some health services and substitute for physician in some health services. It was seen that delivery is the most common cause for hospitalization in district hospitals in Nepal so we assume that nurses can be supplementary as well as complementary for physician depend on the situation of district hospitals. We expect that nurse per physician ratio have positive impact on efficiency.

Out-Patient visits/ Physician: This proportion shows how much outpatient manages by one Physician. One physician can manage more outpatient visits mean more hospital efficiency. It was seen that district hospitals in Nepal are less than fully utilized so they can accommodate more outpatient. We expect that higher OP visit per physician have positive impact on efficiency.

(Technology)Ultrasound: A report on review of determinants of hospital performance (WHO, 1994) had mentioned that technology as a important variable that can effects on hospital performance. Technology is not merely the machines but includes the drugs, devices and medical and surgical procedures. However, for this study Ultrasound is taken as proxy for technology. We expect that hospital with new technology might be more technical and scale efficient.

Population Density: Population density of the district can effect on the technical and scale efficiency of hospitals. In Nepal some districts have less population density because of difficult geographical terrain and it result on low utilization of services. We expect that the high population density of the district may positively associates with technical and scale efficiency.

Budget: As our sample hospitals are government hospitals, central government was the main sources of regular budget. The allocated budget is different in each hospital. The ability of public hospitals to provide an acceptable service depends on the level of funding too. The share of budget allocated to district hospitals by center government was 2.26% and 1.86% of total budget in 2009 and 2010.We expect that allocated budget from center government to district hospitals have positive association with hospitals efficiency.

Geographic location: There might have differences in hospital performances in different geographical location because of distance from center level, availability of other facilities and infrastructure. Similarly, regulatory environments, demographics and socio-economic status in different geographical ecological region of Nepal, might effect on the hospitals' performance. Hospital located in hill and terai (flat) region might be more efficient than mountain region. This assumption is supported from the study result of Farrier and Valdmanis (1996); (coelli, Rao and Battese, 1998).

Year: There might be differences in hospitals performances during two years. Hence yearly dummy was included to control the effect of period.

Hypothesis:

H1: Bed occupancy rate is expected to be positively associates with technical and scale efficiency.

H2: No. of beds (hospital size) is expected to have positive relationship with technical and scale efficiency.

H3: Bed/physician ratio is expected to have negative relationship on the efficiency of hospital.

H4: Nurse/physician ratio is expected to have positive impact on efficiency.

H5: Outpatient/physician ratio is expected to have positive impact on efficiency.

H6: Population density of hospital located district is expected to be a positive factor to increase technical and scale efficiency of hospitals.

H7: Different Geographical location may affect on the efficiency level of district hospitals.

H8: Allocated budget for district hospital by center government is expected to have positive association with efficiency.

H9: Year 2010 is expected to be positive for efficiency.

Model:

$$\frac{1}{EFFj} = \beta_0 + \beta_1 OCCR_j + \beta_2 BED_j + \beta_3 BEDPHY_j + \beta_4 NURSEPHY_j + \beta_5 OPPHY_j + \beta_6 US_j + \beta_7 POPDEN_j + \beta_8 BUDGET + \beta_9 REGION1_j + \beta_{10} REGION2_j + \beta_{11} YEAR2 + \varepsilon_j$$

Where,

$1/EFF_j$ = Technical /Scale Efficiency score of hospital alternately

$OCCR_j$ = Bed occupancy rate of hospital

BED_j = no. of functioning beds in hospital

$BEDPHY_j$ = Bed /Physician ratio

$NURSEPHY_j$ = Nurses/Physician ratio

OPPHY= Outpatient / Physician ratio

US= Ultra sound (dummy for technology, hospital with Ultrasound=1, 0 otherwise)

$POPDEN_j$ = Population density of hospital located district.

$REGION1_j$= hospital located in mountain region (dummy variable)

$REGION2_j$ = hospital located in hill region (dummy variable)

$REGION3_j$ = hospital located in terai region (omitted dummy variable)

YEAR2 = Year 2010

βo is constant and $\beta 1$, β_2, β_3,β_4,β_5,β_6,β_7 ,β_8, β_9 ,β_{10} are the coefficient of the variables.

4.5.4 Definition, abbreviation and expected sign of Explanatory variables:

Variable	Abbreviation	Sign	Definition
Occupancy Rate	OCCR	+	The proportion of inpatient stay days in a year and no. of beds for a year in each
No. of beds	BED	+	No. of beds is taken as proxy for size of hospital which define as no. of functioning beds in hospitals.
Bed Physician Ratio	BEDPHY	_	The proportion of no. of beds and number of physicians (beds/physician)
Nurse physician	NURSEPHY	+	The proportion of no. of nurses and no. of physicians (physician/Nurse)
Outpatient visits /	OPDHY	+	The proportion of total outpatient visit and no of physician.
Ultrasound	US	+	Dummy variable for technology, US =1, if Hospital have ultrasound US = 0
Population Density	POPDEN	+	Population per square km. of district where the district hospital located
Budget	BUDGET	+	District hospitals budget allocated from central government

Geographical Location	REGION1= Mountain (dummy), REGION2 = Hill (dummy), REGION3=Te	– + +	Dummy variable to measure geographic location of hospitals. Region1 if hospital located in Mountain, Region2 if located in Hill and Region3 if located in Terai (Flat).
YEAR2	Year2=year 2010	+	Dummy variable to control the effect of year. Year2=1 if the year is 2010 and 0 otherwise.

CHAPTER V
RESULT AND DISCUSSION

5.1 General description of data

The data used for this study was collected from 56 district hospitals operating under Department of Health Services, Ministry of Health and Population, Nepal. The hospitals are distributed over all regions across the country. Data were obtained from Health Management Information System (HMIS), Human Resource Development Information System (HuRDIS), and administrative section of Department of Health Services. Table 5.1 presents the descriptive statistics (mean, standard deviation, maximum and minimum) and their trend over the study year for the input and output variables of sample hospitals.

It was seen that the trend of descriptive statistics for input and output variables change during the period 2009 to 2010. In 2009 a district hospitals on an average employed 2.86 doctors, 4.99 nurses and 4.85 other technical staff (including Health Assistant, Auxiliary Health Worker, Lab Technician/assistant, and Radiographer) had a mean capacity of 19.20 beds and served an average population of 15482.52 in outpatient, 3047 in emergency and deliveries of 370 persons. The mean inpatient stay days in hospitals are 3559.39 for a year.

In 2010 it was seen that the average number of doctor increase to 3.30 whereas the maximum number of doctor is 9 and minimum number of doctor is one. The average number of nurse has been rise to 5.04 and the average number of other technical staff increases slightly from 4.85 to 4.98 during the period. Most of the output data are in increasing trend in 2010. The outpatient visit is increasing from 15482.52 to 17720 and inpatient stay days rising from 3559.39 to 3650.04. Similarly the mean no. of emergency and no. of deliveries are also increasing slightly from 3047 and 370 to 4034 and 442 over the period.

Table 5.1 : Descriptive Statistics of Output and Input Variables

	2009				2010			
Variables	Mean	SD	Min	Max	Mean	SD	Min	Max
Out patient Visits	15482.52	7205.76	1889	39945	17720	8413	1242	40262
Inpatient stay days	3559.39	2320.04	6	10346	3650.04	2402.51	58	11492
No.of emergency	3047	2771.57	128	17647	4034.04	3568.88	58	19045
No. of deliveries	370	313.48	4	1449	442	373.34	2	1549
No. of beds	19.20	7.02	7	50	19.89	7.31	7	50
No.of Doctors	2.86	1.36	1	7	3.30	1.56	1	9
No.of Nurses	4.99	2.03	2	15	5.04	1.83	1	13
No.of other technical staff	4.85	1.42	2	9	4.98	1.45	3	10

5.2 Efficiency result from DEA model

We have used number of doctors, nurses, beds and other medical staff as inputs and outpatient visit, inpatient stay days, number of emergency and number of deliveries as outputs for this study. So the operational definition of technical efficiency was the ability of each decision making unit (Hospitals) in using its staff and bed to produce outpatient care inpatient care and emergency.

The relative efficiency of district hospitals for the period 2009 and 2010 were estimated using the input oriented VRS models of DEA described in chapter III, section 3.4.2. DEA was performed two times for two different years to compare the yearly efficiency scores. The table 5.2 shows the summary of technical and scales efficiency scores.

Table 5.2 Descriptive Statistics of TE and SE scores

Descriptive Statistics	2009		2010	
	TE	SE	TE	SE
Mean	0.895	0.850	0.904	0 .781
SD	0.131	0 .193	0.124	0 .223
Max	1	1	1	1
Min	0.642	0 .290	0 .554	0.104
Mean of inefficient	0.796	0.728	0.814	0.612

The result indicates that the average VRS technical efficiency score among whole sample was 0.895 in 2009 and 0.904 a slight increase in 2010. The inefficient hospital has an average TE score of 0.796, ranging from .642 to .999 in 2009 and 0.814 ranging from 0.554 to 0.984 in 2010. This finding implies that if the hospitals were operating efficiently, they could have produced average 11% and 10% more output respectively in two years using their current level of endowment. Alternatively the hospitals could produce their current levels of health service output with 11% and 10% less of their existing health system input endowment.

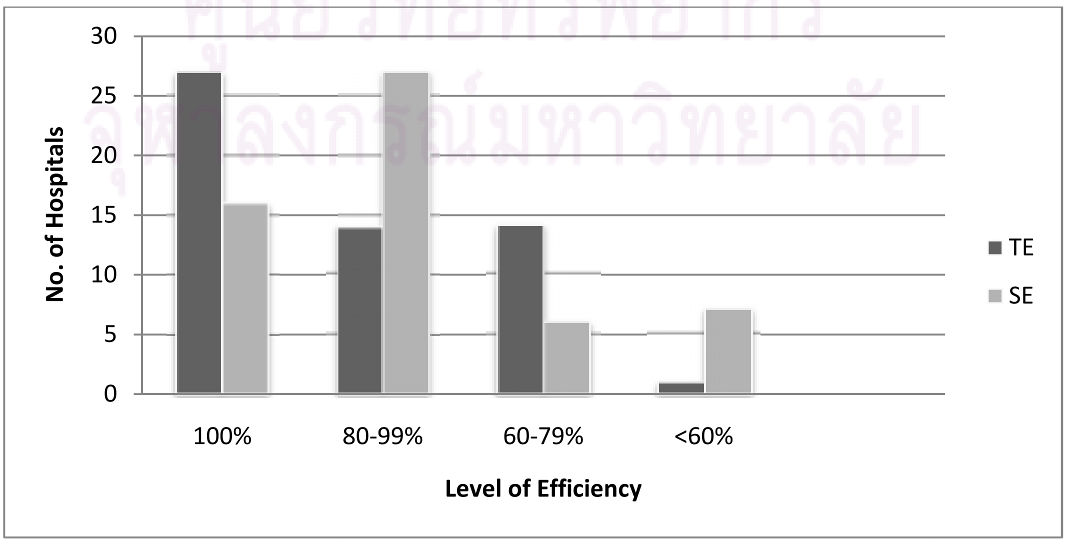
The average scale efficiency score in sample hospitals are 0.850 in 2009 and decline to 0.781 in 2010. The average scale efficiency score among inefficient hospitals are 0 .728 in 2009 and 0.612 in 2010. This implies that the scale inefficient hospital could reduce their size by 28% and 39 % without reducing their current output levels or increase output by 28% and 39% with current inputs level during two year respectively to become scale efficient.

The frequency of Technical efficiency and scale efficiency level in the year 2009 and 2010 are presented in table 5.3 and 5.4 below. In 2009, out of the 56 hospitals, 27 (48.21) % were technically efficient since they had a relative technical efficiency (TE) score of 100%. The remaining 29 (51.79%) had a TE score of less than 100%, which means that they were run inefficiently in 2009. Among the inefficient hospitals, 14 (23.29) have TE score between 80-99%, 14(26.78) have 60-79% and 1(1.78%) is less than 60%.

Table 5.3 Ranking of Efficiency in 2009

Level of efficiency	TE	%	SE	%
100%	27	48.21	16	28.6
80-99%	14	25.00	27	48.21
60-79%	14	25.00	6	10.71
<60%	1	1.78	7	12.50
Total	56	100	56	100

Figure: 5.1 Distribution of Hospitals by level of efficiency in 2009

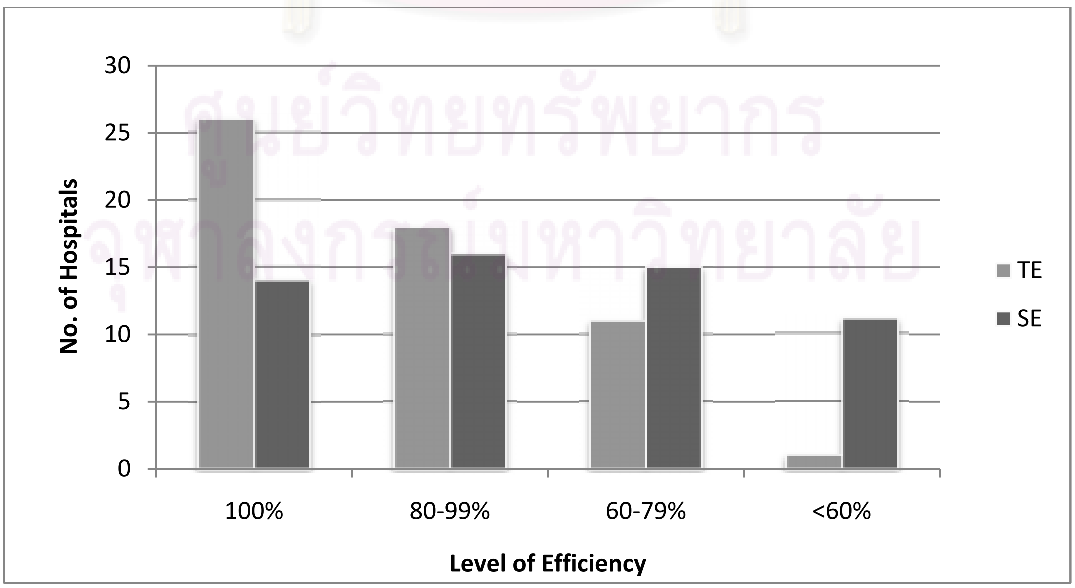


Similarly in 2010, of the 56 hospitals, 26 (46.43%) were technically efficient as they had relative efficiency score of 1.00 therefore lies on the efficiency frontier. Eighteen (32.14%) hospitals have efficiency score between 80-99%, 11 (19.64 %) lie in the range of 60-79% and one have <60% efficiency score. It was clearly seen that no. of hospital located in efficiency frontier decline but average efficiency level is improve during the study period. However there has been not significant change.

Table 5.4 Ranking of Efficiency in 2010

Level of efficiency	TE	%	SE	%
100%	26	44.43	14	25.00
80-99%	18	32.14	16	28.57
60-79%	11	19.64	15	26.79
<60%	1	1.78	11	19.64
Total	56	100	56	100

Figure: 5.2 Distribution of Hospitals by level of efficiency in 2010



The VRS model technical and scale efficiency scores for individual hospitals are contained in Table 5.5. All the scale-efficient hospitals displayed constant returns to scale (CRS), implying thereby that they were operating at their most productive scale sizes.

Table 5.5 Technical and Scale Efficiency Scores of District Hospitals

		2009			2010		
Sn.	**Hospital name**	**TE**	**SE**		**TE**	**SE**	
1	Bhojpur	0.814	0.841	irs	0.750	0.728	irs
2	Dhankuta	0.896	1	-	0.892	0.988	drs
3	Ilam	0.879	0.820	irs	1	0.922	irs
4	Khotang	0.886	0.960	drs	1	0.965	irs
5	Rangeli	1	0.925	irs	0.873	0.650	irs
6	Panchthar	1	1	-	1	1	-
7	Sankhuwasabha	0.999	0.962	irs	0.730	0.976	irs
8	Siraha	1	0.840	irs	0.877	0.704	irs
9	Solukhumbu	0.590	0.214	irs	0.788	0.365	irs
10	Sunsari	1	1	-	1	1	-
11	Taplejung	1	1	-	1	1	-
12	Tehrathum	0.782	0.684	irs	0.659	0.744	irs
13	Udayapur	1	1	-	0.951	0.788	irs
14	Kalaiya	1	1	-	1	1	-
15	Dhading	1	1	-	0.969	0.871	irs
16	Mahottari	0.912	0.954	drs	0.664	0.830	irs
17	Hetauda	1	1	-	1	1	-
18	Trishuli	1	1	-	1	1	-
19	Rasuwa	0.601	0.330	irs	0.800	0.239	irs
20	Gaur	1	1	-	1	1	-
21	Sarlahi	0.779	0.832	irs	1	1	-
22	Sindhuli	0.883	0.824	irs	0.860	0.676	irs
23	Sindhupalchowk	0.944	0.915	irs	1	0.718	irs
24	Argakhanchi	0.726	0.588	irs	0.643	0.534	irs
25	Baglung	0.658	0.993	irs	0.771	0.977	irs
26	Gorkha	0.970	0.976	irs	1	1	-
27	Tamghans	0.757	0.638	irs	1	1	-
28	Kapilbastu	1	1	-	0.971	0.844	irs
29	Manang	1	0.52	irs	1	0.104	irs
30	Mustang	1	0.613	irs	1	0.360	irs
31	Beni	0.745	0.942	irs	0.806	0.911	irs

32	Nawalparasi	0.947	0.888	irs	0.761	0.677	Irs
33	Palpa	0.642	0.761	irs	0.672	0.479	Irs
34	Parbat	1	0.880	irs	0.969	0.718	irs
35	Bhairahawa	0.642	0.843	irs	0.554	0.853	irs
36	Syangja	0.816	0.814	irs	0.987	0.704	irs
37	Damauli	0.760	0.999	drs	0.863	0.852	drs
38	Bardiya	0.749	0.975	irs	1	1	-
39	Dailekh	0.830	0.952	irs	0.680	0.967	irs
40	Dolpa	1	1	-	1	0.352	irs
41	Humla	1	0.876	irs	1	1	-
42	Jajarkot	1	1	-	0.888	0.636	irs
43	Jumla	1	0.882	irs	1	0.753	irs
44	Kalikot	1	1	-	1	0.832	irs
45	Mugu	0.911	0.822	irs	1	0.655	irs
46	Pyuthan	1	0.975	irs	0.905	0.958	irs
47	Rolpa	1	0.901	irs	1	1	-
48	Rukum	1	1	-	1	1	-
49	Salyan	0.788	0.767	irs	0.81	0.597	irs
50	Achham	1	0.992	irs	0.994	0.917	irs
51	Baitadi	1	1	-	0.859	0.720	irs
52	Bajhang	1	0.290	irs	0.908	0.589	irs
53	Bajura	1	0.714	irs	1	0.580	irs
54	Dadeldhura	0.742	0.797	irs	1	0.846	irs
55	Darchula	0.809	0.560	irs	1	0.726	irs
56	Doti	0.651	0.566	irs	0.770	0.494	irs
	Average	**0.895**	**0.850**		**0.904**	**0.781**	

In 2009 and 2010, out of 56 hospitals analyzed, sixteen (28.6%) and fourteen (28.6)% hospitals displayed constant return to scale which means that they had the most productive size for that particular input-output mix. Increasing return to scale (IRS) was found during the two year in 37 (66%) and 40 (71.43) hospitals respectively. Three and two hospitals manifested decreasing return to scale (DRS).

In order to operate at the most productive scale size (MPSS), a hospital exhibiting DRS should scale down both its outputs and inputs. Similarly, if a hospital is displaying IRS, it should expand both its outputs and inputs. Decreasing returns to scale (also known as diseconomies of scale) implies that unit costs increase as output

increases and thus the hospital is too large for the volume of activities that it conducts. In contrast, a hospital with increasing returns to scale (economies of scale), since unit costs decrease as outputs increase, is relatively small for its scale of operations.
Since the best firm have perform score on a scale of 0 to 1, the difference in score gives management policy makers an idea of the scope of improvement possible.

Input Savings

Technical efficiency scores indicate the overall extent to which all the inputs have to be reduced in order to attain 100 per cent efficiency for the inefficient units. DEA calculates slacks which specify the amount by which an input or output must be improved in order for the unit to become efficient. The hospitals producing on the efficient frontier define the best practice and thus could be regarded as role models. For each inefficient hospital, the DEA model has identified efficient hospitals that could be used as comparators .The inefficient hospitals could learn from their efficient peers by observing their production processes. Individual facets or cones of the envelopment surface (or the efficiency frontier) and the slack variables for each of the inefficient hospitals are given in the Table (Appendix A.3 and A.4). This information provides the magnitudes by which specific inputs per inefficient hospitals ought to be reduced. Table 5.6 gives the summary of excess inputs used by inefficient hospitals for the output they produced.

Table 5.6 Total input reductions needed to make inefficient public hospitals efficient

Variables	**2009**		**2010**	
	Actual	Excess	Actual	Excess
No. of Beds	1075	14	1114	10
No. of Doctor	160	18	185	15
Nurses	280	25	282	12
Other technical staff	272	12	279	11

The inefficient hospitals could become technically efficient if they were to reduce their current inputs such as number of beds, medical officers, nurses and other technical staff by 1.30%, 11.25%, 8.93%, and 4% respectively in 2009 and 0.90%, 8%, 4% and 4% in 2010. It was seen that the excess input utilized by inefficient hospitals in 2010 is less in comparison to 2009.

Table 5.7 provides the magnitude of output slacks for inefficient hospitals. This means that the inefficient hospitals can move towards the efficiency frontier by further improving their current outputs of output visits, inpatient days, emergency and deliveries by shortfall amount mentioned in table below.

Table 5.7 Total Output increases needed to make inefficient public hospitals efficient

Variables	**2009**		**2010**	
	Actual	Shortfall	Actual	Shortfall
Outpatient visits	867021	71380	992320	117699
Inpatient stay days	199326	13275	204402	29270
No. of emergency	170627	5511	225906	16209
No. of deliveries	20707	1594	24752	2041

As we think that the decision to use or not to use district hospital services is depend on the consumer choice. However, by overlooking the output slacks information hospitals manager can make strategies to improve the access of hospital services for the potential patients in their catchment area and ensure people are not bypassing the hospital.

5.3 Result of regression analysis

In the second part of this study the estimated efficiency scores were analysed by regressing them against a set of observed characteristics of the hospitals and their environments. The technical and scale efficiency are regressed against factor that are likely to influence hospital performance. By determining those factors that are correlated with efficiency, hospital administrator and policy makers can become more effective decision makers. Only if such factors are identified can relevant strategies be adopted to reduce and eliminate inefficiency. As discussed in chapter 4, section 4.5.2, our list of possible factors that can affect on hospitals efficiency include size of the hospital, mix of capital and labor, demand for services, total budget allocated for the hospitals, geographical location, and population density of the district, were estimated through Tobit regression model. The last category of explanatory variables reflected environmental characteristics mostly beyond the influence of managerial actions.

We observe from the Table that the magnitude and sign of coefficient for the variables bed occupancy rate (OCCR), no. of bed (BED), bed physician ratio (BEDPHY), nurse physician ratio(NURSEPHY), out-patient physician ratio (OPDPHY), technology (ultrasound machine-US), allocated budget to hospitals (BUDGET), population density of hospital located district (POPDEN), geographical variation (REGION1 and REGION2) and YEAR. Thus, a negative sign on a coefficient indicates a positive association with efficiency, because the dependent variable in the analysis is the reciprocal of the efficiency scores. The results of Tobit regression analysis are presented as follows.

Table 5.8 Result of Tobit regression for Technical Efficiency

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.204535	0.175222	6.874322	0.0000
OCCR	-0.004506	0.001224	-3.682579	0.0002
BED	0.011205	0.004825	2.322384	0.0202
BEDPHY	-0.044587	0.015281	-2.917907	0.0035
NURSEPHY	0.142494	0.056227	2.534258	0.0113

OPDPHY	-3.46E-05	9.74E-06	-3.549976	0.0004
US	0.053638	0.055665	0.963569	0.3353
POPDEN	-0.000204	0.000305	-0.667777	0.5043
BUDGET	2.88E-08	1.50E-08	1.929344	0.0537
REGION1	-0.125891	0.161925	-0.777466	0.4369
REGION2	0.063938	0.119847	0.533498	0.5937
YEAR2	-0.061266	0.055522	-1.103438	0.2698

Table 5.9 Result of Tobit regression for Scale Efficiency

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.844224	0.481017	3.834010	0.0001
OCCR	-0.009792	0.002926	-3.346127	0.0008
BED	-0.030838	0.014118	-2.184217	0.0289
BEDPHY	0.002295	0.017432	0.131628	0.8953
NURSEPHY	0.028940	0.050219	0.576270	0.5644
OPDPHY	-3.87E-05	1.25E-05	-3.088651	0.0020
US	0.073761	0.143592	0.513686	0.6075
POPDEN	-6.18E-05	0.000800	-0.077238	0.9384
BUDGET	3.48E-08	3.78E-08	0.920533	0.3573
REGION1	0.761622	0.415237	1.834183	0.0666
REGION2	0.221063	0.314762	0.702317	0.4825
YEAR2	0.008535	0.142449	0.059919	0.9522

The occupancy rate (OCCR) was included as measures of demand for hospital services and expected to be positively associates with efficiency. We expected that the high occupancy rate, results in a high efficiency because of better utilization of resources according to their capacity. Keeping the beds full means, a hospital is producing a lot of output from its available inputs. As shown in table the regression confirms that bed occupancy rate has a positive and significant impact on technical as well as scale efficiency. The finding is in line with previous studies. For example, Chang (1998) and Ferrier and Valdmanis (1996) found bed occupancy rate has positive and significant impact on efficiency.

No. of bed (BED) was used as proxy for hospitals size, assuming that the size of hospital might affect positively on efficiency. This variable is significant with technical efficiency but the sign is negative. Generally, the district hospitals in Nepal are considered as 15-25 beds size but some hospitals size increasing gradually to more than 25 beds and a few hospitals have less than 15 beds functioning. Although the bed size increased in some hospitals, other available services complexity is remaining the same so service utilization not increase significantly according their size. However, it seems significant and positively associates with scale efficiency. The DEA result shows that most of the sample hospitals have increasing returns to scale and the regression result also indicates that the hospitals can extends size to achieve scale efficiency.

The coefficients of bed physician ratio (BEDPHY) have positive and significant with TE but not significant with SE. This variable was taken as the proxy to measure the mix of capital and labor input. We expected that it might negatively associates with efficiency assuming too many beds for one physician may negatively effect on efficiency. The result shows that bed physician ratio is positively associates with TE. The average bed size of district hospitals is 20 and average no. of full time equivalent physician is 3which shows that on an average around seven beds for one physician. It seems that increasing bed for current no of physician can contribute to technical efficiency.

We assume that nurse physician ratio (NURSEPHY) will be positively associates with technical efficiency because the annual reports of DoHS mention that delivery is the most common cause for hospitalization in district hospitals in Nepal. Hence, nurse and doctor is the key service provider so it was taken as proxy to measure the affect of mix of labor on efficiency. The regression result indicates that, nurse per physician ratio negatively significant with technical efficiency and not significant with scale efficiency. It shows that the current mix of nurse and physician is not appropriate to increase hospitals efficiency. It may be due to the fact that the misdistribution and mismatch of labor inputs that is not based on needs and demand.

Some of the reports indicate that district hospitals in Nepal are less than fully utilized, they can accommodate more outpatients. So we include the variable outpatient-physician ratio (OPDPHY) to estimate relation with efficiency. We expect that higher OPD visit per physician have positive impact on efficiency. The regression result confirms that outpatient physician ratio has strong impact on technical and scale efficiency. It shows that, more outpatient visits per physician can contribute to increase the technical and scale efficiency.

To measure the effect of new technology in efficiency, we include availability of Ultrasound machine in district hospital as a dummy variable. We expect that the district hospitals with ultrasound machine might be more efficient. We find that this variable is not significant with efficiency. This might be due to lack of skilled man power to handle technology. Technology is not merely the machines but includes the drugs, devices, medical and surgical procedures and skilled man power to drive it. There is always shortage of trained health worker in Nepal. Although hospitals got ultrasound and other type of machine from government and donor, they are not functional regularly due to lack of trained human resources. So we can say that the result is reasonable, when there is lack of skilled man power to handle technology.

Worthington (1999) argued that public hospitals may be relatively inefficient because of governmental budgetary constraints thus the ability of public hospitals to provide an acceptable service depends mainly on the level of funding and the extent of pressures on health care spending. So this study tries to test the effect of the allocated budget on hospitals efficiency. The central government was the main sources of regular budget of District hospitals so it seems quite reasonable to include this variable. In fact, we find that budget is negatively significant with technical efficiency. The result is quite interesting that yearly budget have negative contribution on the hospitals efficiency. It is might be evidence of poor management of resources.

gThe results shows that population density is positively correlated with TE and SE. Though the district hospitals are located in the district headquarter, they are the first level referral hospital of the district level. If the population density high then more people will come for service, hence there will be pressure for service provider to provide quality service and policy planner to increase capacity and size of hospital that can affect on Technical and scale Efficiency.

Regional dummy variable are statistically significant with hospitals scale efficiency. We assume that the hospitals located in mountain region (RE1-region1) might be less efficient compared to flat (excluded) and hill region. The result shows there are significant differences in scale efficiency in hospitals located in mountain region in comparison to other reason. The population density is low in mountain region, which might be the cause for low scale efficiency. However, this variable is statistically not significant with technical efficiency. The reason behind it may be due to higher proportion of health worker distributed in the hill and flat region and the performance is less in relation to the labor input. Another possible reason is the distribution of higher level hospitals is concentrated in hill and Terai region. People have easy access to go to secondary and tertiary level hospitals but in mountain region people have less choice, difficult access and costly to go to higher facility. Ferrier and Valdmanis (1996) also found location differences affect in scale efficiency in us rural hospital but no statistically significant difference in technical efficiency across states.

Yearly dummy variable YEAR 2 is positive for technical efficiency but not significant with both technical and scale efficiency.

Finally, hospitals which have higher occupancy rate, high outpatient visit, higher bed physician ratio, lower nurse physician ratio are seen more technically efficient.

Hospitals with less bed size were found technically efficient in comparison to high bed size whereas higher bed size hospitals located in plain and hill region were found scale efficient than lower bed size in mountain region.

CHAPTER VI

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Using data covering two time-periods from fiscal years 2009 to 2010, we analyzed the technical and scale efficiency of a sample of 56 district hospitals. This study has employed DEA to estimate empirically the relative performance of the government district level hospitals and Tobit regression model to identify the factors affecting on the efficiency of district hospitals in Nepal.

The study is the first attempt in Nepal to estimate TE of district hospitals using DEA methodology. The study has shown a considerable variation in hospitals productivity across the country. The analysis revealed that only 48.21% hospitals in 2009 and 46.43% in 2010 had a TE rating of 100%; implying that they are operating relatively efficiently compared to their peers. These hospitals are using fewer inputs to produce more outputs compared to inefficient peers. On the other hand 51.79% and 53.57% run inefficiently in 2009 and 2010 compared with most efficient hospitals in the sample. The study concludes that average VRSTE score of hospitals improve from .895 to .904 over time however number of efficient hospitals has been declined. On average, inefficient hospitals utilized larger numbers of inputs. Even with their excess inputs, however, inefficient hospitals produced less output than their relatively efficient counterparts. The study further reveals that the prevalent scale inefficiency is increasing returns to scale. In the presence of increasing returns to scale, expansion of outputs reduces unit costs.

The study shows that the inefficient (52 per cent) hospitals taken together have 14 excess beds; 18 excess medical officer, 25excess numbers of staff nurses, and 12 other technical staff in 2009 and 53 percent inefficient hospitals have 10 excess beds 15 excess medical officer, 12 nurses and 11other technical staff in 2010. Therefore, given the need for strengthening health services at the primary levels, these excess medical officers and staff nurses can be transferred to the under staffed sub-district hospitals or PHCs to provide primary health care. We believe that this would provide better access to health care and quality of services provided at the primary level. Alternatively, these excess resources can be redeployed to increase the size in those district hospitals that are technically efficient and experience increasing returns to scale (IRS).

A variety of factors were used to explain the observed differences in performances, providing information that might help hospital administrator and public policy makers to make better decisions. The regression results indicate that hospitals with higher occupancy rates perform better than those with lower occupancy rates. The bed physician ratio, nurse physician ratio and outpatient physician ratio were regressed against efficiency scores. These ratios can be positive and negative for efficiency depending on the situation of hospitals. This study found that bed physician ratio is positively and nurse physician ratio is negatively significant. It shows that the current mix of nurses per physicians is not appropriate for district hospitals efficiency. Either the nurses should be decrease or the physician should be increased according to the situation of individual hospitals. The outpatient physician ratio found strongly significant which means physician should provide service to more outpatient to increase the technical efficiency.

The result also revealed that population density is positively associated with technical and scale efficiency. Hospitals in mountain region are found significantly less scale efficient than other regions. However variables like ultrasound as technology and allocated budget has not contributing positively in district hospitals efficiency.

The findings of this study are in line with few other studies. For example Zere et al. (2006) found average technical efficiency level of district hospitals in Namibia was less than 75% and half of the sample (30) hospitals were inefficient. Osei et al (2005) found 47% district hospitals were technically inefficient with an average TE score of 61% in Ghana. A study in Tamilnadu India found that 52% district hospitals were technically efficient among 29 sample hospitals. A study in Greece found that remote island units were better than urban centers for technical efficiency and urban units showed higher scale efficiency than remote ones.

DEA provides the diagnostic information necessary for effecting productivity-based performance improvements. As we have shown in our analysis, DEA provides specific measures that identify areas of underperformance at the unit level. The slacks serve as guiding posts for focused managerial action. Since DEA accounts for multiple inputs and outputs, hospital administrators/policy makers have the flexibility of achieving maximum efficiency by either increasing outputs or decreasing inputs or both. Tracking productivity over time is meaningful from a long-term perspective.

6.2 Policy Implications

The study has demonstrated how well the district hospitals are performing**.** The presence of inefficiencies indicates that a hospital has excess inputs or insufficient outputs compared to those hospitals on the efficient frontier. With regard to hospitals with excess inputs, the policy makers could transfer excess doctors, nurses, beds and other technical staff to other needy facilities.

Excess beds should reallocate to those hospitals which have low bed physician ratio or low number of beds per physician and excess physician should reallocate to those hospitals which have high bed physician ratio or high number of beds for a physician. Similarly, excess number of nurses in inefficient hospitals should reallocate to those hospitals which have less number of doctors. Further, the population density of the district and geographical differences should also consider in reallocation.

Highest occupancy rate and increase in outpatient visits tends to increase in efficiency level. Focusing on bed utilization at the maximal capacity or decreasing number of unutilized beds should be one solution. Allocation of resources such as doctor, nurses, beds and other technical staff should be done according to needs which can improve equity and efficiency of health outputs, however, a blanket policy will not have such a capacity.

The policy maker should use the evidence of scale efficiency analysis in decision making about which district hospital should be downsized or upsized. According to IRS pattern of scale efficiency, increasing the number of beds in most of the district hospitals, can increase scale efficiency. However, the proper mixes of capital and labor inputs need to be concerned to improve technical efficiency.

Efficiency measurement and benchmarking should be institutionalize within national Health Management Information Systems (HMIS). Therefore, HMIS capacity ought to be enhanced to routinely capture the input, input prices and output data which could be used to monitor economic efficiency among hospitals and lower level facilities regularly.

6.3 Limitation of the study:

Several limitations exist in this research. The study aims to include 61 hospitals in sample, few of them not included in the study. It was come to know that some district hospitals were upgraded to regional/sub-regional hospital during the study period and some were managed by community, INGO and local development body. Similarly the input data were collected from different type of source such as Human Resource Development and Information Center (HuRDIC) in Ministry of Health and Population (MoHP), administration section of Department of Health Services (DoHS) and telephone and email report from some district hospitals.

This study focuses mainly on the technical efficiency and scale efficiency of hospitals. Technical Efficiency of a hospital reflects only the operational efficiency in providing patient care. Calculating allocative efficiency and total economic efficiency of hospitals can be better measurement for overall efficiency.

A better performance measure of hospitals would include both quality of care and efficiency of the process in providing care and services. It may be argued that there may be variation in the quality of care provided by different hospitals, e.g. hospitals offering higher quality of care may require more personnel time and other inputs than those offering low quality of care. Given the fact that all the hospitals studied were district-level public hospitals, designed and resourced to provide a fairly similar level and mix of care, it is unlikely that there would be any significant variance in the quality of care across these facilities.

Selecting a set of most appropriate input and output variables for studying hospital efficiency is always challenging. One may question why certain inputs and outputs are included or excluded from an analysis. It would be argued that the ultimate output of hospitals is the aggregate change in health status of the patients who received hospital outpatient and inpatient services. However, due to paucity of data on health status indices such as Quality Adjusted Life Years or health disability indicators such as Disability Adjusted Life Years, this study used intermediate outputs, i.e. number of outpatient visits, number of inpatient stay days, number of emergency and no. deliveries conducted. On the other hand, even if it were possible to use health outcomes, there would be issues of attribution and consequently the need to adequately control for exogenous factors. Depending on the size and availability of data, we can further expand the number of input and output variables to enrich future analysis.

6.3 Recommendations for further study

The study indicates the relative measures of technical and scale efficiency among the sample hospitals. It does not mean that only reducing input would increase hospital efficiency. In order to increase hospital efficiency, further studies on technical efficiency with qualitative analysis and allocative efficiency should be done in the future.

In DEA, some more important inputs and outputs variable which play the major role in production process of hospitals in Nepal should be include in the model.

For regression analysis, some better control variable such as quality of services, competitive pressure, regulatory pressure, demand patterns, urban and rural location, literacy rate, per-capita income of people in the study area, patient characteristics, provider practice characteristics etc. should estimate for better policy implications.

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APPENDIX

A.1 Raw data of 2009 for DEA

s. n.	Hospitals	Out Patient Visit	Inpatient Stay days	Emergency	No. of deliveries	Beds	Doctors	nurses	Other technical staff
1	Bhojpur	12064	6029	1229	161	20	2	5	4
2	Dhankuta	25139	2619	3907	169	22	3	6	5
3	Ilam	13747	5290	3867	545	25	2	6	5
4	Khotang	25248	4367	2869	190	20	3	6	6
5	Rangeli	17815	636	4612	214	16	2	6	4
6	Panchthar	18574	6008	6197	299	25	2	5	4
7	Sankhuwasabha	20202	5062	2424	334	15	2	6	6
8	Siraha	14258	3201	4395	536	15	2	4	5
9	Solukhumbu	1889	6	162	137	15	3	4	5
10	Sunsari	27021	6090	6413	1449	20	3	5	6
11	Taplejung	19643	5635	2335	195	28	3	5	3
12	Tehrathum	10212	2550	2554	121	16	2	5	5
13	Udayapur	13407	4133	5824	577	15	3	4	5
14	Kalaiya	13074	2739	7227	1233	25	3	4	6
15	Dhading	24858	3616	6767	419	15	4	5	5
16	Mahottari (PH)	27102	4366	5173	764	25	5	5	7
17	Hetauda	39945	9056	17647	1139	50	3	12	9
18	Trishuli	14695	10346	3469	621	25	2	6	5
19	Rasuwa	4663	896	352	30	15	3	4	4
20	Gaur	18855	5365	3263	1121	25	3	4	5
21	Sarlahi	8638	2314	4138	242	19	5	4	6
22	Sindhuli	14943	2601	3240	346	19	2	4	4
23	Sindhupalchowk	12862	5444	2252	261	15	5	6	4
24	Argakhanchi	3099	2412	683	335	15	5	6	5
25	Baglung	13080	6407	3672	933	35	5	6	7
26	Gorkha	21196	4571	3990	360	16	5	5	4
27	Tamghans	9712	2395	2053	226	15	4	4	4
28	P. Bir	28481	1422	3096	429	15	4	4	5
29	Manang	5510	336	348	4	7	1	2	3

s. n.	Hospitals	Out patient Visits	Inpatient Stay days	Emerge ncy	No. of deliveries	Beds	Doctors	nurses	Other technical staff
30	Mustang	8543	658	512	40	15	2	4	2
31	Beni	13509	5474	3762	425	23	3	5	6
32	P.Chandra	18291	3055	4329	621	15	5	4	6.5
33	Palpa	10766	1974	330	24	15	2	6	6
34	Parbat	9068	4293	3734	297	15	2	6	5
35	Bhairahawa (Bhim)	9203	3643	6207	619	33	7	15	7
36	Syangja	13903	2320	3016	309	15	3	5.5	4
37	Damauli	22529	2796	6350	475	23	5	6	8
38	Bardiya	21369	3604	2274	618	25	5	6	5
39	Dailekh	16655	6155	1696	417	30	2	5	5
40	Dolpa	19258	424	1998	73	15	1	3	4
41	Humla	14871	1299	721	138	15	1	3	4
42	Jajarkot	18389	2364	848	155	15	1	4	5
43	Jumla	13964	2907	3483	367	29	2	5	3
44	Kalikot	20942	7924	1225	324	18	2	3	3
45	Mugu	11869	1272	817	207	15	1	3	3
46	Pyuthan	21398	6815	3544	407	26	3	6	4
47	Rolpa	10288	3632	605	94	15	1	4	3
48	Rukum	21742	7677	810	219	15	2	4	4
49	Salyan	12972	2701	617	178	15	2	6	4
50	Achham	20667	3273	2685	206	15	2	5	4
51	Baitadi	18550	679	1626	175	15	4	2	4
52	Bajhang	2024	923	128	122	15	1	4	4
53	Bajura	8303	991	1363	83	10	2	2	2
54	Dadeldhura	14561	2059	1076	306	15	3	5	7
55	Darchula	5980	2520	1237	210	15	2	3	6
56	Doti	7475	1982	1476	208	15	3	7	7

A.2 Raw data of 2010 for DEA

s.n.	Hospitals	Out patient Visits	Inpatient Stay days	Emergency	No. of deliveries	Beds	Doctors	nurses	Other technical staff
1	Bhojpur	14113	4471	1226	156	22	4	6	4
2	Dhankuta	25419	2952	5455	229	22	2	5	5
3	Ilam	14589	5802	6425	881	25	3	6	4
4	Khotang	24901	3929	8175	272	20	4	6	4
5	Rangeli	14765	344	3677	127	16	2	6	6
6	Panchthar	24813	7415	8108	478	25	3	5	5
7	Sankhuwasabha	20448	6233	2938	379	25	3	5	6
8	Siraha	10209	3150	4271	571	15	3	6	5
9	Solukhumbu	7419	159	1411	124	15	2	6	4
10	Sunsari	35606	6466	7469	1549	20	3	5	6
11	Taplejung	26014	5169	2157	265	28	2	4	3
12	Tehrathum	14171	2849	2294	176	23	2	5	5
13	Udayapur	14066	3743	5068	742	15	3	6	5
14	Kalaiya	15593	2197	11990	1376	25	2	6	6
15	Dhading	25975	3551	6516	380	15	5	5	5
16	Mahottari (PH)	19912	3322	3671	830	25	5	5	7
17	Hetauda	40262	10655	19045	1443	50	9	12	6
18	Trishuli	17831	11492	3201	761	25	2	6	4
19	Rasuwa	4868	790	462	42	15	3	3	4
20	Gaur	23677	5838	3234	1386	25	4	4	4
21	Sarlahi	16325	4251	12413	710	15	6	3	7
22	Sindhuli	15027	3127	3653	362	19	3	6	4
23	Sindhupalchowk	14158	3989	1773	200	15	4	6	3
24	Argakhanchi	4440	3173	1015	522	35	5	6	5
25	Baglung	18789	6892	6537	1097	25	5	7	7
26	Gorkha	34877	5543	9539	747	16	3	4	6
27	Tamghans	32374	5227	4651	673	18	5	4	4
28	P. Bir	23457	1358	1919	442	15	5	4	4
29	Manang	1242	58	58	2	7	2	5	3
30	Mustang	7633	1256	881	53	15	2	4	3
31	Beni	14555	6875	3553	447	23	5	5	6
32	P.Chandra	17056	2980	4268	626	18	6	4.5	7
33	Palpa	10540	890	505	28	15	3	6	6

34	Parbat	12968	3345	4576	304	15	2	6	4.5
35	Bhairahawa (Bhim)	9250	4179	6724	970	33	7	13	9
36	Syangja	17644	2329	4709	323	15	3	4.5	4
37	Damauli	35494	2468	10384	417	23	5	6	9
38	Bardiya	30344	4029	3122	678	25	3	6	4
39	Dailekh	15326	6444	2947	439	30	3	5	7
40	Dolpa	7022	372	273	62	15	1	3	4
41	Humla	21889	2057	1535	96	15	1	3	3
42	Jajarkot	14187	2699	1646	169	15	2	4	5
43	Jumla	14849	2930	3399	364	29	2	5	3
44	Kalikot	14280	2329	1144	199	18	2	2	3
45	Mugu	11040	1444	1128	196	15	1	3	4
46	Pyuthan	22914	5219	3685	422	26	3	4	4
47	Rolpa	8849	3058	1117	117	15	2	1	3
48	Rukum	19254	6279	2482	294	17	2	5	3
49	Salyan	13854	2137	585	223	15	4	6	4
50	Achham	27748	4658	4354	213	15	3	5	5
51	Baitadi	16206	1081	2449	190	15	4	3	6
52	Bajhang	12466	2802	1516	266	15	2	4	4
53	Bajura	12636	1196	1146	162	10	3	3	4
54	Dadeldhura	22142	1216	2189	157	12	5	5	10
55	Darchula	14413	4232	4016	448	15	2	4	5.5
56	Doti	12421	1753	3222	267	15	3	5	8

A.3: Input Slacks in 2009

Hospitals	Beds	Physicians	Nurses	Other Technical Staff
Bhojpur	0.000	0.000	0.684	0.000
Dhankuta	0.000	0.000	1.038	0.000
Ilam	0.445	0.000	0.453	0.000
Khotang	0.000	0.000	0.849	0.560
Sankhuwasabha	0.000	0.000	2.175	1.628
Solukhumbu	0.000	0.333	0.128	0.000
Tehrathum	0.000	0.000	0.435	0.000
Mahottari	4.561	1.203	0.000	0.779
Rasuwa	0.000	0.166	0.362	0.000
Sarlahi	0.000	1.338	0.000	0.799
Sindhupalchock	0.000	2.353	1.991	0.000
Argakhanchi	0.000	2.002	1.512	0.000
Baglung	2.382	0.663	0.000	0.000
Gorkha	0.000	1.874	0.991	0.000
Tamghans	0.000	0.984	0.350	0.000
Beni	0.000	0.000	0.000	0.335
P.chandra	0.000	2.046	0.000	1.848
Palpa	0.000	0.000	1.282	0.501
Bhairahawa	0.000	2.003	4.679	0.000
Syangja	0.000	0.000	1.453	0.000
Daumali	0.000	0.121	0.000	0.849
Bardiya	0.990	1.464	1.033	0.000
Dailekh	5.819	0.000	0.000	0.129
Mugu	0.000	0.615	1.075	0.000
Salyan	0.000	0.000	2.070	0.000
Dadeldhura	0.000	0.266	0.712	1.295
Darchula	0.280	0.000	0.000	1.787
Doti	0.000	0.472	1.886	0.991
Mean	0.317	0.320	0.474	0.222
Total	14	18	25	12

A.4 : Input Slacks in 2010

Hospitals	Beds	Physicians	Nurses	Other Technical Staff
Bhojpur	1.592	1.022	0.434	0.000
Dhankuta	3.068	0.000	0.762	0.101
Rangeli	0.000	0.000	0.893	1.398
Sankhuwasabha	0.000	0.000	0.000	0.246
Siraha	0.000	0.063	0.372	0.000
Solukhumbu	0.000	0.000	0.533	0.000
Tehrathum	0.891	0.018	1.036	0.000
Udayapur	0.000	0.195	0.860	0.000
Dhading	0.000	2.237	0.641	0.000
Mahottari	0.000	0.658	0.000	0.000
Rasuwa	0.000	0.200	0.000	0.000
Sindhuli	0.000	0.254	0.000	0.000
Argakhanchi	0.000	0.783	0.000	0.000
Baglung	0.000	1.125	0.428	0.000
Kapilbastu	0.000	1.032	0.000	0.000
Beni	0.000	1.528	0.000	0.023
P. Chandra	0.000	1.673	0.000	0.000
Palpa	0.000	0.000	0.000	0.662
Parbat	0.000	0.000	2.142	0.014
Bhairahawa	0.000	0.887	1.959	0.000
Syangja	2.903	0.387	0.774	0.000
Daumali	0.000	0.687	0.268	1.768
Dailekh	1.419	0.000	0.000	1.029
Jajarkot	0.000	0.000	0.000	1.080
Phyuthan	0.552	0.000	0.000	0.000
Salyan	0.000	0.756	0.508	0.000
Achham	0.000	0.000	0.743	0.000
Baitadi	0.000	0.755	0.000	1.043
Bajhang	0.000	0.000	0.000	1.000
Doti	0.000	0.000	0.000	2.222
Mean	0.186	0.273	0.221	0.189
Total	10	15	12	11

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