



**GOVERNMENT
OF THE
REPUBLIC OF NAMIBIA**

MINISTRY OF HEALTH AND SOCIAL SERVICES

**THE TECHNICAL EFFICIENCY OF DISTRICT
HOSPITALS IN NAMIBIA**

JULY 2004

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PREFACE

The Report on Efficiency of Public Hospitals in Namibia is produced to provide information on the status quo in efficiency of district hospitals.

The report provides information on the state of the technical efficiency of district hospitals in Namibia using ratio and frontier techniques, namely *data envelopment analysis*. It indicates the efficiency savings that are expected from all the district hospitals and the required input use if each of the inefficient hospitals function as efficiently as their peers on the frontier. Furthermore, the basic concepts and methods of hospital efficiency measurement are discussed, thus, greatly contributing to the much needed capacity in the area of efficiency assessment in health care.

The Ministry is grateful for the technical and financial support provided by the World Health Organisation in conducting the study.

My appreciation goes to all the hospitals and the Regional Management Teams for their cooperation and support. Furthermore, my appreciation goes to the team: Dr E. Zere (WHO – Namibia), Messes T. Mbeeli, W. Kapenambili, and B. Tjivambi for conducting this study.

I trust that this document will provide policy makers, managers and planners who are entrusted with the responsibility of resource allocation at various levels in public hospitals, with the necessary information, guidance and rationale that need to be followed when allocating resources. More importantly, I have no doubt that this document will provoke the minds of all policy makers, managers and planners to think of establishing a norm for resource allocation with a view to achieving the required level of efficiency.


DR. K. SHANGULA
PERMANENT SECRETARY



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ACRONYMS

AIDS	Acquired Immunodeficiency Syndrome
ALS	Average Length of Stay
BTR	Bed Turnover Ratio
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DHS	Demographic Health Survey
DRS	Decreasing Returns to Scale
FY	Financial Year
GDP	Gross Domestic Product
GNP	Gross National Product
HDI	Human Development Index
HIS	Health Information System
HIV	Human Immunodeficiency Virus
IRS	Increasing Returns to Scale
MoHSS	Ministry of Health and Social Services
OCC	Bed Occupancy
PDE	Patient Day Equivalent
PHC	Primary Health Care
RMT	Regional Management Team
SADC	Southern African Development Community
SD	Standard Deviation
TE	Technical Efficiency

TI	Turnover Interval
TT	Tetanus Toxoid
UNDP	United Nations Development Programme
US\$	United States Dollars
WHO	World Health Organisation
VRS	Variable Returns to Scale

Executive Summary

The hospital sector is the largest consumer of scarce resources available for health. In Namibia, public hospitals consumed about 44% of MoHSS current health expenditure in FY 2000/2001. The efficiency of the hospital sector merits close attention as efficiency from this sector can potentially release resources to expand services and improve quality of care.

The study thus seeks to examine the technical efficiency of public sector district hospitals with a view to assess the status quo in efficiency and describe some factors associated with inefficiency. The main findings of the study are as follows:

Out of a total of 30 district hospitals surveyed, the data required for analysis were complete for 26 hospitals for FY 2000/01 and FY 1999/2000, 24 hospitals for FY 1998/1999 and 20 hospitals in FY 1997/1998. With regard to capacity utilization the study revealed the following:

- The presence of a wide variation in the size of hospitals as measured by number of authorized beds. The range is between 40 and 450 beds.
- On recurrent expenditure there is a wide gap between the hospital, with the highest allocation receiving 11 times more than that of the hospital that receives the least.
- The number of nursing staff per 10 beds indicates differences between the highest (11) and the lowest ratios (2). The same applies to the number of physicians.
- There is a wide variation in the performance of hospitals as measured by capacity utilization ratios (OCC, BTR, TI, ALS and cost per PDE).

The DEA analysis revealed the following:

- Average efficiency scores for the four years, 1997/98 – 2000/01, range from 62.7 to 74.3%. This indicates the presence of significant amounts of inefficiency that are attributable to both pure technical and scale inefficiency.
- For the period under review, the CRS technical efficiency scores shows that less than half of the district hospitals are located on the frontier.
- In all four years increasing returns to scale was the most prevalent cause of scale inefficiency
- The number of hospitals with decreasing returns to scale is relatively small i.e. 1997/98, 1998/99 and 2000/01 – 3 hospitals, while for 1999/2000 1 hospital.
- Substantial amounts of input savings could have been achieved had the technically inefficient hospitals operated as efficiently as their efficient peers. In terms of recurrent expenditure savings are N\$ 27,009,153 (1997/98), N\$ 43,277,100 (1998/99), N\$ 66,151,450 (1999/2000) and N\$ 73,985,129 (2000/2001).
- Eenhana has appeared on the efficient frontier (technically efficient) in all four years considered while Engela, Katima Mulilo and Outapi have been on the efficient frontier in three out of the four years.

Despite limitations of data, the study has revealed the possibility of reaping substantial efficiency gains from district hospitals. Given the mammoth task of redressing inequities in healthcare that the country faces on the one hand, and the relatively dwindling healthcare resources (owing to increased needs), it is important that efficiency measures be instituted and pursued vigorously to utilize the resources at the disposal of the MOHSS. Wastages of high magnitude as suggested by the findings of this study are likely to jeopardize the government's initiatives to redress past inequities in access to healthcare.

1. Introduction

Health systems in Sub-Saharan Africa face a critical resource constraint in extending health services of acceptable quality to the vast majority of their people. Namibia is no exception to this. This is attributed to a host of factors such as poor macroeconomic performance, cutbacks in public spending the HIV/AIDS epidemic, the resurgence of diseases such as malaria and the increase in non-communicable diseases related to the epidemiological transition.

The hospital sector is the largest consumer of scarce resources available for health. Hospitals in developing countries consume on average 50% -80% of the public sector health resources (Barnum and Kutzin 1993). In Sub-Saharan Africa, public hospitals absorb about 45% to 69% of current government health sector expenditure (Mills, 1990a, 1990b; Mills, Kapalumala and Chisimbi, 1993; Kirigia *et al.*, 1998). For Namibia, public hospitals consumed about 44% of MoHSS current health expenditure in 2000/2001 (MoHSS 2003). Thus, the efficiency of the hospital sector merits close attention as efficiency from this sector can potentially release resources to expand services and improve quality of care.

Inefficiency is one of the major problems of health systems in Sub-Saharan Africa including Namibia. However, not much has been done to assess and quantify the magnitude of individual health facilities performance.

Given Namibia's apartheid history gaps in health indicators and access to health care between the most and the least privileged population groups still exist. Hence, there is a need to assess the efficiency of hospitals as compromised efficiency may hinder government's objectives to redressing inequities in health and health care. In light of this, it is necessary to address the following questions:

- Are hospitals producing their outputs with the least amount of resources feasible?
- Are hospitals operating at an optimal scale? Or are (dis)economies of scale rife (i.e. inefficiency due to largeness or smallness of hospital size)?
- Are substantial efficiency savings to be expected?

1.1 Aims and objectives

The study seeks to examine the technical efficiency of hospitals with a view to assess the status quo in efficiency and some factors associated with inefficiency.

This study has the following specific objectives:

- Evaluate the technical and scale efficiency of public sector district hospitals in Namibia; and
- Identify some factors that are likely to influence the state of efficiency of hospitals

1.2 Significance of the study

The study will have important contributions in the following areas:

- It will generate evidence for policy, which will be important in resource allocation decisions.
- Operational-level managers and planners will avail of this information in resource allocation decisions at the micro-level. This will guide issues such as input-mix, scale of operation and rational use of the available resources.
- It will contribute to capacity building in the area of efficiency assessment in health care. This will include the use of both ratio analyses and frontier techniques.

1.3 Organisation of the report

The study is organized as follows:

Section two presents background information on the Namibian health sector; Section three deals with the concepts and methods of efficiency measurement; Section four explains the study methodology; Section five presents the results and discussion thereof; and Section six presents the conclusion, policy implications and recommendations.

2. Brief profile of the country

2.1. Geography

Namibia with a surface area of 824,116 square km is the 5th largest country in Africa. It is located in the southwestern part of the continent and shares borders with South Africa, Botswana, Angola, Zambia and Zimbabwe. The country is divided into 13 administrative regions and 33 health districts.

2.2 Demographic features

According to Census 2001, the population of Namibia is estimated at 1,830,330 with a growth rate of 2.6% per annum (National Planning Commission 2001). This implies a population density of 2.2 persons per square kilometer, making the country one of the most sparsely populated areas of the world.

Namibia has favourable infant and under-five mortality rates compared to those of many countries in sub-Saharan Africa. In the year 2000 infant and under-five mortality rates were 38 and 62 per 1000 respectively. The total fertility rate was 4.2 during the same period.

While Namibia has achieved major gains in reducing mortality among children over the past 10 years, life expectancy in other age groups has not improved. The HIV/AIDS epidemic has caused a significant drop in average life span. In 2001, life expectancy at birth was estimated at 50 and 48 years for females and males respectively. This has declined from 1991 estimates, which were 63 and 59 years for females and males respectively.

2.3. Socio Economic features

Namibia, with a GNP per capita of US\$ 1,980, is classified as a lower middle-income country¹. Although Namibia is regarded as a lower middle-income country, the GNP per capita of the country does not reflect the realities. There is a high degree of income inequality as evidenced by a gini coefficient² of 0.7, which is among the highest recorded in the world (SADC *et al* 2000). Furthermore, about 35% of Namibia's population lives below \$ 1 a day, indicating high levels of income poverty.

¹ The World Bank classifies countries into three income groups according to 1990 GNP per capita: low income (US\$ 755 or less); lower middle-income (US\$ 756 – 2,995); upper middle-income (US\$ 2,996 – 9,265), and high income (US\$ 9,266 or more)

² The gini coefficient measures the extent to which the distribution of income among individuals or households deviates from a perfectly equal distribution. A gini coefficient of zero means perfect equality, while a coefficient of 1 implies perfect inequality. Countries with a gini coefficient of 0.5 and above are considered to have high levels of income inequality.

On the basis of the Human Development Index (HDI)³, Namibia is classified with the *Medium Human Development* countries (UNDP 2003). The difference between the country's GDP per capita rank and rank in HDI is -53, implying inefficiency in the country's performance in translating resources into welfare.

In addition to the high degrees of income inequality, the disparities in the HDI among various socio-economic groups in the country demonstrate the dual nature of the Namibian society, where there are those that enjoy HDI levels of the developed countries, and those disadvantaged ones who are even worse off when compared to average HDI levels for sub-Saharan Africa.

The prominent challenges for the economy remain to be the redressing of inequalities in income and welfare as well as the reduction of the high levels of poverty. The government, through its various policies and interventions is relentlessly working towards ameliorating these problems.

2.4. Disease Pattern

Communicable diseases account for greatest proportion of the disease burden. Diseases such as HIV/AIDS, tuberculosis and malaria have a relatively high incidence. The prevalence of HIV in 2001 was estimated at a little above 20 percent. Likewise, tuberculosis is on the increase, due partly as a result of its association with HIV/AIDS. In 2001, the incidence rate of tuberculosis was estimated at 680 per 100,000 population. Malaria is also posing a major problem. The disease is endemic in the Northern parts of the country. The annual incidence rate of the disease is estimated at 225 per 1000 population.

The main five causes of mortality in public hospitals are: HIV/AIDS (15%), pulmonary tuberculosis (13%), diarrhoea (12%), malaria (11%) and pneumonia (8%). The main causes of morbidity include diarrhoea (8%), tuberculosis (6%), pneumonia (6%), HIV/AIDS (5%) and malaria (4%). In 2001/02, about 23,944 outpatients were seen in public hospitals and the total number of inpatients was 187,982 for the same period (HIS, 2000).

Non-communicable diseases are also on the increase along with communicable diseases. Hospital statistics indicate that conditions such as cancer and cardiovascular problems are among the top causes of death. This creates an additional burden to the country's health system, which is already overstretched by emerging and re-emerging communicable diseases.

Under-five child malnutrition is also one of the major health problems in the country that needs attention. The prevalence of stunting (low height-for-age) is estimated at about 24% (MOHSS 2000). A breakdown of the average prevalence of stunting by various

³ The Human Development Index (HDI) is a composite measure composed of the GNP per capita, longevity, level of literacy and school enrolment. It measures average achievements in basic human development. It ranges from zero to one.

variables such as geographical location and mother’s level of education shows striking differences between groups highlighting the prevalence of significant inequities in health. For example, the rate of stunting in children whose mothers have no education is more than twice that of children whose mothers have completed secondary school and above.

2.5 Organization of services

The country’s health policy is based on the principles of the Primary Health Care (PHC) approach that include equity, community involvement and inter-sectoral collaboration. The central level Ministry of Health and Social Services plays a stewardship role – it is entrusted with the formulation of policies and strategic plans, resource mobilization and allocation and external relations. There are 13 Regional Management Teams (RMTs) that oversee service delivery in a total of 34 health districts. The clinic is the entry point in the delivery of health services. The distribution of health facilities is depicted in the following table.

Table 1
Health facilities by type

Facilities	Number
National referral hospital	1
Intermediate hospital	3
District hospitals	30
Health centers	37
Clinic	259
Outreach points	1150

As can be seen from Table 1, while there are about 7 clinics for each health center, the number of hospitals and health centers is almost equal.

In addition to the public sector health facilities, there are private for-profit hospitals and clinics that mainly cater for the urban population. There are about 12 private hospitals with a bed complement of 640, comprising about 9% of the total hospital beds in the country.

2.6 The Public Hospital Sector

The provision of health services in Namibia is split between three main providers – Government (70-75%), missions (15-20%), and the private sector (5%). The missions (Lutheran, Roman Catholic and Anglican) are not-for-profit providers, and predominantly work in rural areas. They are 100 percent subsidized by the Ministry of Health and Social Services. The for-profit private sector is mainly urban-based, providing health care from eleven medium-sized private hospitals and from private pharmacies, doctors’ surgeries and nursing homes.

Three intermediate/referral hospitals have been designated in Oshakati, Rundu and Katutura, while the Windhoek Central Hospital performs the role of overall National Referral hospital. This referral hierarchy is expected to augment efficiency and improve the rational use of scarce resources.

2.7 Utilization of and access to services

It is estimated that about 80% of the population lives within 10 km distance from public health facilities. However, a cut-off distance of 10 km for indicating physical access to any form of health facility is too large. It would be worthwhile to have a smaller cut-off point (such as a radius of 5 km) for an increased geographical access. Thus, expectedly the proportion of the population that is within a distance of about 5 km from a health facility will be much less than the 80% stated above.

However, as stated earlier, with a population density of only 2 persons per square kilometer, diseconomies of scale and size are likely to be widespread, thus inflating the costs of running a health facility. In turn, this scale inefficiency is likely to constrain the amount of resources available for taking the facilities close to the people. This problem has necessitated the establishment of outreach services/mobile clinics.

The country's input-to-population ratios are good by the standards of sub-Saharan Africa. These are shown in Table 2 below.

Table 2
Input-to-population ratios 2000/2001

Input category	Number	Per 100 000 population
Doctor	528	30
Pharmacist	155	9
Dentist	89	5
Radiographer	50	3
Registered nurse	2719	153
Physiotherapist	47	3
Occupational therapist	34	2
Social worker	197	11
Health inspector	70	4
Hospital bed*	6,742	379

Source: Draft Ten Year Strategic Human Resource Plan

*Essential Indicators Report 2000/01 (MOHSS) and for public sector only

The average ratios described above, however, do not reveal the reality. There is a wide inter-regional variation that typifies the duality of the Namibian society. Reference to two regions of the country clearly illustrates this fact. Whereas a doctor serves for only 3,000 people in Khomas (a region where the capital city is located), there are more than 22, 000 people per physician in the Ohangwena Region. The same trend holds true for the other health resources such as nurses and health facility beds.

An average per capita visit to a health facility of 1.5 is registered for the period 1995-99 (el Obeid *et al* 2001). Although this might look favourable compared to those of most African countries, it falls short of the visits per capita of 2.5 that is often recommended within the context of developing countries. It has to also be noted at this juncture that these average figures conceal a lot of useful information, which is necessary to evaluate existing health policies and plans in terms of their equity implications. Disaggregating by measures of socio-economic status (e.g. income quintile, education, area of residence *etc*) may give a better informative picture. Utilization of selected preventive services is given in Table 3 below.

Table 3
Utilization of selected preventive services and their trends

Service	Value	
	1992	2000
Immunization coverage, children 12-23 months (%)	58	65
Contraceptive prevalence (%)	23.3	37.8
Antenatal care, provided by doctor/nurse (%)	87	91
Assistance at delivery, by doctor/nurse (%)	68	78
Women who received at least one dose of tetanus toxoid (TT) (%)	61	85

Source: DHS, MoHSS 2000

From the above table it can be discerned that there was a significant increase in the utilization of preventive services over the period noted. However, a breakdown of the data by various attributes of the population exhibits some striking difference in utilization and that reliance only on the above average figures might not give a picture of the whole situation. For example for TT, while the rate for those women who have completed education of secondary school and above is 99%, the figure for those with no education is only 60%. Similarly, by area of residence, whereas the figure for TT coverage is about 97% for urban areas, it is only 78% for rural women. Similar trends are seen in the other measures presented in the above table, albeit to differing magnitudes.

3. BASIC CONCEPTS AND METHODS OF HOSPITAL EFFICIENCY MEASUREMENT

3.1. Definitions

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

The concept of efficiency is used widely. However, its definition is frequently confused. It may mean different things to different people. To some it means a mere *cost-cutting*, while to others it may be equated to effectiveness, which is about achieving outcomes regardless of the resource levels consumed during the process. Still to others efficiency is regarded as synonymous to productivity, which is simply defined as the ratio of outputs to inputs. It is, thus imperative to define basic terms related to efficiency so as to have a clear understanding of the gist of the current report.

3.1.1. Technical efficiency

The efficiency of any production unit including hospitals has two components:

- i. Technical efficiency; and
- ii. Allocative efficiency.

Technical efficiency (TE) refers to the ability of a hospital to produce maximum output that is feasible from a given level of inputs (i.e. maximizing output from a given level of inputs). This definition has an output orientation. When using input orientation, TE may be defined as *minimizing* input/resource use for a given level of outputs. These two versions of the definition address the following two questions:

Output-orientation: *by how much could output quantities be expanded without changing the quantity of inputs used?*

Input-orientation: *by how much could input quantities used be reduced without changing the quantity of outputs produced?*

Technical efficiency focuses on input and output quantities. It does not consider input and output prices. A hospital is technically efficient if its production is located on an *isoquant*⁴ (or production possibility frontier).

⁴ Combination of inputs that yield the same output

3.1.2. Scale efficiency

The size of a hospital may sometimes be a cause for inefficiency. A hospital may be too large for the volume of activities that it is conducting; and therefore may experience *diseconomies of scale*.⁵ On the other hand, a hospital may be too small for its level of operation, and thus experience *economies of scale*.⁶

3.1.3. Allocative efficiency

A hospital experiences allocative efficiency if it produces the correct combination of outputs (e.g. inpatient/outpatient services, minor/major operations, preventive healthcare services *etc*) using the correct mix of inputs given input prices. Thus, in contrast to technical efficiency, allocative efficiency takes into account the budget constraint that the hospital faces. In technical parlance, a hospital is allocatively efficient if it produces at the point where the isoquant is tangential to the *isocost (budget) line*.⁷

3.1.4. Productivity

Productivity is the ratio of output to input. In other words, it is output per unit of input. Some examples in the health sector include: outpatient visits per physician, child deliveries per midwife, radiographic tests per radiographer, and patients per bed (these can be expressed per day, per month, year *etc*).

3.2. Measuring technical efficiency

The performance of hospitals can be measured using ratios that mainly measure capacity utilization or frontier techniques such as *data envelopment analysis* (DEA). The following sections will give a brief description of the various ratios and DEA.

3.2.1. Ratios

Ratio analysis involves the piecemeal examination of different key measures, such as average cost per inpatient day, bed occupancy rate or cost per child immunized. Although easy to use, ratios are only meaningful and easy to understand in single input, single output situations. Difficulties emerge when multiple inputs and/or outputs are involved and have conflicting indications. For example, a hospital may have a relatively lower cost per child delivery, but higher cost per a specific surgical operation (for

⁵ In the presence of diseconomies of scale, a hospital is inefficiently large. Unit costs increase as the scale of production increases. Diseconomies of scale may arise due to problems such as red tape, poor communication and poor labour relations that are often encountered in large organizations.

⁶ In the presence of economies to scale a hospital is inefficiently small. Unit costs decrease as the scale of production increases, thus inefficiently small hospital may improve its efficiency by increasing its size. Economies of scale may occur as a result of staff being able to specialize in their areas of expertise, the ability to spread overhead costs over a larger number of output units, discounts from bulk-buying of supplies and the ability to use expensive diagnostic equipment at full capacity.

⁷ The alternative combinations of two different goods that can be purchased with a given income and given prices of the two goods

example, appendectomy) as compared to other hospitals in the group. This makes inter-hospital comparison very difficult, because one hospital does not excel on all measures. Comparisons of multiple outputs by means of ratio analysis require *a priori* weights and/or standardizing measurement to get an overall indicator. The arbitrariness and pre-determination of these weights and standardization has often been questioned (Huang 1989). An exposition of some performance indicator ratios commonly used by hospitals is presented in the following section.

i. Average length of stay

This measure refers to the average number of days that a patient stays in a hospital. It is calculated using the following formula:

$$ALS = \frac{\textit{inpatient days}}{\textit{admissions}} \tag{1}$$

This study focuses on a relatively homogeneous group of district hospitals that are assumed to have a similar case-mix. Hospitals with ALS lower than that of their peers are regarded as performing well relative to those with higher ALS.

ii. Bed occupancy rate (OCC)

The occupancy rate is a measure of utilization of the available bed capacity. It indicates the percentage of beds occupied by patients in a defined period of time, usually a year. It is computed using the formula:

$$OCC = \frac{\textit{patient days}}{\textit{bed days}} \times 100 \tag{2}$$

Where,

$$\textit{patient days} = \textit{admissions} \times \textit{ALS} ; \text{ and}$$

$$\textit{bed days} = \textit{number of beds} \times 365 \text{ (i.e. the number of days in a year)}$$

This is a method commonly used in assessing hospital performance. Barnum and Kutzin (1993) suggest that hospitals would be operating efficiently at an occupancy rate of 85-90 percent.

iii. Bed turnover ratio (BTR)

The turnover ratio is a measure of productivity of hospital beds and represents the number of patients treated per bed in a defined period of time (usually a year). It is computed as:

$$BTR = \frac{\textit{total patient admissions}}{\textit{number of beds}} \tag{3}$$

Turnover ratio in acute care hospitals is expected to be higher than in chronic care hospitals. It is also expected to be higher in lower-level hospitals as compared to higher-level ones.

iv. Turnover interval (TI)

This is a measure that is related to the BTR. It measures the average time that beds are unoccupied between successive patients. It is computed using the following formula:

$$TI = \frac{365}{BTR} - ALS \quad (4)$$

The ideal turnover interval is suggested to be 1-3 days.

v. The Pabón Lasso (PL) technique

It has to be stressed that an assessment based on only one of the aforementioned ratios of hospital bed-capacity utilization may be flawed and misleading. Thus, it becomes necessary to make use of all indicators simultaneously so as to have a better picture. To this end, the method devised by Pabón Lasso (1986) is useful.

The PL technique is a graphical method that makes use of the three indicators (BTR, OCC and ALS) concurrently in assessing the relative performance of hospitals. In this method, the occupancy rate (horizontal axis) is plotted against the turnover ratio (on the vertical axis), with vertical and horizontal lines dividing the diagramme into four zones. The horizontal and vertical demarcations represent the mean values of the turnover ratio and occupancy rate. It follows from the functional relationship of the three measures that the slope of the line linking the origin to any of the observations (any point on the graph) represents the reciprocal of the ALS of the hospital under consideration. Figure 2 represents the possible features of hospitals located in each of the four zones.

Figure 1
Pabón Lasso technique

Bed turnover (patients/bed)	<u>Zone II (high BTR, low OCC)</u>	<u>Zone III (high BTR, high OCC)</u>
	<ul style="list-style-type: none"> • Excess bed capacity • Unnecessary hospitalisation • Many patients admitted for observation • Predominance of normal deliveries 	<ul style="list-style-type: none"> • Good quantitative performance • Small proportion of unused beds
	<u>Zone I (low BTR, low OCC)</u>	<u>Zone IV (low BTR, high OCC)</u>
	<ul style="list-style-type: none"> • Excess bed supply • Less need for hospitalisation • Low demand/utilization 	<ul style="list-style-type: none"> • Large proportion of severe cases • Predominance of chronic cases • Unnecessarily long stays
	Occupancy rate (%)	

From the above figure, it can be seen that Zone III, which has relatively high levels of bed occupancy and turnover is the most desirable situation. Zone I is the least desirable. The setting of the cut-off points at the mean values of the BTR and OCC may be contentious. However, Pabón Lasso (1986) also suggests using other cut-off points (e.g. allowing a margin of one standard deviation from the mean).

vi. Average cost per patient day equivalent

Patient day equivalent (PDE) is defined as the number of inpatient days plus one-third the number of outpatient and casualty visits. This is based on the assumption that an inpatient day consumes three times as much resource as an outpatient visit (McIntyre 1995). This measure has been used in hospital performance studies in South Africa. The PDE is expressed using the formula shown below.

$$PDE = \textit{inpatient days} + \frac{1}{3} \textit{outpatient visits} \tag{5}$$

Hospitals with a lower cost per PDE are regarded as more efficient than their peers with higher cost per PDE. Unit costs are expected to decrease as one moves down the gradient of hospital levels (McIntyre *et al* 1995).

3.2.2 Data envelopment analysis

Data envelopment analysis (also called *frontier analysis*) was first introduced by Charness *et al* in 1978 for measuring the relative efficiency of organizations such as hospitals and schools, which lacked the motive of profit maximization that characterizes private enterprises. However, since its introduction, its use has been expanded for a variety of uses in both public and private (for-profit) institutions.

In DEA, the efficiency of an organization (district hospital in this case) is calculated 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 and not a value fixed by hospitals outside of the group. The basic DEA model assists Health Management Teams and planners to find answers to questions such as:

- Which district hospitals (or hospital departments) are the most efficient?
- If all district hospitals are to perform according to best practice (i.e. the efficient peer hospitals), by how much could inputs/resources be reduced to produce the current output levels; or alternately, by how much could outputs be increased with the current input levels.
- What is the optimum size of each district hospital, and how much resources can be potentially saved if all district hospitals are operating at an optimum scale?
- Which of the efficient district hospitals can serve as role models for the inefficient ones (so that their organization of work can be emulated)?

Data envelopment analysis uses the linear programming technique⁸ to compute the efficiency scores of each hospital. Hospitals that are technically efficient (producing on the frontier) have a score of 1 or 100%, whereas inefficient hospitals have efficiency scores of less than 1 (i.e. less than 100%).

DEA has the following main advantages:

- It easily accommodates multiple inputs and outputs without the requirement for a common denominator of measurement. This makes it particularly suitable for analyzing the efficiency of hospitals that use many inputs to produce many outputs, and where it is sometimes difficult to assign prices to many of their outputs.
- It provides specific input and output targets that would make an inefficient hospital relatively efficient. Furthermore, it identifies efficient "peers" for those hospitals that are not efficient. This helps the inefficient hospitals to emulate the functional organization of their peers so as to improve their efficiency.
- It helps to identify both the levels and sources of inefficiency, thus providing guidance on remedial actions to be taken.

⁸ See Appendix 1 for the formulation of the mathematical (linear programming) model.

However, like many empirical methods, DEA has the following main limitations:

- It produces results that are very sensitive to measurement error. For example, if one hospital's inputs are understated or its outputs overstated, it can become an outlier and significantly reduce the efficiency of other hospitals.
- DEA measures efficiency relative to the best practice within hospitals in the particular sample. Therefore, it is not possible to compare how district hospitals in Namibia fare relative to their counterparts in South Africa or Zimbabwe with respect to technical efficiency.

In conducting a DEA study of hospitals, it is important to seek answers to two key conceptual questions:

- What are the hospitals that we plan to assess?

DEA compares hospitals to one another (i.e. the efficient frontier is decided by best practice from the group). Therefore, it is mandatory that the hospitals be engaged in similar set of operations. For example, it would be erroneous to include specialized hospitals in the same study sample with district hospitals, as they differ in their scope of operations (e.g. case-mix).

- What are the inputs and outputs?

Specification of the inputs and outputs is the second important question that has to be addressed, as the distribution of efficiency is likely to be affected by the type and number of inputs and outputs.

To test for the robustness of the DEA technical efficiency measures, the jackknife analysis is used. This technique helps to assess if there were extreme outliers, which affected the frontier and efficiency scores. In the jackknife analysis, a limited number of samples are obtained by omitting one observation at a time (Efron 1982). In this case each efficient hospital is dropped one at a time from the analysis and the efficiency scores re-estimated. The similarity of the efficiency rankings between the model with all the hospitals included and those based on dropping each efficient hospital one at a time is tested by using the Spearman rank correlation coefficient. A correlation coefficient of 1 implies that the rankings are exactly the same. A value of 0 indicates the absence of relation between the rankings and reverse ranking is implied by a value of -1.

DEA has recently gained currency in assessing the efficiency and productivity of hospitals in the public sector. However, its use in sub-Saharan Africa has been very limited.

4. Study methodology

4.1 Sampling

The study focuses on the 30 public sector district hospitals in Namibia, inclusive of mission hospitals. In other words, the entire population of district hospitals is included in the study. The hospitals are distributed over the 13 regions of the country.

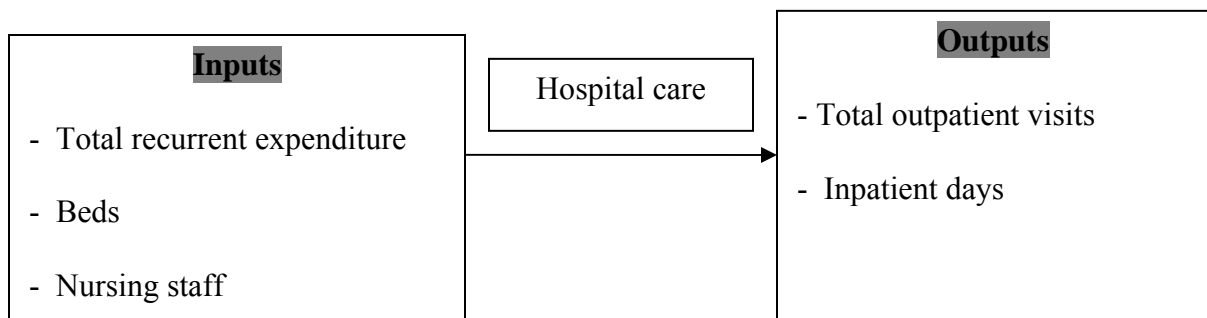
Efficiency measurement can only be meaningful when hospitals are compared with their peers; hence the intermediate and national referral hospitals are not included.

4.2 Inputs and outputs

Improved health status is the ultimate output of hospitals or the health care system at large. However, due to the difficulty in accurately measuring improvements in health status, hospital output is measured by an array of intermediate health services that supposedly improve health status (Grosskopf and Valdmanis 1987). Hospital outputs are categorized as total outpatient visits, inpatient days, surgical operations (major and minor), diagnostic tests (lab, x-ray) and preventive care (immunization).

Inputs in the hospital production are classified as human resources, total recurrent expenditures and the number of beds. The human resources can be classified into various professional groupings such as physician, nurse and administrative staff. The total recurrent expenditure is inclusive of salaries of personnel, expenditure on drugs and expenditure on other goods and services. The figure below depicts the inputs – outputs used for analysis.

Figure 2
The empirical model



4.3 Data collection

Data was collected using a questionnaire that included information on inputs, outputs and other factors that are likely to influence the efficiency and productivity of hospitals. Data on inputs and outputs was required for the financial year period 1997/98 – 2000/2001.

The questionnaire was forwarded to the 30 district hospitals through the regional management teams for the respective principal medical officers to provide the necessary information.

4.4 Data analysis

The technical efficiency scores are computed using data envelopment analysis programme, version 2.1 (DEAP 2.1) designed by Coelli (1996). Hospital utilization ratios are also used to compare with the DEA technical efficiency scores.

5. Results

5.1 General description

Out of a total population of 30 district hospitals, data for 26 hospitals were complete in the variables required for the analysis. The findings indicate that there is a wide variation in the size of district hospitals as measured by the authorized number of beds. The mean number of beds is 130 (SD = 78), with small fluctuations from one year to the other. The range is between 40 and 450 beds for Okahandja and Onandjokwe hospitals respectively.

Similarly there is a wide gap in the recurrent expenditure, the hospital with the highest allocation (Onandjokwe) receiving ten times more than that of Karasburg hospital, which receives the least. A similar trend is also observed in the number of nursing staff. Onandjokwe hospital has a nursing staff complement of more than ten- fold compared to that of Andara with the lowest nursing staff. The number of nursing staff per ten beds also manifests striking differences between the highest and the lowest ratios. Tsandi hospital has 11 nursing staff per ten beds while Andara has only two. With respect to the number of physicians the same applies. Table 3 below presents summary statistics for the relevant variables for the FY 2000/01. For the FY 1997 – 2000 they are given in appendix 2.

Table 4
Summary statistics for 2000/01

Variable	Mean	SD	Minimum	Maximum
Recurrent expenditure N\$	12,038,075	8,304,679	4,557,855	45,227,355
Beds authorised	130	78	40	450
Nursing staff	68	48	22	261
Physician	4	3	1	20
Outpatient	30,780	27,501	2,104	97,998
Inpatient days	37,372	36,875	8,579	183,654

From the above table, it appears that there is no homogeneity in the size and resource profile of the district hospitals. Hospitals like Onandjokwe may well fit into the category of intermediate hospitals.

5.2 Capacity utilization ratios

There is a wide variation in the performance of the hospitals as measured by the indicators: bed occupancy rate, bed turnover ratio, turnover interval, average length of stay and cost per patient day equivalent.

For the FY 2000/01 wide fluctuations were observed among the hospitals in terms of the above-mentioned indicators. For example, the bed occupancy rate ranged between 18% and 135% (mean = 67%, SD = 28). Thus, while some hospitals are seriously under-

utilised (a greater proportion of their capacity remaining idle), others are over-utilized. It should be noted that under normal circumstances, occupancy rate should not exceed 100%, as we can only produce within our means. An occupancy rate of more than 100% may imply that the actual number of beds is more than the number of authorized beds reported. Table 5 below presents the aggregate bed occupancy rates for the period covered.

Table 5
Bed occupancy ratios

Year	Mean	SD	Minimum	Maximum
1997/98	55	19	17	98
1998/99	58	21	10	103
1999/00	57	23	8	107
2000/01	67	28	18	135

As can be seen from the above table the overall mean occupancy rates are low compared to the recommended 85 – 90% occupancy rate (Barnum & Kutzin 1993). In all the FY's about half of the hospitals had bed occupancy rates that are less than the averages for the group. It is interesting to note occupancy rates that are less than 10% signifying serious underutilization. Appendix 3 highlights the capacity utilization ratios for all the district hospitals for the FY 1997 – 2001.

The bed turnover ratio for the period under review shows similar fluctuations. The turnover ratio fluctuated from 9 (Khorixas) to 73 (Outapi). Over the reporting period, these two hospitals had the lowest and highest turnover ratios respectively. Table 6 presents the aggregate turnover rate for the four years.

Table 6
Bed turnover rate

Year	Mean	SD	Minimum	Maximum
1997/98	32	13	9	73
1998/99	33	15	7	87
1999/00	33	13	9	64
2000/01	38	15	9	73

From the above table it can be seen that there was a gradual increase in the mean turnover ratios. More than half had turnover ratios that are below the group means implying that many of them may have high average length of stay and / or a very low demand for beds (thus beds are most of the time unoccupied).

The turnover interval ranges from -2 (Outapi) to 34 (Khorixas). As turnover interval measures the average time that beds are unoccupied between successive patients, the minimum turnover intervals indicated in Table 7 below imply that there was no time interval between admission and discharge of patients.

Table 7
Turnover interval

Year	Mean	SD	Minimum	Maximum
1997/98	8	9	0	40
1998/99	7	9	0	49
1999/00	7	7	0	35
2000/01	5	6	-2	34

The ideal turnover interval is suggested to be 1 – 3 days. However, Namibia’s averages as seen above are remarkably higher than the suggested norm. There is a wide fluctuation among the hospitals as indicated by the range. Khorixas hospital has consistently shown maximum turnover interval that is much higher than the group means.

The average length of stay ranges from 3 to 12 days. The mean for the average length of stay has remained constant over the reporting period as shown in the table below.

Table 8
Average Length of Stay

Year	Mean	SD	Minimum	Maximum
1997/98	7	2	2	10
1998/99	7	2	2	12
1999/00	6	2	2	12
2000/01	7	2	3	12

It is expected for district hospitals to have a low average length of stay given the type of patients that they treat. A significant proportion of hospitals had an average length of stay that is higher than the mean.

The cost per patient day equivalent ranges from N\$ 78 (Oshikuku) to N\$ 715 (Keetmanshoop) for 2000/01. Keetmanshoop hospital also had the highest cost per PDE in FY 1999/2000.

Table 9
Cost per PDE (N\$)

Year	Mean	SD	Minimum	Maximum
1997/98	219	108	45	468
1998/99	226	131	90	603
1999/00	275	154	81	675
2000/01	306	165	78	715

In all four financial years a wide fluctuation is seen in the cost per PDE range. All hospitals with the highest cost per PDE had occupancy rates that were below the group averages.

Capacity utilization ratios as described in 3.2.1 have some pitfalls. Hence there is a need for using robust frontier method. The findings from a DEA model are presented in the following sections.

5.3 Technical efficiency results from DEA model

The CRS DEA models for the four years included in the study indicate marked deviations from the best-practice/efficient frontiers. Average Efficiency scores for the four years, 1997/8 – 2000/1, range from 70.1 to 78.3%. This indicates the presence of significant amounts of inefficiency that are attributable to both pure technical and scale inefficiencies. There are inefficiency levels ranging between 28 - 43%, i.e. if the inefficient hospitals were to operate as efficiently as their peers on the best practice frontier, the health system could have saved the amount of resources used by about 28-43%. The efficiency scores obtained are robust as indicated by Spearman rank correlation coefficient, which is very close to one.

The average CRS efficiency scores for the four years under consideration are given in Table 10 below.

Table 10
CRS DEA efficiency scores, 1997/8 - -2000/1

Constant returns to scale (CRS)						
Year	Mean efficiency score (%)	SD	Min %	Max %	Total number of hospitals	Hospitals on frontier
1997/1998	71.6	28.8	11.9	100	20	7
1998/1999	74.3	26.8	7.3	100	24	8
1999/2000	62.7	25.3	6.2	100	26	3
2000/2001	66.9	27.4	28.9	100	26	4
Variable returns to scale (VRS) technical efficiency (pure technical efficiency)						
1997/1998	87	20.2	32.1	100	20	11
1998/1999	88.8	18.2	22.6	100	24	13
1999/2000	85.2	18.7	43.9	100	26	9
2000/2001	85.7	16.6	44.3	100	26	8
Scale efficiency						
1997/1998	81.1	24.4	15.3	100	20	8
1998/1999	83.7	22.6	7.3	100	24	9
1999/2000	73.2	22.3	7.8	100	26	3
2000/2001	76.8	24.9	57.2	100	26	5

The CRS technical efficiency scores in the above table indicate that in all the years considered, less than half of the district hospitals are located on the frontier (i.e. have technical efficiency score of 100% in the group). Furthermore, it is revealed that there are hospitals whose performance is dismally poor. Technical efficiency scores as low as 7.3% are registered. This implies that that specific hospital (Usakos in this case) could have produced its current outputs in terms of outpatient visits and inpatient days with only 7.3% of its inputs (recurrent expenditure, beds and nursing staff), indicating tremendous input savings.

The CRS technical efficiency scores reveal a combined inefficiency that is due to both pure technical inefficiency and inefficiency due to inappropriate hospital size. The table further reveals that scale inefficiency is as equally prevalent as pure technical inefficiency. In the given period of time, *increasing returns to scale* was the predominant form of scale inefficiency.

The above table is, however, a presentation of average values, which do not show the situation of each hospital included in the study. It is therefore very important to present the values for each hospital, as will be done in the forthcoming sections.

In all the four years for which data was collected, Usakos hospital had the lowest performance, with technical efficiency scores in the range of 5.7 – 11.9%. This efficiency score indicates the presence of very high levels of inefficiency – the current use of inputs could have minimized by about 88-94%, which is a very significant amount of efficiency saving. Efficiency scores for each of the hospitals for the period of four years are given in Table 11.

Table 11
CRS efficiency scores by hospital, 1997/8 – 2000/1

Hospital	Technical efficiency score (%)			
	1997/98	1998/99	1999/2000	2000/2001
Andara	90.3	78.6	71.6	100
Eenhana	100	100	100	100
Engela	98.6	100	100	100
Gobabis	100	100	97.1	83.3
Grootfontein	32.9	40.0	33.0	28.9
Karasburg	100	100	74.4	57.2
Katima Mulilo	100	100	100	77.6
Keetmanshoop	45.6	43.7	33.8	39.6
Kongo	73.1	72.4	66.3	52.6
Luderitz	76.5	77.3	65.9	100
Nankudu	74.4		39.4	46.3
Nyangana	100	93.0	78.0	76.0
Okahandja	41.6	48.9	51.5	44.7
Okahao	25.7	75.7	66.7	22.0
Okakarara	52.3	48.3	28.0	37.0
Omaruru		100	50.6	69.6
Onandjokwe	60.3	74.7	62.4	89.7
Oshikuku		98.3	53.9	80.8
Otjiwarongo		77.5	71.2	68.1
Outapi	100	100	95.7	100
Rehoboth		63.3	45.0	60.8
Swakopmund	48.5	49.2	44.3	41.5
Tsandi			64.1	94.8
Tsumeb		34.9	40.2	73.7
Usakos	11.9	7.3	6.2	5.7
Walvis Bay	100	100	90.9	90
MEAN	71.6	74.3	62.7	66.9

N.B.: The shaded areas indicate missing data

Information on technical efficiency is more important for management when it is disaggregated by hospital as is shown in the above table. It can be seen that the technical efficiency scores of some hospitals have been consistently low even when compared to the mean technical efficiency scores for each year. Throughout the four years period, the

following hospitals have consistently shown technical efficiency scores that are below the mean values (Box 1):

Box 1

Hospitals with technical efficiency scores less than the mean values, 1997/8 – 2000/1

Grootfontein
Keetmanshoop
Okahandja
Okakarara
Rehoboth
Usakos
Swakopmund

It has to be emphasised that all hospitals whose technical efficiency scores are less than 100% have some degree of inefficiency. Thus, it has to be noted that the hospitals in Box 1 are not the only hospitals with compromised efficiency. It is only to indicate that they consistently manifest marked inefficiencies that are below the mean technical efficiency scores. Given the high magnitude and consistency of the inefficiency, these hospitals merit close scrutiny.

On the other hand only Eenhana hospital has appeared on the efficient frontier in all four years considered (i.e. technical efficiency score of 100%). Hospitals that have been on the efficient frontier in three out of the four years include: Engela, Katima Mulilo and Outapi.

5.3.1 Scale efficiency

The efficiency score obtained from the CRS model has two components: pure technical efficiency and scale efficiency. The variable returns to scale (VRS) model isolates the pure technical efficiency component. Hospitals that are overall efficient exhibit constant returns to scale, i.e. an increase in all factors of production (inputs: recurrent expenditure, bed, nursing staff) results in a proportionate increase in the volume of outputs (i.e. outpatient visits and inpatient days). For example, if all inputs increase by 1%, outputs will increase by the same 1%. Hospitals with constant returns to scale thus have the required optimal size (scale efficient).

On the other hand, in hospitals with variable returns to scale, a percentage increase in all inputs is not followed by a proportionate increase in outputs. Variable returns to scale has two dimensions: increasing returns to scale (IRS) and decreasing returns to scale (DRS). When a hospital manifests increasing returns to scale, a one percent increase in all inputs will be followed by more than one percent increase in outputs. On the cost side, this denotes the presence of economies of scale. In contrast, when a hospital exhibits decreasing returns to scale, a percentage increase in inputs will result in less than

proportionate increase in outputs. In other words, this denotes the presence of diseconomies of scale.

In all four years increasing returns to scale was the most prevalent cause of technical inefficiency. Increasing returns to scale may be explained by factor (i.e. input) *indivisibility*, which implies that some methods of production can only work on a large scale. The distribution of returns to scale over the four years period is presented in the table below.

Table 12
Returns to scale, 1997/8 – 2000/2001

Year	Number of district hospitals with		
	Constant returns to scale	Increasing returns to scale	Decreasing returns to scale
1997/98	8	9	3
1998/99	9	12	3
1999/00	3	22	1
2000/01	5	18	3

As can be observed from the above table, more than half of the hospitals had increasing returns to scale in the financial years 1999/2000 and 2000/2001. Furthermore, increasing returns to scale was also prevalent in the first two years, although it was not seen in as many hospitals as it was in the later two years. In the presence of increasing returns to scale (which also means economies of scale), average costs of production can decrease if the scale of operation increases. This, in other words, means that efficiency will increase if outputs are increased – being large helps the hospital to attain efficiency in production.

As discussed in Section 3 on definition of efficiency terms, increasing returns to scale (economies of scale) may occur as a result of staff being able to specialize in their areas of expertise, the ability to spread overhead costs over a large number of output units and the ability to use expensive diagnostic/therapeutic equipment at full capacity. In the presence of increasing returns to scale, there are advantages in having fewer, larger hospitals.

The number of hospitals with decreasing returns to scale is relatively small. Hospitals experiencing decreasing returns to scale (diseconomies of scale) will be rendered scale efficient if they decrease their scale of operations. Thus, in the presence of decreasing returns to scale, there are advantages in having many smaller hospitals rather than few larger ones. In all four years, Onandjokwe hospital with 450 beds consistently experienced decreasing returns to scale. Decreasing returns to scale imply that the hospital is too large; its average costs increase with increases in output. Decreasing returns to scale (diseconomies of scale) generally arise as a result of problems such as poor communication that are often seen in large organizations.

By and large, the form of scale inefficiency that is most prevalent is increasing returns to scale (economies of scale/decreasing costs) that may be remedied by having fewer and larger hospitals. Hence, to minimize inefficiencies emanating from small size, there is a need to merge hospitals that are in close proximity so that the hospital resources can be utilized fully and outputs increased so as to reap the economies of scale. This decision may, however, pose problems of access in areas with low population densities. If a few hospitals of larger size are to be established in centrally located places, residents that are far from these large hospitals may have to incur additional costs (e.g. travel expenses) and delayed treatment of emergency conditions. This problem, may however, be addressed to some extent by establishing health centres (or other PHC units) that are linked to the hospitals through an effective referral system.

For a better understanding of the magnitudes of pure technical as well as scale inefficiencies, the results of the variable returns model are presented in the table that follows for all hospitals and time periods under investigation.

Table 13
Technical and scale efficiency scores from Variable Returns to Scale Model

Hospital	Efficiency score (%)							
	1997/98		1998/99		1999/2000		2000/2001	
	Pure technical	Scale	Pure technical	Scale	Pure technical	Scale	Pure technical	Scale
Andara	90.3	99.6 [↓]	78.6	88.6 [↑]	71.6	71.6 [↑]	100	100
Eenhana	100	100	100	100	100	100	100	100
Engela	98.6	98.6 [↓]	100	100	100	100	100	100
Gobabis	100	100	100	100	97.1	97.1 [↑]	83.3	96.4 [↓]
Grootfontein	32.9	76.5 [↑]	40.0	87.8 [↑]	33.0	75.2 [↑]	28.9	65.3 [↑]
Karasburg	100	100	100	100	74.4	74.4 [↑]	57.2	57.2 [↑]
Katima Mulilo	100	100	100	100	100	100	77.6	95.8 [↑]
Keetmanshoop	45.6	100	43.7	100	33.8	76.3 [↑]	39.6	80.6 [↑]
Kongo	73.1	79.2 [↑]	72.4	75.2 [↑]	66.3	66.3 [↑]	52.6	52.6 [↑]
Luderitz	76.5	86.3 [↑]	77.3	79.7 [↑]	65.9	69.3 [↑]	100	100
Nankudu	74.4	74.4 [↑]			39.4	44.5 [↑]	46.3	53.5 [↑]
Nyangana	100	100	93.0	93.0 [↑]	78.0	82.7 [↑]	76.0	85.9 [↑]
Okahandja	41.6	41.6 [↑]	48.9	48.9 [↑]	51.5	51.5 [↑]	44.7	44.7 [↑]
Okahao	25.7	39.6 [↑]	75.7	78.9 [↑]	66.7	85.1 [↑]	22.0	36.8 [↑]
Okakarara	52.3	65.8 [↑]	48.3	56.7 [↑]	28.0	29.7 [↑]	37.0	41.4 [↑]
Omaruru			100	100	50.6	63.7 [↑]	69.6	81.5 [↑]
Onandjokwe	60.3	60.3 [↓]	74.7	74.7 [↓]	62.4	62.4 [↓]	89.7	89.7 [↓]
Oshikuku			98.3	98.3 [↓]	53.9	94.2 [↑]	80.8	98.0 [↓]
Otjiwarongo			77.5	87.6 [↑]	71.2	77.0 [↑]	68.1	83.2 [↑]
Outapi	100	100	100	100	95.7	95.7 [↑]	100	100
Rehoboth			63.3	99.9 [↓]	45.0	78.1 [↑]	60.8	83.7 [↑]
Swakopmund	48.5	85.4 [↑]	49.2	74.3 [↑]	44.3	75.1 [↑]	41.5	70.6 [↑]
Tsandi					64.1	69.3 [↑]	94.8	94.8 [↑]
Tsumeb			34.9	57.3 [↑]	40.2	61.0 [↑]	73.7	77.5 [↑]
Usakos	11.9	15.3 [↑]	7.3	7.3 [↑]	6.2	7.8 [↑]	5.7	7.5 [↑]
Walvis Bay	100	100	100	100	90.9	96.2 [↑]	90.0	99.0 [↑]
MEAN	71.6	81.1	74.3	83.7	62.7	73.2	66.9	76.8

↓ Decreasing returns to scale; ↑ Increasing returns to scale

As can be seen from the above table, hospitals such as Usakos, Onandjokwe, Okakarara, Okahandja and Nankudu suffer from a high degree of scale inefficiency. Increasing returns to scale is observed in all of these hospitals except Onandjokwe that manifests decreasing returns to scale. It has to be noted that these are hospitals with a high magnitude of scale inefficiency compared to pure technical inefficiency. Onandjokwe hospital exhibits scale inefficiency that is related to large size. This is evident from the fact that this hospital commands 450 beds - a bed-size, which is more than four-fold the mean number of beds for this group of district hospitals.

5.3.2 Input savings

Given the levels of inefficiency discussed above, significant input savings are expected from this group of district hospitals. If the inefficient hospitals were to operate as efficiently as their peers on the efficient frontier, the following input savings can be reaped by the health system at large (Table 14):

Table 14
Input savings from district hospitals, 1997/1998 - 2000/2001

Input type	Input saving in the financial year:			
	1997/98	1998/99	1999/2000	2000/2001
Recurrent expenditure (N\$)	27,009,153	43,277,100	66,151,450	73,985,129
Bed	309	411	633	632
Nursing staff	190	212	443	348

As can be seen from the above table, substantial amounts of input savings could have been achieved had the technically inefficient hospitals operated as efficiently as their efficient peers. The saving in recurrent expenditure that could have been realized in the 2000/2001 financial year is equivalent to the amount needed for the construction of 50 clinics. Such a substantial amount of leakage due to inefficiency is likely to have adverse consequences on the government's move towards redressing past inequities, as the amount of resources available would seriously constrain the government's means to do so.

The aggregate input savings in the above table however, do not give the recommended input use levels and efficiency savings at the hospital level. Meaningful and vital information can only be generated when the above table is disaggregated to the micro-level. Hence, Table 15 presents the current and projected input use levels for all district hospitals included in the study.

Table 15
Actual and projected use of inputs by district hospitals 2000/2001

Hospital	Actual Use			Projected use if efficient		
	Recurrent expenditure N\$	Bed	Nursing staff*	Recurrent expenditure N\$	Bed	Nursing staff
Andara	6,399,003	100	22	6,399,003	100	22
Eenhana	6,110,782	120	65	6,110,782	120	65
Engela	10,472,615	230	93	10,472,615	230	93
Gobabis	17,585,703	179	46	7,416,211	132	39
Grootfontein	13,204,369	150	83	5,852,894	66	36
Karasburg	4,557,855	60	35	4,557,855	60	35
Katima Mulilo	8,720,894	220	55	7,067,529	127	44
Keetmanshoop	24,559,609	162	109	6,567,412	79	53
Kongo	11,574,724	62	36	11,574,724	62	36
Luderitz	12,965,559	98	26	12,965,559	98	26
Nankudu	8,283,925	100	29	6,190,158	86	25
Nyagana	8,023,924	120	43	7,096,208	106	38
Okahandja	5,462,188	40	36	5,462,188	40	36
Okahao	10,102,128	100	61	6,051,545	59	36
Okakarara	6,201,724	82	43	5,542,982	73	38
Omaruru	7,065,696	126	43	6,038,266	99	36
Onandjokwe	45,227,355	450	261	45,227,355	450	261
Oshikuku	17,958,186	236	173	14,808,490	194	107
Otjiwarongo	6,841,238	166	89	5,600,984	100	55
Outapi	16,384,141	120	107	16,384,141	120	107
Rehoboth	10,016,535	140	64	7,275,538	101	46
Swakopmund	13,461,015	106	72	6,044,020	62	42
Tsandi	16,384,141	120	107	16,384,141	120	107
Tsumeb	8,979,742	76	56	7,081,201	72	53
Usakos	6,654,390	63	48	5,091,329	48	35
Walvis Bay	17,134,381	110	81	7,083,563	100	64

• All nursing categories

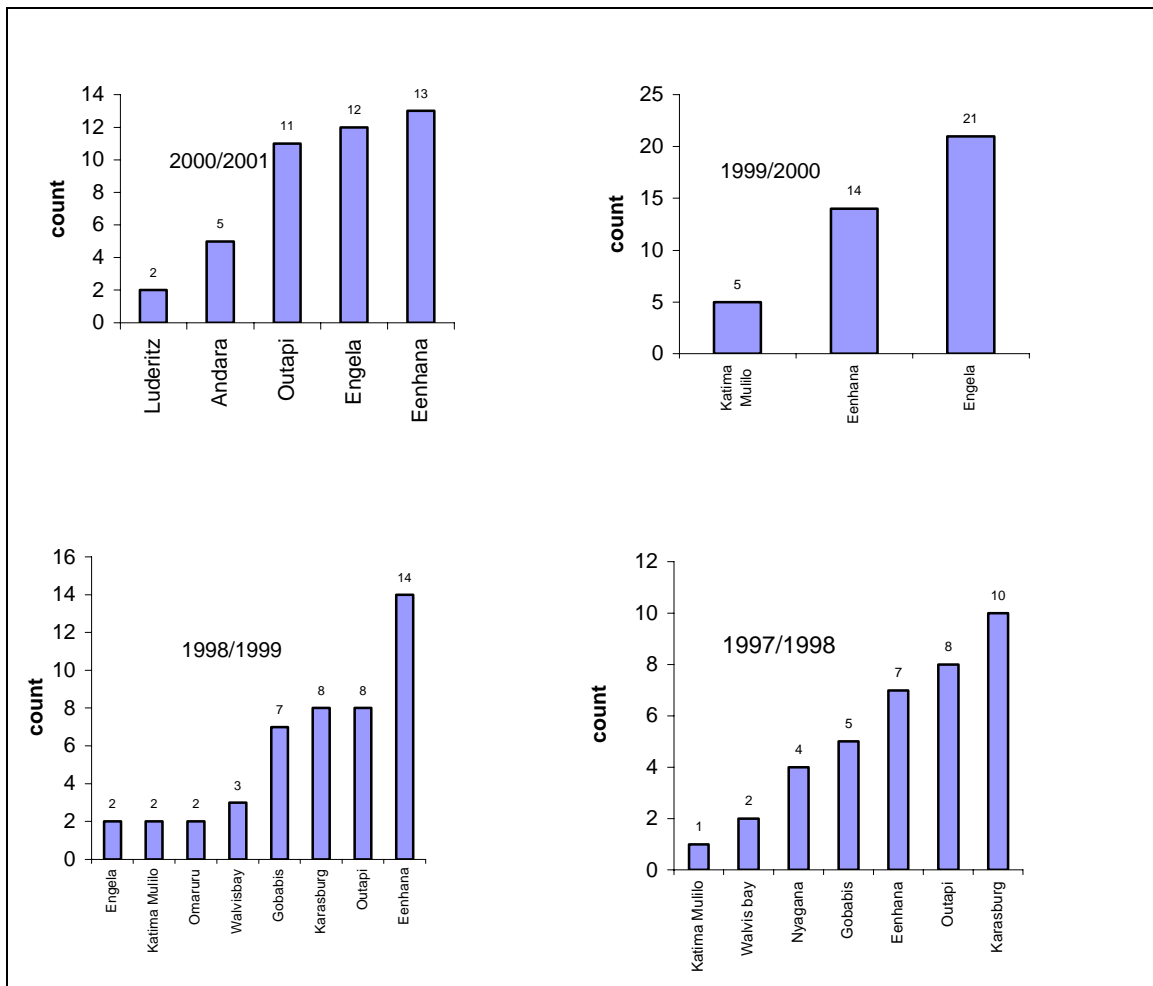
The above table presents information that is very useful for decision-making process as it clearly indicates the recommended use of inputs given the levels of output produced. A list of actual and projected use of inputs by district hospital for FY 1997 - 2000 is given in Appendix 4.

5.4 Best-practice hospitals

In data envelopment analysis, the frontier against which the technical efficiency of all hospitals is measured is defined by those hospitals in the group with a technical efficiency of 100%. In other words, those hospitals producing on the efficient frontier

define the best practice and thus can be taken as role models to be emulated by the other hospitals. For each inefficient hospital, the DEA model identifies efficient hospitals that act as suitable units for comparison. The inefficient hospitals are expected to learn from their efficient peers by observing how they operate. The figure below presents the peer count summary, i.e. the number of times an efficient hospital is a peer for others.

Figure 3
Peer count summary of the efficient hospitals



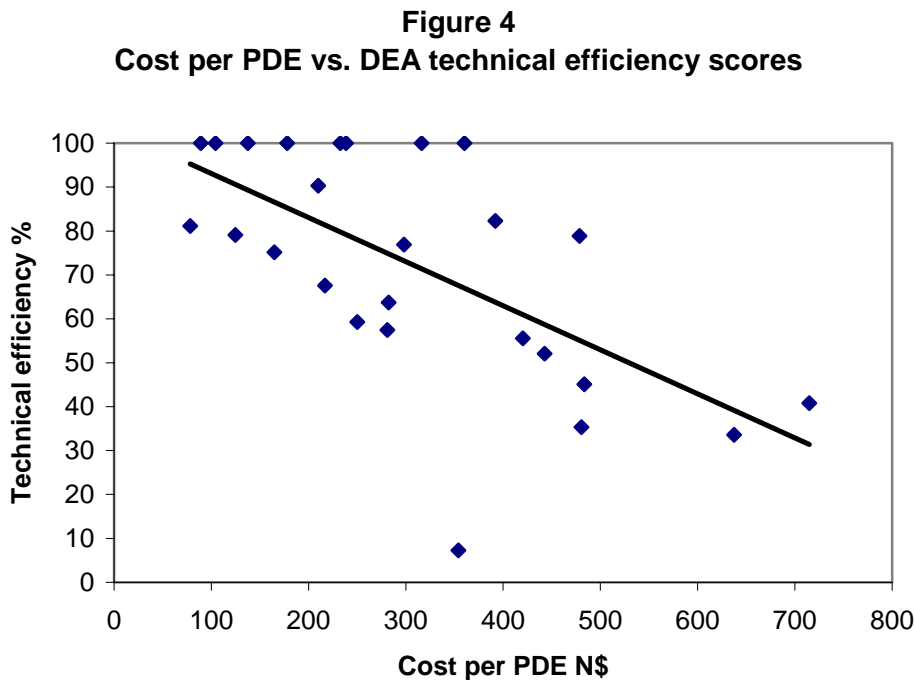
* Number of times that each efficient hospital is a peer for another (i.e. it defines best practices for those inefficient ones that it is a peer).

A hospital identified as peer by many other hospitals may be a “center of excellence” in terms of efficiency (Hollingsworth and Parkin 1998). It can thus be seen from the above figure, Engela hospital was worth learning from in 2001/2002, as it featured as a peer for 18 of the 26 hospitals considered in the study. Walvis Bay hospital has consistently been one of those with a relatively higher number of peer counts throughout the period under consideration. Hence, it is worthwhile for many of the inefficient hospitals to learn from hospitals such as this one on how they conduct their day-to-day operations. A list of peers for each of the inefficient hospitals is given in Appendix 5.

5.5. DEA vs. ratio methods

5.5.1 DEA technical efficiency vs. cost per patient day equivalent (PDE)

It is important to validate commonly used ratio measures of efficiency with those obtained from more advanced measures of efficiency such as data envelopment analysis, as they are easy to compute and do not require a specialized expertise. One of the measures that were used to compare the hospitals with respect to their performance was PDE. The following figure depicts the relationship between DEA technical efficiency scores and PDE.

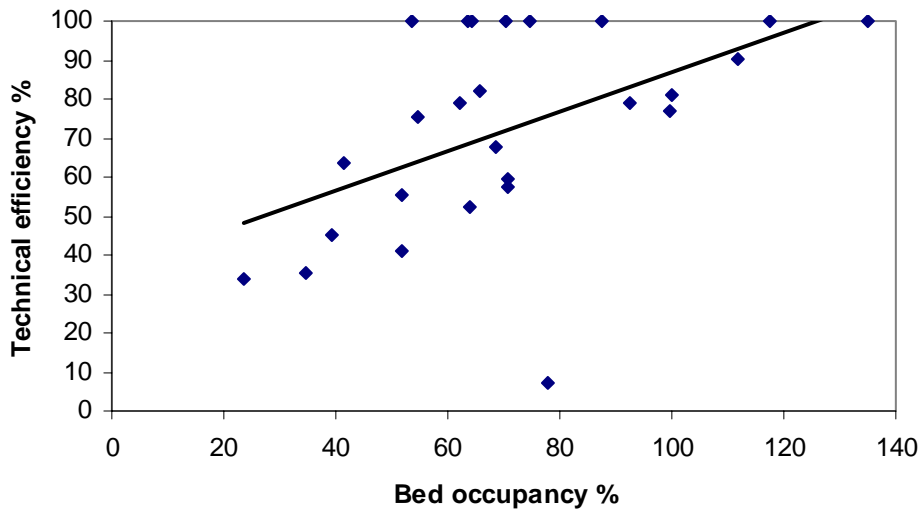


It is seen from the above figure that the costs per inpatient day equivalent and DEA efficiency scores have the expected negative relationship. This implies that when cost per inpatient day equivalent increases, technical efficiency decreases. The correlation coefficient between the two measures is -0.64 ($p=0.004$), which is statistically highly significant. Hence, in the absence of expertise to undertake DEA or other frontier techniques (e.g. stochastic frontier models), it seems that ratios such as cost per PDE may be helpful. However, it should clearly be noted that such ratios are not real measures of technical efficiency, and are just to be taken as proxies.

5.5.2 DEA technical efficiency vs. bed occupancy rate

Bed occupancy rate is a measure of bed capacity utilization that is frequently used by hospital managers to assess performance. In line with expectation, the DEA technical efficiency scores are observed to increase with increases in bed occupancy rate, with a statistically significant correlation coefficient of 0.51 ($p=0.007$). For further clarity the following figure is presented.

Figure 5
Bed occupancy rate vs. DEA technical efficiency



The above figure clearly demonstrates the positive relationship between the two measures as discussed earlier. Other studies using regression analyses have also shown this positive relationship, and that the occupancy rate can be used as a proxy measure for technical efficiency (Zere 2000).

6. Conclusion

The study has attempted to assess the efficiency of district hospitals in Namibia using ratio methods and data envelopment analysis.

Out of a total of 30 district hospitals surveyed, the data required for analysis were complete for 26 hospitals for FY 2000/01 and FY 1999/2000, 24 hospitals for FY 1998/1999 and 20 hospitals in FY 1997/1998.

With regard to capacity utilization the study revealed:

- The presence of a wide variation in the size of hospitals as measured by number of authorized beds. The range is between 40 and 450 beds.
- On recurrent expenditure there is a wide gap between the hospitals- those with the highest allocation receiving eleven times more than those that receive the least.
- The ratios of nursing staff to bed indicate marked differences. While there are 11 nurses per 10 beds in those hospitals with the highest nursing staff complement, there are only 2 nurses per 10 beds in those that are poorly endowed.
- There is a wide variation in the performance of hospitals as measured by capacity utilization ratios (OCC, BTR, TI, ALS and cost per PDE).

Although the emphasis on the analysis was placed on 2000/2001 the above indicators shows the same trend for the other financial years.

The DEA analysis revealed the following

- Average efficiency scores for the four years, 1997/98 – 2000/01, range from 62.7 to 74.3%. This indicates the presence of significant amounts of inefficiency that are attributable to both pure technical and scale inefficiency.
- For the period under review, the CRS technical efficiency scores show that less than half of the district hospitals are located on the frontier.
- In all four years increasing returns to scale was the most prevalent cause of scale inefficiency
- The number of hospitals with decreasing returns to scale is relatively small i.e. 3 hospitals for 1997/98, 1998/99 and 2000/01 and 1 hospital for 1999/2000.
- Substantial amounts of input savings could have been achieved had the technically inefficient hospitals operated as efficiently as their efficient peers. In terms of recurrent expenditure savings are N\$ 27,009,153 (1997/98), N\$ 43,277,100 (1998/99), N\$ 66,151,450 (1999/2000) and N\$ 73,985,129 (2000/2001).
- Eenhana has appeared on the efficient frontier (technically efficient) in all four years considered while Engela, Katima Mulilo and Outapi have been on the efficient frontier in three out of the four years.

The results indicate the potential to improve access and/ or quality of care without injecting additional resources into the health sector. This is important given the financial constraints and the low rate of budget increase to the health sector programmes.

7. Recommendations

The study has revealed the possibility of reaping substantial efficiency gains from district hospitals. The following recommendations are due based on the findings:

- 7.1 In order to reap efficiency gains, it is imperative for the inefficient hospitals to operate as efficiently as their peers. Hence, it is important that the inefficient hospitals emulate the way that those relatively efficient (best-practice) hospitals conduct their business. The DEA model gives a list of peers (role models) from the efficient hospitals for each inefficient hospital, and therefore, explicitly indicates which hospital should learn from which.
- 7.2 Scale inefficiency is found to be widespread. The predominant form of scale inefficiency is *increasing returns to scale*. To improve efficiency in the presence of increasing returns to scale, it is important to consider merger of hospitals that are in close proximity to one another. Having fewer and bigger hospitals in centrally located areas and scaling down some of the hospitals to lower-level facilities (e.g. health centre) is an option that needs to be explored. This should be associated with the establishment of an efficient referral system. It should, however, be noted that this can only be done after reviewing the situation on the ground and taking other issues (e.g. equity) into consideration.
- 7.3 On the other hand, inefficiency related to large size (decreasing returns to scale) is observed in a few hospitals (namely Onandjokwe and Oshikuku). In such a situation, there is a need to break down such hospitals into a manageable size. For example, Onandjokwe hospital with 450 authorized beds is way above the expected size of district hospitals.
- 7.4 The data provide a skewed distribution of the resources (recurrent expenditure, health personnel and beds) available to the hospitals. This variability implies that the district hospitals lack some degree of homogeneity. Therefore, it is important that there should be a standard resource and activity profile of district hospitals. This may necessitate the re-classification of the hospitals. For example, hospitals such as Onandjokwe are no less than intermediate hospitals and therefore their scope of operation needs to be widened accordingly so as to make the best use of the available resources.
- 7.5 Gaps in data are a serious problem to the establishment of hospital efficiency and capacity utilization indicators that are useful for operational management on an annual basis. It is therefore, essential to design hospital data collection tools with the relevant variables that can be incorporated into the routine Health Information System (HIS)
- 7.6 Finally, given the mammoth task of redressing inequities in healthcare that the country faces on the one hand, and the relatively dwindling healthcare resources (owing to increased needs), it is important that efficiency measures be instituted and

pursued vigorously to utilize the resources at the disposal of the MOHSS. Wastages of high magnitude as suggested by the findings of this study are likely to jeopardize the government's initiatives to redress past inequities in access to healthcare.

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APPENDIX 1

The Data Envelopment Analysis Model

DEA may easily be understood using a ratio form. The efficiency of any decision making unit (DMU) as proposed by Charnes *et al* (1978) may be expressed as:

$$\text{Efficiency} = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}} \quad (1)$$

The optimal input and output weights are obtained by solving the following mathematical programming problem:

$$\text{Max } h_0 = \frac{\sum_{r=1}^s u_r y_{rj_0}}{\sum_{i=1}^m v_i x_{ij_0}} \quad (2)$$

Subject to:

$$\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1, \quad j = 1, \dots, j_0, n$$

$$u_r \geq 0; \quad r = 1, \dots, s$$

$$v_i \geq 0; \quad i = 1, \dots, m$$

Where:

y_{rj} = amount of output r from hospital j

x_{ij} = amount of input i to unit j

u_r = weight given to output r

v_i = weight given to input i

n = number of hospitals

s = number of outputs

m = number of inputs

The above formulation involves finding values for u and v which are most favourable to the hospital being studied and maximizes its efficiency. However, the above non-linear model poses a problem as it has an infinite number of solutions. To avoid this it is converted to a linear programming problem as indicated below.

$$\text{Max } h_0 = \sum_{r=1}^s u_r y_{rj_0}$$

Subject to:

$$\sum_{i=1}^m v_i x_{ij_0} = 1$$

$$\sum_{r=1}^s u_r y_{rj} - \sum_{i=1}^m v_i x_{ij} = 1 \leq 0, \quad j = 1, \dots, n$$

$$u_r, v_i \geq 0$$

The above linear programming problem is solved for each hospital by maximization of the weighted sum of outputs with the restriction that the weighted sum of inputs equals one. A further restriction is that for all hospitals, the weighted sum of outputs minus the weighted sum of inputs must be less than or equal to zero. This implies that all hospitals are on or below the production possibility frontier.

The above model is based on the assumption of constant returns to scale (CRS). This presupposes that hospitals are operating at an optimal scale. However, this may not always hold true. To this end Banker *et al* (1984) developed an extension of the original CRS model (i.e. variable returns [VRS] model)⁹ by introducing into the model a new term that corresponds to an intercept.

⁹ For a detailed discussion, see Banker *et al* (1984); Bjurek *et al* (1990), and the textbook mentioned in section 3.

Appendix 2
Summary statistics FY 1997 - 2000

Variables	1999/00*				1998/99**				1997/98***			
	Mean	SD	MIN	MAX	Mean	SD	MIN	MAX	Mean	SD	MIN	MAX
Recurrent expenditure N\$	9,392,129	5,778,991	3,416,603	29,754,220	8,277,652	5,191,196	2,673,900	22,266,973	7,158,567	4,379,763	1,041,142	20,505,989
Beds authorized	130	78	40	450	129	79	40	450	128	79	40	450
Nursing staff	68	49	26	272	67	48	26	273	66	47	26	262
Physicians	4	3	0	18	3	3	0	16	3	3	0	17
Outpatients	38110	42155	809	172498	38772	39034	1996	139293	32653	39553	2151	135696
Inpatient days	30851	24941	5537	125278	31762	24331	5230	119126	26158	19367	4628	92745

Appendix 3

3.1 Hospital capacity utilization ratios 2000/01

Hospitals	Bed occupancy rate	Bed turnover ratio	Turnover interval	Average length of stay	Cost per PDE	Physicians	Nurses	Authorized beds
Andara	70	34	3	8	138	2	22	100
Eenhana	93	46	1	7	125	3	65	120
Engela	117	50	-1	9	89	6	93	230
Gobabis	66	20	6	12	392	4	46	179
Grootfontein	35	28	9	5	481	3	83	150
Karasburg	71	66	2	4	281	2	35	60
Katima Mulilo	54	36	5	6	165	6	55	220
Keetmanshoop	52	32	5	6	715	5	109	162
Khorixas	18	9	34	8		3	50	127
Kongo	62	57	2	4	479	3	36	62
Luderitz	75	41	2	7	360	3	26	98
Mariental	77	31	3	9		5	49	120
Nankudu	39	24	9	6	484	2	29	100
Nyagana	64	30	4	8	178	4	43	120
Okahandja	64	65	2	4	443	2	36	40
Okahao	24	33	9	3	638	1	61	100
Okakarara	41	23	9	7	282	2	43	82
Omaruru	69	42	3	6	217	4	43	126
Onandjokwe	112	41	-1	10	210	20	261	450
Opuwo	48	34	6	5		4	63	80
Oshikuku	100	40	0	9	78	5	173	236
Otjiwarongo	64	33	4	7	104	4	89	166
Outapi	135	73	-2	7	233	4	107	120
Outjo	18	24	13	3		1	42	92
Rehoboth	71	43	2	6	250	5	64	140
Swakopmund	52	26	7	7	420	4	72	106
Tsandi	88	54	1	6	238	2	64	60
Tsumeb	100	52	0	7	298	4	56	76
Usakos	78	34	2	8	354	2	48	63
Walvis Bay	54	33	5	6	316	4	81	110
MEAN	67	38	5	7	306	4	68	130
STDEV	28	15	6	2	165	3	48	78
MIN	18	9	-2	3	78	1	22	40
MAX	135	73	34	12	715	20	261	450

3.2 Hospital capacity utilization ratios 1999/2000

Hospitals	Bed occupancy rate	Bed turnover ratio	Turnover interval	Average length of stay	Cost per PDE	Physicians	Nurses	Authorised beds
Andara	63	30	5	8	202	3	26	100
Eenhana	30	18	14	6	540	2	60	120
Engela	77	35	2	8	111	7	90	230
Gobabis	86	25	2	12	284	4	43	179
Grootfontein	41	28	8	5	423	3	83	150
Karasburg	107	63	0	6	146	1	32	60
Katima Mulilo	46	33	6	5	81	6	63	220
Keetmanshoop	47	30	6	6	589	4	104	153
Khorixas	14	9	35	6		3	49	127
Kongo	68	46	3	5	231	2	35	62
Luderitz	71	39	3	7	248	2	33	98
Mariental	47	28	7	6		4	49	120
Nankudu	41	31	7	5	325	2	31	100
Nyagana	67	28	4	9	153	4	43	120
Okahandja	44	57	4	3	276	2	34	40
Okahao	72	37	3	7	204	3	57	100
Okakarara	40	18	12	8	275	2	38	82
Omaruru	67	44	3	6	174	4	45	126
Onandjokwe	76	33	3	8	171	18	272	450
Opuwo	53	36	5	5		3	61	80
Oshikuku	74	36	3	7	171	6	178	236
Otjiwarongo	44	28	7	6	108	4	87	166
Outapi	104	64	0	6	218	4	110	120
Outjo	8	19	18	2		0	43	92
Rehoboth	65	45	3	5	286	4	65	140
Swakopmund	49	26	7	7	403	4	66	106
Tsandi	68	31	4	8	219	2	66	60
Tsumeb	38	25	9	6	455	4	54	76
Usakos	24	14	20	6	675	2	51	63
Walvis Bay	74	47	2	6	200	3	80	110
MEAN	57	33	7	6	275	4	68	130
STDEV	23	13	7	2	154	3	49	78
MIN	8	9	0	2	81	0	26	40
MAX	107	64	35	12	675	18	272	450

3.3 Hospital capacity utilization ratios 1998/99

Hospital	Bed Occupancy Rate	Bed turnover ratio	Turnover interval	Average length of stay	Cost per PDE	Physicians	Nurses	Authorised beds
Andara	66	30	4	8	180	3	40	100
Eenhana	80	27	3	11	104	2	62	120
Engela	80	36	2	8	102	4	89	230
Gobabis	84	25	2	12	292	3	49	179
Grootfontein	38	27	8	5	428	3	81	150
Karasburg	97	57	0	6	124	1	31	60
Katima Mulilo	46	31	6	6	109	5	59	220
Keetmanshoop	45	26	8	6	603	4	99	162
Khorixas	10	7	49	5		3	48	127
Kongo	72	46	2	6	310	2	39	62
Luderitz	67	35	3	7	229	1	36	98
Mariental	43	30	7	5		4	49	120
Nankudu	57	38	4	5		3	26	100
Nyagana	65	26	5	9	139	3	43	120
Okahandja	36	57	4	2	283	2	32	40
Okahao	46	26	8	7	219	3	45	100
Okakarara	41	19	11	8	237	2	37	82
Omaruru	68	38	3	7	100	3	47	126
Onandjokwe	73	28	4	10	149	16	273	450
Opuwo*	41	28	8	5		3	54	80
Oshikuku	73	37	3	7	91	6	164	236
Otjiwarongo	50	26	7	7	90	4	83	166
Outapi	103	87	0	4	225	2	96	90
Outjo*	34	18	13	7		0	45	92
Rehoboth	59	42	4	5	283	1	64	140
Swakopmund	47	25	8	7	184	3	66	106
Tsandi	72	31	3	9		2	61	60
Tsumeb	37	24	10	6	465	2	53	76
Usakos	32	18	14	6	319	2	50	63
Walvis Bay	70	46	2	6	166	3	79	110
MEAN	58	33	7	7	226	3	67	129
STDEV	21	15	9	2	131	3	48	79
MIN	10	7	0	2	90	0	26	40
MAX	103	87	49	12	603	16	273	450

NB.: Shaded areas indicate missing data

3.4 Hospital capacity utilization ratios 1997/98

Hospital	Bed occupancy ratio	Bed turnover ratio	Turnover interval	Average length of stay	Cost per PDE	Physicians	Nurses	Authorised beds
Andara	77	29	3	10	127	2	40	100
Eenhana	52	21	8	9	127	2	57	120
Engela	80	34	2	9	90	6	90	230
Gobabis	66	31	4	8	233	3	44	179
Grootfontein	30	27	9	4	313	2	84	150
Karasburg	98	55	0	7	45	1	29	60
Katima Mulilo	48	31	6	6	140	5	57	220
Keetmanshoop	49	32	6	6	381	4	105	150
Khorixas	17	9	34	7	212	3	46	127
Kongo	72	44	2	6	220	1	40	62
Luderitz	60	33	4	7		1	36	98
Mariental	35	23	10	6			48	120
Nankudu	47	33	6	5	282	3	26	100
Nyagana	74	26	4	10	112	3	41	120
Okahandja	32	55	5	2	335	3	36	40
Okahao	22	22	13	4	468	3	49	100
Okakarara	48	20	10	9	255	2	36	82
Omaruru	51	39	5	5		3	42	126
Onandjokwe	56	27	6	8	151	17	262	450
Opuwo*	55	24	7	9		4	55	80
Oshikuku	68	33	3	7		5	167	236
Otjiwarongo	48	26	7	7		4	88	166
Outapi	92	73	0	5		2	97	90
Outjo	38	16	14	9		0	45	92
Rehoboth	52	27	7	7		1	64	140
Swakopmund	47	25	8	7	225	2	64	106
Tsandi	35	24	7	6		2	58	60
Tsumeb	67	42	2	5		2	55	76
Usakos	55	21	12	7	335	2	49	63
Walvis Bay	19	46	3	2	161	5	75	110
MEAN	55	32	7	7	219	3	66	128
STDEV	19	13	6	2	108	3	47	79
MIN	17	9	0	2	45	0	26	40
MAX	98	73	34	10	468	17	262	450

NB.: Shaded areas indicate missing data

Appendix 4

4.1 Actual and projected use of inputs by district hospitals 1999/2000

Hospital	Actual use			Projected use if efficient		
	Recurrent expenditure N\$	Bed	Nursing staff	Recurrent expenditure N\$	Bed	Nursing staff
Andara	5,818,151	100	26	5,818,151	100	26
Eenhana	6,233,688	120	60	6,233,688	120	60
Engela	8,750,568	230	90	8,750,568	230	90
Gobabis	16,721,673	179	43	16,721,673	179	43
Grootfontein	12,951,763	150	83	4,340,592	65	36
Karasburg	3,710,647	60	32	3,710,647	60	32
Katima Mulilo	7,653,658	220	63	7,653,658	220	63
Keetmanshoop	18,569,303	153	104	4,525,069	67	39
Kongo	5,980,194	62	35	5,980,194	62	35
Luderitz	8,307,113	98	33	5,376,275	93	31
Nankudu	6,143,045	100	31	5,366,732	88	27
Nyagana	7,515,985	120	43	6,107,278	113	40
Okahandja	3,416,603	40	34	3,416,603	40	34
Okahao	8,517,610	100	57	4,610,810	78	43
Okakarara	3,721,580	82	38	3,514,300	46	33
Omaruru	5,375,970	126	45	4,270,557	76	35
Onandjokwe	29,754,220	450	272	29,754,220	450	272
Oshikuku	13,265,540	236	178	7,588,461	135	69
Otjiwarongo	5,757,698	166	87	5,320,217	102	50
Outapi	13,288,002	120	110	13,288,002	120	110
Rehoboth	10,704,047	140	65	4,411,308	80	37
Swakopmund	11,828,888	106	66	4,070,584	62	38
Tsandi	5,295,018	60	66	3,881,737	55	37
Tsumeb	8,813,338	76	54	4,250,596	50	35
Usakos	4,321,838	63	51	3,416,603	40	34
Walvis Bay	11,779,206	110	80	5,665,373	103	54

4.2 Actual and projected use of inputs by district hospitals 1998/1999

Hospital	Actual Use			Projected use if efficient		
	Recurrent expenditure N\$	Bed	Nursing staff	Recurrent expenditure N\$	Bed	Nursing staff
Andara	5,562,867	100	40	3,972,612	85	35
Eenhana	4,574,179	120	62	4,574,179	120	62
Engela	8,362,588	230	89	8,362,588	230	89
Gobabis	16,898,288	179	49	16,898,288	179	49
Grootfontein	12,464,458	150	81	3,432,960	68	36
Karasburg	2,863,438	60	31	2,863,438	60	31
Katima Mulilo	9,130,969	220	59	9,130,969	220	59
Keetmanshoop	18,897,224	162	99	5,054,771	70	43
Kongo	7,718,805	62	39	3,879,096	59	37
Luderitz	7,228,666	98	36	3,943,893	82	34
Nyagana	6,763,187	120	43	6,763,187	120	43
Okahandja	3,239,376	40	32	3,239,376	40	32
Okahao	8,049,436	100	45	5,249,769	95	43
Okakarara	3,359,039	82	37	2,861,383	60	31
Omaruru	3,219,547	126	47	3,219,547	126	47
Onandjokwe	22,266,973	450	273	22,266,973	450	273
Oshikuku	6,790,463	236	164	6,790,463	236	164
Otjiwarongo	4,723,388	166	83	4,178,831	108	59
Outapi	12,119,883	90	96	12,119,883	90	96
Rehoboth	9,837,767	140	64	6,234,542	88	40
Swakopmund	5,030,864	106	66	3,335,256	70	42
Tsumeb	5,669,294	76	53	3,121,595	46	31
Usakos	2,673,900	63	50	2,673,900	63	50
Walvis Bay	11,219,048	110	79	11,219,048	110	79

4.3 Actual and projected use of inputs by district hospitals 1997/1998

Hospital	Actual Use			Projected use if efficient		
	Recurrent expenditure N\$	Bed	Nursing staff	Recurrent expenditure N\$	Bed	Nursing staff
Andara	4,285,401	100	40	2,961,035	90	36
Eenhana	3,761,788	120	57	3,761,788	120	57
Engela	7,280,415	230	90	7,280,415	230	90
Gobabis	10,741,829	179	44	10,741,829	179	44
Grootfontein	7,758,294	150	84	3,340,049	64	36
Karasburg	1,041,142	60	29	1,041,142	60	29
Katima Mulilo	11,160,450	220	57	11,160,450	220	57
Keetmanshoop	11,986,202	150	105	3,044,896	68	47
Kongo	4,855,724	62	40	2,889,625	57	36
Luderitz	6,317,364	98	36	3,884,159	86	31
Nankudu	6,155,765	100	26	6,155,765	100	26
Nyagana	5,399,277	120	41	5,399,277	120	41
Okahandja	3,406,993	40	36	3,406,993	40	36
Okahao	6,033,895	100	49	3,912,466	64	31
Okakarara	3,927,643	82	36	1,702,463	65	28
Onandjokwe	20,505,989	450	262	20,505,989	450	262
Outapi	8,268,160	90	97	8,268,160	90	97
Swakopmund	5,627,094	106	64	2,723,347	60	36
Usakos	3,025,772	63	49	2,350,196	48	32
Walvis Bay	11,632,140	110	75	11,632,140	110	75

Appendix 5

5.1 Listing of peers for inefficient hospitals 2000/2001

Hospitals	Peers				
	Andara	Eenhana	Engela	Luderitz	Outapi
Gobabis	√		√		
Grootfontein		√	√		√
Karasburg			√		√
Katima Mulilo	√	√	√		
Keetmanshoop			√		√
Kongo		√		√	
Nankudu	√	√	√		
Nyagana	√	√		√	
Okahandja		√		√	√
Okahao		√			
Okakarara		√		√	
Omaruru	√		√		
Onandjokwe			√	√	
Oshikuku			√	√	
Otjiwarongo		√	√		
Rehoboth			√	√	
Swakopmund		√		√	
Tsandi		√			
Tsumeb			√	√	
Usakos		√		√	
Walvis Bay		√			

5.2 Listing of peers for inefficient hospitals 1999/2000

Hospitals	Peers		
	Eenhana	Engela	Katima Mulilo
Andara		√	√
Gobabis		√	
Grootfontein	√	√	
Karasburg		√	
Keetmanshoop	√	√	
Kongo	√	√	
Luderitz		√	√
Nankudu		√	√
Nyagana	√	√	√
Okahandja	√		
Okahao	√	√	
Okakarara		√	
Omaruru		√	
Onandjokwe	√	√	
Oshikuku	√	√	
Otjiwarongo		√	√
Outapi	√	√	
Rehoboth		√	
Swakopmund	√	√	
Tsandi	√	√	
Tsumeb	√	√	
Usakos	√	√	
Walvis Bay	√		

5.3 Listing of peers for inefficient hospitals 1998/1999

Hospital	Peers							
	Eenhana	Engela	Gobabis	Karasburg	Katima Mulilo	Omaruru	Outapi	Walvis Bay
Andara	√		√	√				
Grootfontein	√		√	√			√	
Keetmanshoop			√	√			√	
Kongo	√		√				√	
Luderitz	√		√				√	
Nyagana	√		√		√			
Okahandja	√							√
Okahao	√				√			√
Okakarara	√	√		√		√		
Onandjokwe	√			√			√	
Oshikuku	√					√		
Otjiwarongo	√							
Rehoboth	√		√	√			√	
Swakopmund	√			√			√	
Tsumeb				√			√	
Usakos	√							√

5.4 Listing of peers for inefficient hospitals 1997/1998

Hospitals	Peers						
	Eenhana	Gobabis	Karasburg	Katima Mulilo	Nyagana	Outapi	Walvis Bay
Andara		√	√		√		
Engela		√	√		√		
Grootfontein	√		√			√	
Keetmanshoop			√			√	
Kongo	√		√			√	
Luderitz		√	√		√		
Nankudu		√		√	√		
Okahandja	√					√	√
Okahao	√					√	√
Okakarara		√	√				
Onandjokwe	√		√			√	
Swakopmund	√		√			√	
Usakos	√		√			√	

Appendix 6

6. Recurrent expenditure of hospitals in N\$

Hospital	FY			
	2000/01	1999/2000	1998/99	1997/98
Andara	6,399,003	5,818,151	5,562,867	4,285,401
Eenhana	6,110,782	6,233,688	4,574,179	3,761,788
Engela	10,472,615	8,750,568	8,362,588	7,280,415
Gobabis	17,585,703	16,721,673	16,898,288	10,741,829
Grootfontein	13,204,369	12,951,763	12,464,458	7,758,294
Karasburg	4,557,855	3,710,647	2,863,438	1,041,142
Katima Mulilo	8,720,894	7,653,658	9,130,969	11,160,450
Keetmanshoop	24,559,609	18,569,303	18,897,224	11,986,202
Khorixas				
Kongo	11,574,724	5,980,194	7,718,805	4,855,724
Luderitz	12,965,559	8,307,113	7,228,666	6,317,364
Mariental				
Nankudu	8,283,925	6,143,045		6,155,765
Nyagana	8,023,924	7,515,985	6,763,187	5,399,277
Okahandja	5,462,188	3,416,603	3,239,376	3,406,993
Okahao	10,102,128	8,517,610	8,049,436	6,033,895
Okakarara	6,201,724	3,721,580	3,359,039	3,927,643
Omaruru	7,065,696	5,375,970	3,219,547	
Onandjokwe	45,227,355	29,754,220	22,266,973	20,505,989
Opuwo				
Oshikuku	17,958,186	13,265,540	6,790,463	
Otjiwarongo	6,841,238	5,757,698	4,723,388	
Outapi	16,384,141	13,288,002	12,119,883	8,268,160
Outjo				
Rehoboth	10,016,535	10,704,047	9,837,767	
Swakopmund	13,461,015	11,828,888	5,030,864	5,627,094
Tsandi	9,042,265	5,295,018		
Tsumeb	8,979,742	8,813,338	5,669,294	
Usakos	6,654,390	4,321,838	2,673,900	3,025,772
Walvis Bay	17,134,381	11,779,206	11,219,048	11,632,140
Mean	12,038,075	9,392,129	8,277,652	7,158,567
SD	8,304,679	5,778,991	5,191,196	4,379,763
MIN	4,557,855	3,416,603	2,673,900	1,041,142
MAX	45,227,355	29,754,220	22,266,973	20,505,989

NB.: Shaded areas indicate missing data