Efficiency in hospitals owned by the Iranian Social Security Organisation:

Measurement, determinants, and remedial actions

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Hajialiafzali H, Moss JR, Mahmood MA. A conceptual health-oriented framework to select the most appropriate variables for measuring hospital efficiency in Iran. *Eastern Mediterranean Health Journal* (under review).

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- **Hajialiafzali H**., Moss J.R., and Mahmood M.A. *Construction of a health-oriented framework to select the most appropriate variables in hospital efficiency measurement using DEA.* <u>17th Triennial Conference of the International Federation of Operational Research Societies (IFORS). Hawaii: USA; July 11-15, 2005, p. 106.</u>

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ABSTRACT

Given the need to ensure the best use of scarce resources, increasing emphasis is being placed on hospital efficiency measurement. In the literature about hospital efficiency measurement, there is an absence of a well-defined framework to select the most appropriate set of input and output variables. Variables used in hospital efficiency studies predominantly reflect a narrow view of hospital functions with a little attention to quality variables. This implies that the hospital goal and its full range of functions in efficiency measurement are poorly understood.

While numerous studies have been undertaken in developed countries, there have been only a few attempts at measuring hospital efficiency in developing countries. However, there has so far been no systematic attempt, using frontier-based techniques, to measure the efficiency of Iranian hospitals, and to identify factors affecting efficiency and remedial actions to improve efficiency.

By focusing on the above two issues, this thesis makes three arguments. First, by undertaking an in-depth investigation regarding the multi-product nature of hospitals, considering a fuller range of hospital functions, and the values of various stakeholders including patient, staff, and community, this study has proposed a health-oriented framework with a focus on the Iranian hospitals to select the most appropriate variables for measuring hospital efficiency. I argue that both variables (existing in the literature, and discussed for addition) should be taken into account in order to enhance the validity of hospital efficiency studies.

Second, two types of techniques (simple ratio analysis and data envelopment analysis) were used for measuring the technical efficiency of hospitals owned by the Iranian Social Security Organization (SSO). The benefits and shortcomings of each method were discussed. For example, considering major surgery rates, which implicitly provide information about the case-mix, has revealed that all high-turnover, high-occupancy outlying hospitals as well as the majority of hospitals falling in the relatively well-performing quadrant in the Lasso diagram had a low major surgery rate. This suggests that simple ratio analysis can only measure the performance of hospitals over a single dimension ignoring their multi-input and multi-output nature of hospitals.

Using Data Envelopment Analysis (DEA), I measured technical efficiency, scale efficiency, and types of returns to scale for the SSO hospitals. In addition to studying their overall and relative efficiency, I analysed the magnitude of the inefficiency for each individual hospital. The results revealed that 22 of the 53 hospitals were deemed to be efficient. Inefficient hospitals had an average score of 78%, implying a potential reduction in all inputs on average by about 22% with no impact on output levels. The comparison of DEA results and simple ratio analysis has revealed that hospitals with an exceptional performance on individual variable even though less valuable compared with other variables can gain a full efficiency score. This critical analysis of the study strongly suggests that the findings obtained from unconstrained DEA should be interpreted with caution.

Finally, in addition to simply measuring efficiency, it was felt that a better understanding of the factors affecting hospital efficiency and remedial actions to improve efficiency is needed. Using qualitative methods, a complex mix of organisational factors such as hospital financing, political influences such as political pressures in determining hospital location, and the training and experience of the managers were argued to be influential factors in hospital efficiency. The interviews also provided a great insight into remedial actions such as reforms in the regulatory framework and corporatization.

DECLARATION

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis being made available in the University Library.

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Hajialiafzali H, Moss JR, Mahmood MA. Efficiency measurement for hospitals owned by the Iranian Social Security Organisation. *Journal of Medical Systems* 2007; 31: 166-172.

Hossein Hajialiafzali

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ABBREVIATIONS

AHRQ	Agency for Health Care Research and Quality
ALOS	Average Length of Stay
BOR	Bed Occupancy Rate
BTR	Bed Turnover Rate
CRS	Constant Returns to Scale
DALY	Disability Adjusted Life Years
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
DRG	Diagnosis Related Groups
DRS	Decreasing Returns to Scale
FTE	Full Time Equivalent
GDP	Gross Domestic Product
HDI	Human Development Index
HPH	Health Promoting Hospital
IRS	Increasing Returns to Scale
QALY	Quality Adjusted Life Years
SFA	Stochastic Frontier Analysis
SSO	Social Security Organisation
VRS	Variable Returns to Scale
WHO	World Health Organisation
WIES	Weighted Inlier-Equivalent Separations

GLOSSARY

Benchmarking analysis	The comparison of service providers against a benchmark or ideal level of performance chosen on the basis of performance over time or across a sample of comparable service providers, or an externally set standard.
Constant returns to scale	Where a given percentage increase in inputs will lead to the same percentage increase in outputs.
Data Envelopment Analysis (DEA)	A mathematical programming method for estimating the efficient production frontier and measuring the relative level of efficiency based on a measure of distance to the frontier.
Decision Making Units (DMU)	DMU is the name used by Charnes et al (1978) to describe the units being analysed in DEA. It refers to the entity (such as hospital, school, etc) which is regarded as being responsible for converting inputs into outputs.
Decreasing returns to scale	A property of a production function of the DMU such that changing all inputs by the same proportion changes output less than in proportion.
Increasing returns to scale	A property of a production function of the DMU such that changing all inputs by the same proportion changes output more than in proportion.
Iranian Social Security Organisation (SSO)	The SSO provides different range of social benefits including health care services for 40% of the Iranian population (28 million). The SSO, after the Ministry of Health, is the main institutional source in hospital care in Iran. In the financial year 2002-03, the SSO operated 59 hospitals with around 8,200 beds.
Peer group	A peer group of an inefficient unit is the set of efficient units to which the inefficient unit has been most directly compared when calculating its efficiency rating.
Stochastic Frontier Analysis (SFA)	An econometric method of estimating the efficient cost or production frontier for measuring the level of efficiency for service providers. A deviation from the frontier is assumed to be the results of inefficiency or random error.
Targets	The values of the inputs and outputs which would result in an inefficient unit becoming efficient.
Variable returns to scale	Where a given percentage of increase in inputs will lead to a larger or smaller percentage increase in output.

CHAPTER 1

INTRODUCTION

1.1 Background

Most nations are experiencing a rapid rise in health care spending. During the past few decades, health care expenditures have increased significantly not only in absolute terms but also relative to Gross Domestic Product (GDP). For example, health care spending as a share of GDP for the Organisation for Economic Co-operation and Development (OECD) nations as a whole rose dramatically from 5.3% in 1970 to 8.9% in 2004.[1] This upward trend has been due to the combined effect of demand and supply related factors including demographic change, epidemiologic transition, the growing use of sophisticated and high-cost technology, specific features of the health care market, institutional responses, and community expectations. As the growth rate of health care expenditures has accelerated, the motivation to identify the source of this trend has intensified in both developed and developing countries.

The ever increasing health care spending highlights the importance of health care management in any health system in general and in hospitals in particular, because hospitals are the prime resource-consuming unit in any national health system.[2] Although it is difficult to find direct evidence, it is reasonable to assume that hospitals can potentially contribute to the improvement of overall population health status by providing care to people of all ages. In addition, hospital services can reduce poverty levels by promotion of economic development through minimising mortality and morbidity in the population.[3] However, they absorb the major share of health care expenditures, imposing a significant financial burden on any nation. In 2004, 32% of total recurrent expenditure on health services was spent on hospital care in the OECD countries.[1] In developing countries, hospitals consume an average of 50-80% of recurrent government health sector expenditures.[4] However, it is worth noting that, if these expenditures lead to the improvement of population wellbeing and increase the quality of life, they can hardly be regarded as an unmitigated burden on society.

Traditionally, it has been assumed that hospitals should be acknowledged as a centre for offering a wide range of diagnostic and therapeutic services. From this point of view, hospitals are responsible for treating ill people. These services, although considered to be core functions, do not wholly reflect all hospital functions. There is a growing body of literature indicating that both the definition and functions of hospitals are changing. It has been argued that hospitals should have a multidimensional approach to the health of the patients and communities in the target/catchment areas, responding to community needs and patient expectations, and not merely focusing on therapeutic services.[2,5] Adopting this perspective implies that the emphasis on the roles and functions of hospitals is shifting from just patient care to the consideration of other aspects, including their role in responding to societal needs, protective care, preventive care, and interaction with other elements of the health care system. It seems that, in addition to the role of demand and supply related factors in the escalating trend of health expenditures in general and by hospitals in particular, the consideration of these roles and functions for hospitals may extend people's expectations and so requires new resources or more preferably, the efficient use of existing resources.

Many studies have documented that public and private sector organisations do not always use resources efficiently.[6] From this standpoint, increasing emphasis is being placed on measures of efficiency in hospitals to compare their relative performance, given the need to ensure the best use of scarce resources.[7] Efficiency measurement, by monitoring the performance of individual hospitals and comparing them with each other, is a useful tool for improving management, rationalizing resource allocation, and mobilizing additional inputs. This evidence has convinced researchers to conduct many health system efficiency studies in general, and hospitals studies in particular during the past few years.

Hollingsworth[8] describes a rapid increase in hospital efficiency studies using frontier-based techniques[i] in recent years. These studies have offered useful alternative perspectives in terms of the methods used, the reason for selecting the method, the variables selected, and factors affecting efficiency. The vast majority of the findings have been based on simple measures of technical efficiency, using variables concerned with the quantity and/or cost of services provided and resources used. Examples of these variables include the number of beds, the number of staff, and the (adjusted) number of separations. The main focus of such studies is usually on the volume of diagnostic and therapeutic services provided, with little attention to other hospital functions affecting the preferences of patients, staff and population, and quality of care. In not addressing the quality of care and a full range of hospital functions, however, hospital efficiency studies may run the risk of making biased comparisons, resulting in

[i] A number of techniques developed to estimate the best possible cost or production set (frontier) and the associated inefficiency of individual organisations.[249]

misleading findings. In order to enhance the validity of the results of the efficiency measurement studies, this kind of analysis should be located within a careful understanding of the hospital functions, and the perspectives of different stakeholders including the patient, the staff, and the relevant community.

It should also be pointed out that having a holistic approach to population health indicates that hospital functions should be considered as a part of the functions of a wider health care system. From this point of view, the main objective of a hospital can be regarded as its role in improving population wellbeing and meeting societal needs. Clearly, if we define the main aim of a hospital in this manner, the variables that are selected to measure its efficiency should be defined in relation to explicit functions reflecting the values of a variety of stakeholders including patients, staff, and community. My review of existing hospital efficiency studies has revealed that, while the choice of measurement methods in hospital efficiency assessment has been widely argued in the literature, few authors have offered a framework to specify variables that reflect different hospital functions, the quality of the process of care, and the effectiveness of hospital services. This implies that the main objective of a hospital and its full range of functions in efficiency measurement are poorly understood. This is evident from the fact that a body of empirical studies selected different sets of variables, and offered only vague recommendations for selecting variables (see chapter 2; literature review). One explanation for these inconsistencies is the lack of conceptual clarity for selecting the most appropriate variables for measuring hospital efficiency. Without knowledge of the hospital main objective and all relevant functions, efficiency studies may produce biased comparisons, particularly against hospitals which provide higher quality services and/or provide services related to various hospital functions (i.e. activities related to prevention or health promotion) and/or attempting to address the community needs with the particular socio-demographic and cultural context requiring the use of resources not conventionally used in this sector.

As pointed out earlier, many countries are being challenged with a crisis of an escalating trend in health services costs, particularly in public hospitals, and Iran as a developing country is no exception.[9] Hospitals consume a large share of the total health care funds in Iran.[10] Among the different institutions/organisations providing inpatient care, the Iranian Social Security Organisation (SSO) is the second largest, after the Ministry of Health, institutional source of hospital care in this country. The SSO provides various welfare services including retirement benefits and disability pensions, and provides health care services for more than 28 million insured people. The SSO provides hospital-based care both through hospitals that it owns and operates, and by purchasing hospital services from other providers. In the financial year 2002-03, the SSO operated 59 hospitals with around 8,200 beds. From 1997 to 2001, the share of hospital expenditures as a proportion of all SSO health care costs increased from 59% to 66%.[11] This trend is a concern for the SSO, not only for the amount that is spent on hospitals, but more importantly because, if hospitals are inefficiently organised, their potentially positive impact on overall population wellbeing will be reduced. Despite such a general awareness, however, there has so far been no systematic attempt to measure efficiency (using frontier-based techniques), and analyse factors affecting the efficiency of the Iranian hospitals in general and the SSO hospitals in particular.

This study has set out to rectify the above two gaps (lack of conceptual clarity for selecting suitable variables for measuring hospital efficiency, and the absence of any systematic attempt to measure Iranian hospital efficiency using frontier-based techniques) in the hospital efficiency literature. By rectifying these gaps, the present study aims to enhance hospital performance (with a focus on the SSO hospitals). More specifically, beyond the conventional measurement of hospital efficiency, the study adds to the preceding hospital efficiency literature using frontier-based techniques by proposing a health-oriented framework encompassing a broad conception of hospital functions to identify the most appropriate input and output variables for measuring hospital efficiency with a focus on its applicability to the SSO hospitals. This can provide relevant new dimensions for enhanced hospital databases. The study then measures the efficiency of the SSO hospitals using a frontier-based method (Data Envelopment Analysis) followed by the identification of possible causes of inefficiency, and possible actions for improving this efficiency using qualitative techniques.

It is expected that the findings of the study will provide guidance for health policy makers and hospital managers in the SSO on issues such as determining deficiencies in the current SSO hospital database to enhance efficiency measurement, assisting allocative decisions, mobilizing resources, and identifying remedial actions to improve efficiency. Furthermore, the results of this study are expected to be generalizable to the other Iranian hospitals and possibly to the hospitals of countries at a comparable stage of socioeconomic development like Jordan, Syria, Morocco, UAE, Bahrain, and Qatar.

1.2 Thesis scope and structure

This study embarks upon a systematic approach to the measurement of hospital efficiency. This approach includes three components. After a review of the literature and a statement of the research objectives and methods, the first component is an in-depth consideration of the specification of suitable variables for hospital efficiency measurement (with a focus on the SSO hospitals) using frontier-based techniques. The focus is on proposing a conceptual framework. It should be stressed that I do not intend to identify new variables. Rather, given a full range of hospital functions, I suggest a number of variables which focus more on the change in health status for individual patients and community. In the second component, using simple ratio analysis and Data Envelopment Analysis (DEA), the results of measurement of SSO hospital efficiency are presented. The third and final component includes an analysis of factors affecting efficiency and remedial actions that would make an inefficient hospital more efficient.

This thesis consists of eight chapters. The first contains a statement of the existing gaps in the hospital efficiency literature. It also introduces the significance of the thesis, and the thesis outline.

Chapter two presents a more detailed understanding of, and insight into, existing gaps in the literature. More specifically, chapter two provides a review of key concepts including the concept of efficiency, and establishes the theoretical and empirical basis from which the aim and objectives of the thesis have been formulated. At the end of the literature review, I outline the research aim and objectives.

Based on chapter two, chapter three (methods) describes how the research objectives will be fulfilled. It should be noted that I only outline the methods in this chapter. A more detailed description of the methods used is provided in the relevant chapters.

By undertaking an in-depth investigation regarding the main objective of a hospital, its multi-product nature, and its various functions, chapter four proposes a health-oriented framework to select the most appropriate variables for measuring hospital efficiency.

After identifying variables for hospital efficiency measurement, and mindful of data availability, chapters five and six present the results of analyses to measure SSO hospital efficiency using two different methods. Chapter five reports the results of efficiency measurement using simple ratio analysis. This chapter provides a general overview of the data set. It also provides information useful for identifying outliers. The results of this chapter are finally compared with the findings of efficiency measurement using DEA presented in chapter six. In chapter six, DEA is employed to handle multiple inputs and outputs to measure the SSO hospitals' technical and scale efficiency with a view of determining the target levels for inefficient hospitals which would render them efficient.

With the results of SSO hospital efficiency measurement available, chapter seven analyses various organisational and environmental factors influencing hospital efficiency, and remedial actions that would make an inefficient hospital more efficient using qualitative methods.

Chapter eight, finally, returns to my thesis objectives presenting the extent to which they were met. This chapter also provides a summary of the main findings together with their implications.

CHAPTER 2

LITERATURE REVIEW

Chapter overview

This literature review examines published studies on hospital efficiency measurement using frontier-based methods. It is my aim to pay particular attention to the variables selected and methods used, and to the generic and local factors that determine what is measured as hospital efficiency in these studies and hence the conclusions drawn. This chapter provides a detailed analysis of the literature in order to identify the existing gaps in the hospital efficiency literature, and to formulate the aim and objectives of this thesis.

This chapter is structured in seven sections and the first of these, section 2.1, will provide a brief discussion of the protocol for the literature review as a way of presenting an overview of the method. Following this, section 2.2 will address issues involved in the definition of efficiency and its main categories, namely technical, operational, and allocative efficiency. This section (2.2) provides an overview of the concept of efficiency that is useful for a better understanding of efficiency studies. Section 2.3 begins with a primary appraisal of studies in terms of their ability to cover the review questions. Hospital efficiency studies using frontier-based techniques will be reviewed to identify the variables selected and methods used. By reviewing variables and methods used in both developed and developing countries, this section (2.3) will provide a sufficient ground for claiming that there is an existing dearth in the literature. Section 2.4, then, will review hospital efficiency studies to specify factors affecting hospital efficiency. The following sections (2.5 and 2.6) summarise the key findings of this review, and identify existing gaps in the literature. These sections (2.5 and 2.6) establish the theoretical and empirical basis from which the objectives of this study have been formulated. Section 2.7 presents the formal statement of the research aim and objectives, which are drawn from the foregoing review. Concluding remarks follow in section 2.8.

2.1 Protocol for the literature review

Over the past few decades, a clearer understanding has emerged of the different types of literature review methodologies, including narrative review and systematic review.[12] Of these, a structured literature review uses an explicit method to identify and evaluate relevant studies.

The present literature review aims to identify and interpret all types of evidence relevant to the review questions. To ensure that, a predetermined plan should be used, and so, the following steps have been taken:

- *Formulating review questions*

In the present study the review questions were the following:

- In hospitals, which methods and variables are used to calculate efficiency using frontier-based techniques?
- Why did the authors select the particular method and variables?
- Is there any framework for selecting the most appropriate variables for hospital efficiency measurement?
- Which factors reported in the literature influence hospital efficiency?

Accordingly, inclusion criteria for the literature review were:

- Population: hospitals
- Intervention: efficiency, productivity or performance measurement
- Study design: including frontier-based techniques such as DEA and Stochastic Frontier Analysis (SFA)

- *Finding relevant studies:*

This study used several strategies to enhance the efficiency of the search. The first strategy was to break down the review questions into their components to identify key words.[13] These components are shown in Figure 2.1.

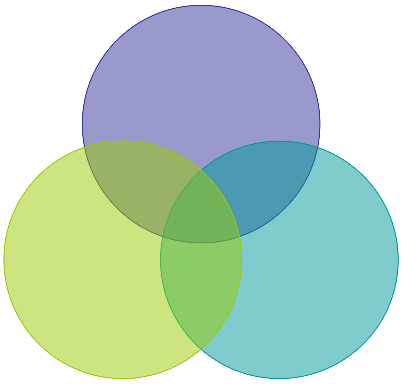

Figure 2.1*: Different components of the review questions*

The second strategy was to look for synonyms for each component. For example, using National Library of Medicine - Medical Subject Headings (MESH) revealed other words like performance measurement, productivity, program, and organisational efficiency that all relate to the word of "efficiency".

- *Search for relevant studies:*

The search was undertaken using the following search engines and electronic databases:

- Internet search engines (Google, Copernic)
- Pub Med
- Cochrane database
- Relevant journals (accecced through the ISI Web of Science) including Annals of Operations Research, Applied Economics, European Journal of Operational Research, Health Care Management Science, Health Economics, Health Services Research, International Journal of Operations and Production Management, Journal of Econometrics, Journal of Health Economics, Journal of Medical Systems, Journal of Productivity Analysis, Journal of Public Economics, Cost Effectiveness and Resource Allocation, and Medical Care.

- Relevant working papers (Centre for Health Economics at Monash University and the University of Melbourne, Centre for Health Economics at the York University, Centre for Health Economics and Policy Analysis at McMaster University, Australian Bureau of Statistics)
- NHS Economic Evaluation Database (http://www.york.ac.uk/inst/crd/nhsdhp.htm)
- Database of Abstracts of Reviews of Effects (DARE) (http://www.york.ac.uk/inst/crd/darehp.htm)
- Health Economics Evaluation Database (http://www.ohe-heed.com)
- WHO site (http://www.who.int/en/)
- World Bank site (http://www.worldbank.org/)
- Hand searches of the references of retrieved literature

Using the above sources, the keywords "hospital", "efficiency", "factors affecting efficiency" and their combinations identified a large number of papers. These could be reduced to more manageable numbers using additional keywords such as "DEA", "SFA", "frontier-based techniques", and by further restricting them to papers for which the keywords were the main focus of the paper. According to the review questions, relevant hospital efficiency studies have been selected to identify their variables and methods used to measure efficiency, and factors affecting hospital efficiency.

2.2 Concept of efficiency

One of the major concerns of mainstream economic theory is the efficient use of scarce resources, and efficiency measurement is a useful tool for making choices between alternatives.[14] In simple words, resources go into a Decision Making Unit (DMU)[ii] to be processed to produce products. In economic terms, the concept of efficiency can be defined as the relationship between scarce factor inputs and products. It examines how well scarce resources are converted into products. Concerned with this core definition, there are a number of efficiency definitions namely technical, operational, and allocative efficiency.

[ii] A DMU denotes any unspecified set of managerial units engaged in producing similar outputs (Haung Y. Using mathematical programming to assess the relative performance of the health care industry. J Med Syst 1989; 13: 155-162.).

Technical efficiency seeks to identify, in physical terms, the best possible combination of factor inputs to produce a given output.[15] Nunamaker[16] describes technical efficiency as a measure of the ability of a micro level unit (DMU) to avoid waste by producing as much output as input usage will allow, or using as little input as an output level will allow. Technically inefficient hospitals use a relatively excessive quantity of inputs when compared with peer groups achieving the same amount of output.

Operational efficiency seeks to identify the combination of factor inputs that minimise the cost of producing a given output.[17] In other words, it is concerned with the minimisation of the cost of achieving a given output.

Both technical and operational efficiency pursue the lowest level of scarce resources (valued in physical terms in technical efficiency and monetary terms in operational efficiency) to produce a given product. However, they do not take into account whether or not the outputs produced are the "best" ones to be produced.

Allocative efficiency is an aspect of market performance that denotes the optimum allocation of scarce resources between end users, in order to produce the combination of goods and services which best accords with the pattern of consumer demand, as well as the optimal mix of technically or operationally efficient interventions.[15,18] It refers to producing, with the minimum use of scarce resources, the amount and type of product most preferred by consumers (for example the greatest possible amount of health improvement). This concept is in line with Pareto's welfare-based notion of efficiency that refers to an allocation of resources such that no resource reallocation could make anyone better off without making someone else worse off.[19] Here it should be noted that, if Pareto optimality were the only criterion, an economist could recommend an allocation that was characterized by one person in the economy continuing to own virtually all the wealth while all the others in economy live in poverty providing no one was thereby made any worse off. This raises the question of distribution, which is often discussed in terms of a trade-off between efficiency and equity. It has been argued that equity and efficiency should both be used to find the optimal allocation of resources.[287] This is particularly important in the context of health care systems in which efficiency improvements should be assessed in the context of equity and the health care needs of the community in the target area.

After defining efficiency and its main categories, the next section (2.3) reviews hospital efficiency studies using frontier-based methods in developed and developing countries. The main aim of this section is to identify the variables selected and methods used in these studies. Then, section 2.4 reviews hospital efficiency studies to specify factors affecting hospital efficiency.

2.3 Review of hospital efficiency studies using frontier-based techniques

During recent years numerous studies have been undertaken to measure the efficiency of health care centres, particularly hospitals. Hollingsworth [8] has indicated that from 1983 to 2003 there has been a substantial increase in the number of published studies measuring the efficiency of health care providers using frontier-based methods. In terms of the area of application, hospitals received most attention. This is not surprising as hospitals are regarded as key health providers in any health system. Hollingsworth [8] has stated that almost 50% of efficiency studies have been undertaken in hospitals. Other studies were mostly located in the field of nursing home, physician practices, and primary care.

Before reviewing hospital efficiency studies using frontier-based techniques, there are two issues which need to be addressed. Firstly, because the rest of this review deals with input, throughput, output, and outcome variables, a brief discussion is needed to examine different types of variables. In approaching this issue, section 2.3.1 uses a simple health production pathway to discuss briefly different variables used in hospital efficiency studies. The discussion is useful as the specification of variables is generally considered as a key issue in efficiency measurement. Secondly, studies have adopted a number of benchmarking techniques to measure hospital efficiency. These techniques could be divided into two main groups, namely non-frontier based methods such as simple ratio analysis and frontier-based methods such as DEA. The main focus of the present literature review is on studies using frontier-based methods. However, due to the importance of simple ratio analysis in providing a general overview of any data set and in identifying outliers, section 2.3.2 provides a brief review of studies using simple ratio analysis and its limits in hospital efficiency measurement. This section explores why the present study aims to use frontier-based methods for measuring hospital efficiency.

2.3.1 Variables in hospital efficiency measurement

Hospitals like other health care institutions are responsible for providing goods and services to contribute to maintaining and improving the health of the population. The idea of applying industrial concepts to hospitals has been presented throughout the century. One of the most commonly cited has been the production line concept dicussed by Fetter[iii] in his book about the development of Diagnosis Related Groups (DRGs). Fetter argues that the major function of a hospital is to provide diagnostic and therapeutic services for patients. Based on this concept, he divides the hospital production line into three components. Hospitals use inputs (such as labour and materials) to produce intermediate ouputs (such as x-rays and laboratory tests). The author argues that hospital operations can transform the inputs to the intermediate outputs. These goods and services, the author claims, are intermediate outputs in a sense that they are only contributors to the final products such as separations.

The above-mentioned conceptual framework to define hospital products, however, suffers from some limitations. For example, it is mainly based on the argument that the major function of a hospital is to treat patients. Although this is an important function, it does not wholly reflect all hospital functions. There is a growing body of literature indicating a major change in the definition of hospital functions. Hospitals, now, should have a multidimentional approach to the health of individuals as well as communities in the target areas.[2] Furthermore, Fetter's conceptual framework does not include the outcomes which reflect the final results of the consumption of the goods and services provided by hospitals. This stage is important as it can directly contribute to individual and population health and well being. The framework described by Fetter also fails to clearly portray the role of process or throughput in transforming inputs to outputs. This stage is important as it can provide useful information about the extent to which a hospital is busy. Considering the above issues, the production of health can be depicted in a multi-stage pathway (Figure 2.2).

[iii] Fetter RB.DRGs: their design and development. Michigan: Health Administeration Press; 1991.

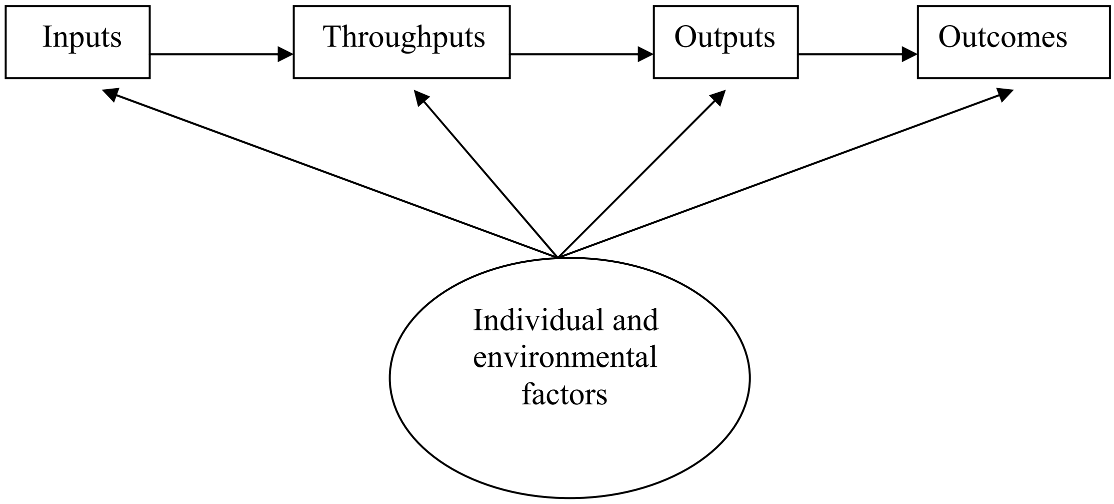

Figure 2.2: A simple illustration of the health production pathway

Health service inputs include human (both its number, and skills and knowledge) and physical capital (equipment and technology), and consumables such as drugs. The next step in producing health is the transformation of inputs into outputs. This step is also called throughput or process. Hospital literature considers variables such as the average length of stay and bed occupancy rate as examples of this step. In the hospital literature, output (perhaps confusingly) is considered as an expression of the number of hospital activities such as the number of separations and patient days. In the definition of the hospital outputs, however, there are Finally, the path of health production ends with health outcome in terms of population wellbeing improvement, measured for instance as quality adjusted life years. This health production pathway is also influenced by other factors, individual and environmental (both physical and socio-political), that should be taken into account. Factors affecting these variables and consequently hospital efficiency will be further explored in section 2.4.

2.3.2 Studies using simple ratio analysis: strengths and limitations

A review of the literature has shown the diversity in techniques used and variables employed in hospital efficiency measurement. In the literature, simple ratio analysis and frontier analysis are the usual techniques applied to analysing efficiency in hospitals.

Simple ratio analysis concerns relationships between pairs of variables in a data set. In this method, hospital performance is measured by the ratio of a single output per unit input. Many have used simple ratio analysis to measure hospital efficiency.[20,21] For example, in an attempt to compare the technical efficiency of hospitals in private and public sectors, Duckett et al [22] used the total hospital cost adjusted for discrepant elements as an input, and separations adjusted by Diagnosis Related Groups (DRGs) as an output, showing a greater technical efficiency of public hospitals over private hospitals. Simple ratio analysis has also been employed to identify outliers in hospital efficiency studies. For example, to assess throughput ratios simultaneously, Mahapatra et al[23] plotted Bed Occupancy Rate (BOR) on the x-axis, and Bed Turnover Rate (BTR) on the Y-axis, dividing the graph into sixteen sectors by drawing six intersecting lines (two lines drawn from the average values of BOR and BTR, and four lines drawn one standard deviation away from the average values). Using this graph they could identify hospitals with very high BOR and BTR and hospitals with very low BTR and BOR as outliers.

It has been argued that these ratios have the principal advantages of simplicity in calculation, providing a general overview of a data set, requiring a small sample size[24], and identifying outliers. However, these ratios suffer from at least two limitations. Firstly, simple ratio analysis measures the performance of hospitals over a single dimension ignoring the multi-input and multi-output nature of hospitals. Studies have shown that different ratios produce different performance evaluations of the same organisation.[25] Accordingly, one hospital may be regarded as an efficient unit based on one ratio but inefficient according to others. Secondly, a focus on simple ratio analysis can lead to perverse incentives. For example, focusing on BOR and BTR as criteria to assess hospital performance, hospital managers are encouraged to admit unnecessary and/or non-complicated patients who need a shorter stay, thereby keeping BOR and BTR high. Because of these limitations, some researchers tend to refer to simple ratio analysis as a method for partial efficiency measurement.[26] Moving from partial to total efficiency measurement needs more advanced techniques generally known as frontier-based methods.

The two main approaches to estimating a frontier, and the calculation of the individual DMU deviations from the frontier, have been a non-parametric mathematical programming approach (DEA) and an econometric approach (Stochastic Frontier Analysis; SFA).[27,28] Using these approaches, efficiency can be measured relative to a best-performance frontier determined by a representative peer group. The measurement of firm-specific technical and operational efficiency is based upon deviations of observed output from the best production or efficient production frontier. If a firm's actual production point lies on the frontier it is regarded as an efficient unit whereas inefficient units operate below the frontier. In the case of inefficient units, the ratio of the actual to potential production is defined as the level of efficiency. The main difference between DEA and SFA revolves around the approaches used to estimate the frontier. This difference is explained in detail in chapter 3, section 3.2.

2.3.3 Hospital efficiency studies in developing countries using frontier-based methods

The review of the literature has revealed that there have been only a few studies in developing countries measuring hospital efficiency using frontier-based methods. This may be due, at least in part, to the lack of appropriate data in these health systems. Given the small number of hospital efficiency studies in developing countries found in the literature (twelve studies), all studies will be reviewed in this section with a particular focus on the variables and methods used.

The results of studies in developing countries provided important insight into hospital efficiency measurement while suggesting useful recommendations. For example, some studies identified statistically outlying hospitals which should be given priority for further investments. These studies, however, suffer from some limitations. For selecting variables, no study offered a framework. Furthermore, there was no study using quality variables. Finally, due to the lack of appropriate variables such as DRG-based separations, reflecting procedural complexity, most studies used the number of unadjusted services as output variables e.g. the number of inpatient days.

Using DEA, and the number of patient days and outpatient visits as output variables, Kwakey[29] measured the relative efficiency of 20 selected hospitals in Ghana. The reason for selecting these outputs, the author mentioned, is their ability to cover the main activities provided by hospitals. The study has also selected as inputs the number of beds (as a proxy for capital), physicians, nurses, administrative, technicians, and other staff. The researcher used DEA because it produces more accurate results with small samples.

Adopting a similar approach to specifying outputs, Zere [30] has selected inpatient days and the number of outpatient visits to measure 87 hospitals in South Africa. The number of beds and the aggregate total recurrent expenditure were also employed as input variables. The study used DEA because it can handle multiple inputs and outputs with no requirement to specify functional distribution. Although the study acknowledges the important role other variables such as quality variables in hospital efficiency studies, it fails to offer criteria with which to select the variables.

The Kwakey and Zere studies have employed outpatient visits and patient days as proxies for output variables. However, Pavananunt [31] has added another service variable, the number of emergency visits, to the list of outputs to measure the operational efficiency of public community hospitals in Thailand (662 hospitals). He also used the annual payroll of personnel, the total amount of annual expenditure of capital, and medical and non-medical expenses as input variables. The frontier method used in this study was SFA. The author used SFA because of its capability in identifying measurement errors. By incorporating emergency visits, the study tried to cover a broader set of hospital activities. However, it does not offer any framework for selecting these particular variables.

Similarly, in an attempt to include input prices, Zere et al [32] used recurrent hospital expenditure combined with the number of beds and staff as input variables in order to measure the efficiency of district hospitals in Namibia employing DEA. They also employed the number of outpatient visits and inpatient days as output variables. The authors acknowledged the impact of the selection of variables on the efficiency scores and hospital ranking. However, once again, the variables were selected on the basis of previous studies, and no framework was proposed for selecting the most appropriate variables.

Some studies have used statistical methods to select the most appropriate variables. Baht et al (2001) have compared the efficiency of district and grant-in-aid hospitals in Gujarat state in India.[33] They selected the number of cases treated under inpatient and outpatient services, and also the number of cases handled under the laboratory service as major outputs for each hospital. Then, the authors identified relevant inputs through a series of stepwise regressions. Inputs for which the co-efficient of regression (where regressed with any of three outputs) was not significant were excluded from the final list. Subsequently, the number of doctors, nursing, paramedical, administrative and non-technical staff, the number of beds, medicine expenditures, physical infrastructure and equipment index, laboratory hours per week and maintenance expenditures were selected as inputs. The authors provided two reasons for using DEA. First, it is a flexible tool in handling multiple inputs and outputs. Second, it does not need the estimation of a function production. This study used a statistical assessment to identify the relationship between input and output variables. However, as for many other studies, the authors did not mention the reason for selecting the variables. There is a concern as to what extent the outputs employed can reflect the valued products on which we wish to assess hospital efficiency.

In Kenya, Owino et al [34] have used a frontier cost function parametric approach to measure the efficiency of public hospitals. This model reveals absolute efficiency rather than the relative measure that is the final result of non-parametric approaches like DEA. The method also does not suffer from the sensitivity to mismeasurement that is a main concern for researchers who use DEA. To estimate the cost function, the authors selected average wages and the number of beds as inputs, and outpatient visits, inpatient cases and surgical interventions as outputs, because, as the authors mentioned, these variables form the major components of hospital costs. Although, this study seems to be successful in addressing absolute efficiency levels rather than relative ones, the validity and reliability of the results strongly depend on the precise estimation of a frontier function that is not always a straightforward task, particularly for multi-production firms like hospitals.

In another study in Kenya, Kirigia et al [35] used DEA to measure the technical efficiency of public hospitals. They employed the number of medical staff, paramedical staff, nurses, administrative staff, technicians, subordinate staff, the number of beds, the costs of drugs, the cost of non-pharmaceutical consumables, the cost of foods and maintenance as inputs. They also used outpatient visits, general inpatient admissions, dental care visits as outputs. They concluded that out of 54 hospitals included in the analysis, 26% were technically inefficient. Although, this study tried to select a broader set of variables to reflect various hospital activities, it fails to propose a framework with which to select inputs and outputs. Moreover, by using 17 variables (the sum of inputs and outputs), and with its small sample size (54 hospitals), 40 hospitals (74%) were regarded as efficient units leading to very low discrimination. This low grade of discrimination is an important issue because the study can comment on performance improvement for only 14 out of 54 hospitals.

Another study using frontier-based methods in developing countries was about the measurement of the level of technical efficiency of the Taiwan hospitals undertaken by Chang et al.[36] The authors selected the number of beds, medical staff, nurses, and supporting medical staff (such as pharmacists and medical technicians) as input variables. As output variables, the authors used the number of patient days, the number of outpatient visits, and the number of surgeries. The authors employed DEA as a frontier estimation method to calculate efficiency scores. This, as the authors pointed out, is because of the ability of DEA in handling multiple inputs and outputs.

All the above-mentioned studies used the number of un-adjusted services as output variables with little attention to the procedural complexity. This could lead to higher efficiency scores for hospitals which admit and treat non-complicated cases. There were, however, three studies that used output variables that reflect the complexity of interventions more properly. The first two studies grouped surgical interventions into major and minor surgeries on the basis of their relative values. Using DEA, Al- Shammari[37] used the number of bed days, physicians, and health personnel (full time equivalent) as input variables and the numbers of inpatient days and minor and major surgical interventions as output variables. Using these output variables, the authors employed more appropriate variables to capture the procedural complexity. However, the use of such variables does not cover some important activities such as emergency visits and outpatient visits. Furthermore, none of the variables used reflect the complexity of non-surgical interventions (possibly due to a lack of data), though some medical procedures such as chemotherapy and renal dialysis are quite resource intense. In terms of the method used, the author mentioned that he employed DEA, because in parametric approaches such as SFA, the functional form should be known or be estimated statistically, and as Norman and Stoker[38] have indicated, in many cases particularly public sector organisations there is no known functional form.

Using similar output variables to capture the procedural complexity, Ramanathan[39] measured the technical efficiency of 20 hospitals in the Sultanate of Oman. He added the total number of outpatient visits to the list of output variables, using the same input variables employed by Al-Shammari. Using minor and major surgical interventions (similar to Al-Shammari’s study) again underlines the inability of the study to capture the complexity of non-surgical interventions. In this study, efficiency scores have shown that 60% of hospitals are efficient. The findings show a low level of discrimination that might be partly due to the large number of variables used (seven variables) compared with the total number of hospitals (20 hospitals). In terms of the method used, the author used DEA, as it is able to handle multiple inputs and outputs more easily.

The third study in this group used output variables which reflect the complexity of interventions more appropriately. This study was about efficiency measurement for Thai public hospitals. Valdmanis et al.[iv] aimed to assess the capacity of Thai public hospitals to proportionately expand services to both the poor and the nonpoor by measuring the production of services provided to the poor, relative to the nonpoor. The authors selected seven inputs, namely the numbers of beds, doctors, nurses, and other staff, and allowance expenditures, drug expenditures, and other operating expenditures. For output variables, the authors selected the number of outpatient visits for poor patients, the number of outpatient visits for nonpoor patients, the total number of inpatient cases adjusted by the average Diagnostic Related Group (DRG) weighting for poor patients, and the total number of inpatient cases adjusted by the average DRG weighting for nonpoor patients.[v] The study used DEA mainly because it can readily accommodate multiple inputs and outputs and so is relevant for hospitals that produce multiple services.

So far, all the studies reviewed defined hospital outputs as clinical and diagnostic outpatient visits and separations. There is, however, one study investigating the technical efficiency of public district hospitals in Ghana that used some output variables capturing preventive care. Using DEA, Osei et al [40] employed maternal and child care (i.e. antenatal care, family planning, child immunisation, and growth monitoring) along with the number of separations as output variables. They also used the number of hospital staff and beds to capture hospital inputs. The main reason for selecting DEA was its appropriateness in handling multiple inputs and outputs with different units. Furthermore, as the authors mentioned, DEA does not require an assumption of a functional form relating inputs to outputs. Compared to other studies undertaken in developing countries, although this study provided a different view on hospital outputs (i.e. the inclusion of variables reflecting some preventive care activities), it does not present a framework for selecting the most appropriate variables with a comprehensive approach to hospital objectives and functions. Appendix A presents a summary of each of the above studies with a focus on the variables and methods used.

[iv] Valdmanis V, Kumanarayake L, Lertiendumrong J. Capacity in Thai public hospitals and the production of care for poor and nonpoor patients. Health Ser Res 2004; 39: 2117-2134.
[v] From the artcle it is not clear how the authors defined poor and nonpoor patients.

To sum up, the review of hospital efficiency studies using frontier-based techniques in developing countries has revealed the following issues. Firstly, the use of frontier analysis for measuring hospital efficiency in developing countries has a history going back only a few years (the earliest study was in 1997). Secondly, the review has shown that DEA is the dominant method, as more than 80% of all studies employed this non-parametric technique for measuring hospital efficiency. Thirdly, almost all studies have used quantity data (such as patient days, the number of outpatient visits, emergency visits, the number of beds, etc.) with little attention to quality variables or to those which can reflect a full range of hospital functions including health promotion activities, preventive and protective care, and hospital roles in responding to society needs (only one study used some variables reflecting preventive care). This is mainly because that the cost is prohibitive when provision of basic care is the priority. Fourthly, there was a little attention to using appropriate variables reflecting procedural complexity. This, of course might be in part due to the absence of such data in the hospital databases in most developing countries. Finally, and most importantly, no study proposed a framework with which to select the most appropriate variables, although almost all studies acknowledged the crucial role of the specification of the variables in the validity of the results.

2.3.4 Hospital efficiency studies in developed countries

Compared to developing countries, hospital efficiency studies in developed countries have used a broader set of variables. Furthermore, there have been quite a considerable number of hospital efficiency studiers using frontier-based methods in developed countries. For the sake of clarity, I devote two separate sections to the methods used (section 2.3.4.1) and variables employed (section 2.3.4.2).

2.3.4.1 Methods

As was mentioned earlier, there are different choices available for frontier-based techniques in hospital efficiency studies. To some degree, this has been revealed in the review of studies undertaken in developing countries. In developed countries, the issue is more prominent. Under the assumption of a known distribution for the inefficiency and random components, SFA estimates the frontier. In this method, deviations from the frontier can be decomposed into two components; inefficiency and random error. This enables users to measure inefficiency and econometric errors separately. This is what is generally considered to be a relative advantage of SFA over DEA. A number of studies have used SFA for measuring hospital efficiency, for example, Yong et al.[41], and Rosko.[42] However, the critics of this method argue that the results would be misleading because of the imposition of a known functional form for hospitals despite the functional form of their production technology actually being unknown. This well-grounded argument has led to the use of non-parametric methods (DEA) in hospital efficiency measurement studies, because these methods have no requirement to specify a functional form. Furthermore, the ability of DEA in identifying the source and amount of inefficiency, and being more flexible in handling multiple variables with different unit of measurement has convinced most authors to use this method when estimating a frontier.[43-54]

These theoretical and empirical features of DEA can explain its dominance in health care and hospital efficiency studies as confirmed by Worthington[55] and Hollingsworth et al.[56] There is one drawback to this method. That is the interpretation of any deviation from the estimated frontier as inefficiency. This apparent drawback, however, can be dealt with by employing the right variables in their natural physical units.[57] The findings of the present literature review are in line with the results of other studies (Worthington[55] and Hollingsworth et al [56]) confirming that compared to simple ratio analysis and parametric methods, DEA is the dominant and probably more appropriate method currently available to measure efficiency amongst health service providers.

2.3.4.2 Variables

Because of the importance of the proper specification of variables used in hospital efficiency studies, input and output variables are discussed separately. The first section (2.3.4.2.1) considers input variables followed by section 2.3.4.2.2 examining output variables.

2.3.4.2.1 Input variables

According to the literature review, input variables used in hospital efficiency studies could be further divided into two categories based on whether or not they are being measured in quantity or monetary values.

Quantity input variables

The review of hospital efficiency studies undertaken in developed countries has shown that, compared to output variables, there is little controversy in selecting input variables. In hospital efficiency studies, quantity input variables fall broadly into three categories, namely human, capital, and consumables.

Human inputs play a crucial role in hospital performance, because as it has been argued that the performance of hospitals ultimately depends on the knowledge and motivation of health workers.[2] For this reason, in most hospital efficiency studies staff characteristics have been employed as input variables using various approaches. A group of studies have used the number of staff to reflect human inputs. [45,59] For example, Hollingsworth et al [45] used the total number of medical, nursing, and other staff as human input variables. This is consistent with the findings of other studies showing the association between staff intensity particularly physicians and nurses with better health outcomes including lower in-hospital mortality rate.[60] However, because this variable does not take into account the mix of full-time, part-time and casual workers, it provides little information about the use to which the workforce is put.[24] From this standpoint, the number of Full Time Equivalent (FTE) staff is regarded as a more appropriate human input variable. Examples of studies using the number of FTE staff include Mobley et al [61] and Chern et al.[62] It should also be noted that, because of the vital role of some staff such as physicians and nurses in affecting patients' satisfaction and final outcome, some studies have further disaggregated staff input variables into the number of physicians, nurses, and others. This classification is mainly based on the fact that these staff (particularly physicians) direct appropriate treatments and resources use for their patients. It has been argued that around 80% of decisions in resource utilization are made by physicians.[63] Examples of such studies include Webster et al [64] and Maniadakis et al. [65] For instance, Webster et al [64] have used FTEs of physicians, FTEs of nursing staff, and FTEs of other staff as input variables to measure the level of technical efficiency of 301 Australian private non-psychiatric hospitals.

In the hospital literature, capital inputs refer to a wide range of manufactured products which include buildings, machinery, complex medical equipment, and vehicles. They are often considered as durable stocks that are to be used to provide services and are usually held for a long period. In efficiency studies, an important focus to determine the most appropriate variables reflecting capital inputs should be the measurement of capital services, a term which refers to the contribution of capital to production in contrast to capital stock which concerns the quantity of something held.[55] However, the data to measure capital services are not readily available. For this reason, it is often assumed that there is a directly proportional link between the quantity of capital stocks and capital services.[24] Under this assumption, a simple and easily available variable, “number of beds”, is the most commonly used variable in hospital efficiency studies. The use of this variable as a proxy for capital inputs has been accepted by a group of researchers.[66,67] However, it has been argued that this variable is a crude proxy. Using variables that reflect capital stocks (and not capital services), as Worthington [55] pointed out, can lead to the overestimation of the use of capital and hence misleading findings. Other aggregated quantity measures of capital stocks are an “index of high technology”[vi] used by Zuckerman et al.[68] This variable, however, has not commonly been used in hospital efficiency studies.

Consumables are regarded as another major category for hospital inputs. They often include drugs and medical supplies. In the literature, a few studies have employed this variable as a quantity. For example, Long et al [69] have used the number of drugs as an input variable. However, the variable is commonly based on its monetary value. This issue will be discussed in the following section, input prices. It should also be noted that in some less-developed countries, as Nolan et al[70] have pointed out, patients are asked to procure consumables, including some drugs and medical supplies. Using consumables as input variables for measuring hospital efficiency in these countries can result in underestimating inputs used and hence misleading findings and recommendations.

<u>Input prices</u>

Some researchers prefer to measure operational efficiency, which needs the use of input prices. This enables the expression of the value of different kinds of input in the common unit of currency. One reason might be the popularity of cost containment policies among policy makers due to the ever-increasing trend in health care expenditures.

In an aggregated form, some studies have used total operating expenditures as an input which reflects all hospital costs.[71] However, this variable can only provide an overall picture of

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[vi] The index is the number of eight capital-intensive services (high technology services) including cardiac catheterization laboratory, open heart surgery, extracorporeal shock-wave lithotripter, megavoltage radiation therapy, nuclear magnetic imaging, organ/tissue transplant, neonatal ICU, and certified trauma centre.

hospital expenditures, thereby obscuring the expenditure on particular inputs such as human or capital inputs which could have been used to identify excess inputs and the magnitude of inefficiency.

From this standpoint, all three inputs (human, capital, and consumables) can be separately measured based on their monetary values. Normally, labour costs comprise the largest share of hospital expenditures.[19] Therefore, to measure hospital operational efficiency, emphasis is placed on this variable in hospital efficiency studies. Total labour costs have been used in some studies.[72] Similarly to quantity variables, labour costs can be further disaggregated into medical and non-medical costs, as used by Chirikos et al.[51] Zuckerman et al [68] have used the average annual salary per FTE employee because as they have stated "this variable reflects hospitals' choices regarding the number and skill-mix of employees." Some hospitals (particularly private hospitals) pay more because they have better trained or highly skilled doctors compared to public hospitals. It should also be noted that in addition to the sensitivity of this variable to the type of employees, it is also very sensitive to the geographical region where hospitals are located. For this reason, some authors have suggested a wage index to correct for the latter.[73]

A reliable way to capture capital input prices, as Webster et al [64] have pointed out, is to divide the price of capital, including depreciation and the opportunity cost of holding the stocks, into the number of capital stocks. However, due to the lack of available data, this is not always a straightforward task. Some studies have used "depreciation charges" as a proxy for capital costs.[51] In other hospital efficiency studies, capital input prices have been proxied by "net plant assets"[74], "the United Kingdom's NHS capital charges on assets and investment"[58] (for studies undertaken only in the UK), or "expenditure on repair and the maintenance".[68] Once again, it is evident these variables represent only capital stock and not the contribution of this stock in producing services. For this reason, the findings of those studies which employ these variables should be cautiously interpreted, as they may overestimate the use of capital inputs.

Consumables - sometimes dubbed non-labour, non-capital inputs - can be measured based on their monetary values. These variables include expenditures on drugs and medical supplies. These variables are important as they comprise a major share of total hospital expenditures. Furthermore, over-prescription remains as one of the most important concerns of health policy makers. This issue, through increasing unnecessary input use with no additional health improvement (and sometimes negative health outcomes due to adverse effects), can lead to inefficiency. For this reason, some studies have employed these variables in hospital efficiency studies.[75]

2.3.4.2.2 Output variables

By employing different inputs, hospitals provide a wide range of clinical and diagnostic services to improve population health reflected by outcome variables (See section 2.3.1). However, outcome measurement poses difficulties because health is a multi-dimensional concept and there is subjectivity involved in assessing the quality of life of patients.[76] Accordingly, hospital output in the majority of hospital efficiency studies found in the present literature is measured as an array of health services provided. These services are generally considered to be the defining features of a hospital. Review of hospital efficiency studies has shown that these services can be classified into two main categories; clinical and diagnostic services.

Clinical services include those services that are based on direct observation of the patient and/or providing bedside treatment. These services include inpatient care, outpatient services, and emergency care. Reflecting the importance of the classification of separations into relatively homogenous groups, there are some studies which have categorized inpatient care as intensive (ICU, CCU) versus non-intensive care[77] or surgical versus non-surgical.[78] Diagnostic services include a wide range of activities which can assist physicians to make a diagnosis. These activities can be regarded as imaging (X-rays, ultrasound, CT scan, MRI, etc.) and laboratory tests. In addition to these services, there are some intermediate services which play a crucial role in supporting main clinical and diagnostic services. These services include laundry, catering, maintenance, and transport which are essential for the running of a hospital.

Clinical output variables

Clinical services offered by hospitals are mainly divided into three groups; inpatient, outpatient, and emergency services.

In the literature about hospital efficiency measurement using frontier-based methods, the unweighted unit of measurement for inpatient activities varies between the number of separations, the number of admissions, and the number of patient days. The use of these output variables is contentious. It might be argued that there are some economic differences in measuring hospital efficiency on the basis of the number of admissions or the number of patient days. In efficiency studies using the number of admissions instead of the number of patient days, hospitals that admit more complicated cases might be labelled, ceteris paribus, inefficient hospitals. Some studies prefer to employ separations rather than admissions.[79,80] There are at least two reasons. First, the inpatient casenote abstracts of the vast majority of hospitals are based on information gathered at the time of discharge. Furthermore, any patient transferred from one ward to another may be counted twice in the admission record. This can lead to a discrepancy between the numbers of admissions and separations. Another variable reflecting inpatient activities employed by some hospital efficiency studies is the number of patient days.[74,81] The selection criteria for specifying these variables have not been discussed at any length in these studies. However, since aggregate patient days can be computed by multiplying the average length of stay by the number of separations, the former might be preferred as an output variable in hospital efficiency studies, because it can reflect the length of stay as well.

It must be emphasised that measuring hospital outputs by such variables does not capture the casemix. Using unweighted separations or patient days in hospital efficiency studies may lead to higher efficiency scores for hospitals which admit and treat uncomplicated cases. Some authors have tried to address this problem by strategies such as using the proportion of patients aged under 15 and over 60[82], surgical versus non-surgical patient-days[78], or intensive care versus non-intensive care patient-days.[83] These approaches are largely based on the fact that the treatment of aged patients, surgical interventions or intensive care warrant a different input mix in terms of both human factors and physical capital, when compared with their alternative. The impact of casemix adjustment on efficiency measurement is well documented in the literature. For example, Rosko et al[84] have found that the inclusion of a casemix index for measuring hospital efficiency reduced the estimated average inefficiency by more than 50%. Bjorkgren et al[85] have shown that the use of different casemix approaches for classifying inpatient activities can significantly affect efficiency scores. These findings underline the importance of casemix adjustment in hospital efficiency studies.

One customary approach for classifying inpatients to homogeneous groups is the Diagnosis Related Groups (DRG) system.[86] Hospital efficiency studies using this approach define DRG-adjusted surgical or medical separations as the sum of all surgical or medical discharges weighted by their DRG case weight based on the relative cost of each particular DRG. Cost weights describe the cost (and complexity) of patients within particular DRGs, as compared to the average for all episodes within the scope of the classification. They are calculated by dividing the average cost of episodes within a DRG by the average cost of all episodes i.e. across all DRGs. The relativities of the cost weights of different DRG groups mirror the relativities of the costs of the corresponding treatment. O'Neill [75] used DEA to measure the performance of 27 large urban hospitals located in the Philadelphia area of the USA. The study used DRG- adjusted non-surgical inpatient discharge, surgical inpatient discharges and the adjusted number of outpatient visits as proxies for output variables. DRG adjusted inpatient separations have also been used in other hospital efficiency studies, including Morey et al [87] and Linna.[72]

DRG-based methods consider high and low boundary points for the length of stay within each group. However, in some cases it is possible that a patient's length of stay is outside of normal boundary (or "trim") points. To adjust actual stay against high and low boundary points, some studies have used so-called Weighted Inlier Equivalent Separations (WIES) as an output variable. A study undertaken by Yong et al[88], by using a stochastic frontier approach, has estimated the mean cost inefficiency in total operating expenditure for large Victorian public hospitals to be around 3 percent. The study employed staff salaries and WIES as input and output variables respectively.[vii]

As well as inpatient care, hospitals have to provide services for patients who report (respectively, since these are different functions) to outpatient and to emergency departments. To capture non-inpatient care, the number of outpatient visits and emergency attendances are widely accepted as clinical service variables. These variables refer to all medical and paramedical services delivered to patients who are attending outpatient and emergency facilities and are not formally admitted to the hospital. Hospital efficiency studies frequently use outpatient events such as the number of outpatient visits and/or emergency attendances.[79,89] Some studies have indicated that these outputs are assumed to be homogeneous and consequently do not need to be further aggregated.[90] This assumption, however, may stem from the fact that relatively little work has been done on classifying non-

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[vii] For more information about the calculation of WIES, refer to Yong et al.[88]

inpatient services compared with the detailed efforts made to categorize inpatient activities. Some researchers have attempted to respond to this deficiency. The simplest proposal has been offered by Banker et al.[91] in which they adjusted outpatient visits to reflect differences in resource utilization between surgical and non-surgical visits by consideration of the following formula:

Adjusted outpatient visits = Non-surgical outpatient visits + 2*Surgical outpatient visits

Later on, in 1990 the United States Congress directed the Health Care Financing Administration (HCFA) to develop an outpatient classification system named Ambulatory Patient Groups (APGs).[92] APGs are a patient classification system designed to explain the amount and type of resources used in an ambulatory visit. Patients in each APG have similar clinical characteristics and similar resource use. The APG serves the same function in ambulatory care as the DRGs serve for in-patient hospital care. APGs cover a wide spectrum of outpatient services, including emergency room, same day surgery unit, hospital clinics, and ancillary service departments. There are some differences in the categorisation of same day surgery in different countries. For example, while in the US, same day surgeries are counted within APGs, Australia has opted to count and classify same-day surgeries in its DRG system.

In some countries such as Canada and Australia, there is another system which is used to classify patients attending emergency departments based on the triage scale.[viii] This scale represents the complexity of clinical characteristics of patients and the urgency of their requirements to receive medical and nursing care.[93]

These approaches try to categorise non-inpatients in relatively homogeneous groups in order to increase the validity and reliability of performance measurement studies. However, due to the existence of some challenging issues regarding the successful implementation of the systems and differences in the nature of inpatient and outpatient care, outpatient classification systems were not used in the hospital efficiency studies found in the literature.

[viii] AIHW (2002) reports that the Australian National Triage Scale has five categories including: Resuscitation: immediate; Emergency: within 10 minutes, Urgent: within 30 minutes; Semi-urgent: within 60 minutes; Non-urgent: within 120 minutes

Diagnostic services

Diagnostic procedures are regarded as another hospital output in fulfilment of the service provision function. In this class, laboratory and imaging centre workloads are widely accepted as hospital output variables. The argument goes further to address that, when combined with major clinical events (separations, outpatient visits, and emergency attendances), diagnostic procedures provide a relatively comprehensive picture of the hospital service provision function.[66] These services include imaging and electro-medical tests (such as X-rays, ultrasounds, CT scans[ix], MRI[x], ECGs[xi], and EEGs[xii]) and laboratory tests (pathological, biochemical, and microbiological tests). These variables were used in different hospital efficiency studies. [94،95]

Support services also have outputs which can be measured. For example, "weight of clothes washed" as a variable for laundry, "number of meals served" as a variable for the canteen. [96] However, these variables are not normally used in hospital efficiency studies. This may due, at least in part, to the fact that they are dependant variables, since the number of staff or of admitted patients can affect the workload of these service providers leading to double-counting.

Some authors argue that when diagnostic services contribute to the care process in inpatient services, they become intermediate outputs and should be regarded as inputs to production of the final outputs such as separations.[xiii] This argument, however, has not been supported by the literature about hospital efficiency studies using fronterie-based techniques.

The above literature review on hospital efficiency studies in developed countries has revealed, as with the studies in developing countries, that these studies suffer from the following limitations. Firstly, the majority of these studies simply used the (adjusted) number of treated cases, and/or the number of services provided, and/or the quantity or costs of resources used. Using these variables will not sufficiently reflect the full scope of hospital functions. Omitting these types of outputs from efficiency measurement using frontier-based techniques, Newhouse[336] argues, may distort the results. Furthermore, as in developing countries, no

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[ix] Computed Tomography
[x] Magnetic Resonance Imaging
[xi] Electrocardiography
[xii] Electroencephalography
[xiii] Fetter RB.DRGs: their design and development. Michigan: Health Administeration Press; 1991.

study offered a comprehensive framework by which to select the most appropriate variables for hospital efficiency measurement reflecting a full range of hospital functions. Hospital efficiency studies have also paid a little attention to quality variables. Although a contentious point, a hospital may actually use more resources to provide higher quality services.[97] Despite this, only a few studies have attempted to incorporate quality variables for measuring hospital efficiency. For example, to measure the technical efficiency of perinatal care units in England, Thanassoulis et al [98] used "the level of satisfaction of mothers receiving perinatal care", and "the number of babies-at-risk surviving" as variables reflecting quality of care. They also used some variables reflecting the physical performance of units under assessment such as the "total number of birth episodes", and the "total number of deliveries". In the study undertaken by Sahin et al [99] in Turkish public hospitals, "mortality rate" as an undesired output was used to capture service quality. Although these studies provide a well-grounded argument regarding the importance of incorporating quality variables in health care provider efficiency measurement studies, they fail to compare the results of efficiency measurement by using different sets of variables. This could provide a better understanding of the extent to which the incorporation of quality variables could affect the findings.

In brief, compared to developing countries, hospital efficiency studies using frontier-based methods in developed countries have used a broader set of variables reflecting the resource intensity of procedures. This is mainly because the data on these variables are more readily available. Most developed countries benefit from the implementation of DRGs or other similar systems that reflect the complexity of interventions. Furthermore, a few studies in developed countries have used quality variables such as the number of babies-at-risk surviving. Whilst these studies have included variables that reflect quality of care, those variables are issue-specific, and a systematic framework that reflects the full range of hospital functions incorporating a fuller range of quality variables is not yet available.

2.4 Review of hospital efficiency studies using frontier-based methods to specify factors affecting efficiency

After reviewing hospital efficiency studies to identify the variables selected and the choice of the methods used to estimate the frontier, the next review question (see section 2.1) concerns the specification of possible factors influencing hospital efficiency. However, not all hospital efficiency studies undertook this task. In the literature various factors have been mentioned as affecting hospital performance. Some of these factors are under the control of hospital managers and/or policy makers, while others may not be easily changed. In general, they can be conceptualized in two categories; firstly the internal and external operating environment, and secondly patients characteristics.

2.4.1 External and internal operating environment

Market structure, regulation, and political issues are regarded as external factors that cannot easily be changed by an individual hospital. At the same time, there are some internal factors such as ownership, mismanagement, technology, the mission and the size of hospitals that can affect hospital performance. Market structure refers to the existence of competitors in the market. The factor is proxied by the Herfindahl index[xiv] or by the number of competitors in the local market. Regulation also influences hospital performance through the payment system or the price of services. Furthermore, it might be argued that political issues can impinge on hospital efficiency. For example, Aminloo[100] argued that there is an inappropriate geographical distribution of hospital beds in Iran. This has led to an overload of patients in some areas and unused beds in others, resulting in an inefficient use of resources. At least part of this problem, he argued, is related to existing political pressures to build new hospitals or to increase hospital beds in some geographic areas that will be important in future elections.

Button et al [101] suggested that the degree of uncompetitiveness in the market, the organisation's mission and profit orientation, and regulatory pressures could be regarded as major sources of cost inefficiency. Coulan et al [102] emphasised the role of the payment system in creating incentives for reducing inefficiency. Other studies have focused on the role of demand patterns, revealing that they can be considered as another environmental pressure on hospital efficiency.[103] However, there are some controversies in regard to whether these factors have a positive or negative relationship to hospital efficiency.

Rosko[104] employed regression analysis in two stages to identify factors which are assumed to influence hospital efficiency in the US. First, the study estimated inefficiency scores for 3,262 US hospitals in 1994. Then, the inefficiency scores were regressed against explanatory variables thought to influence hospital efficiency including competitive pressure, ownership,

[xiv] Sum of the squares of the market shares of admissions for all of the hospitals included in a study. This index takes on a value of 1 in monopolistic markets and approaches 0 when output is dispersed among many hospitals.

demand patterns, and the payment system. For the first variable, the study used a Herfindahl index. Ownership status was dichotomized as either investor-owned or otherwise. The study used the unemployment rate to reflect demand patterns, claiming it is related to the amount of uncompensated care provided by hospitals in the US. The author concluded that measured inefficiency was negatively related to the Herfindahl index and the unemployment rate, and contrary to expectations, positively related to for-profit status. The results of Rosko's study regarding for-profit hospitals are consistent with other hospital efficiency studies.[105,68] Regarding the method used in this study, i.e. the regression of non-parametric estimates of efficiency on environmental variables in two-stage procedures, Simar et al[xv] argue that this analysis is less accurate compared to other existing methods such as bootstrap procedures.

A few studies focused on the relationship between hospital efficiency and hospital mission. For example, Grosskopf et al.[106] showed that 90% of teaching hospitals in their samples in the US are unable to attain the best practice frontier of non-teaching hospitals. In other studies, the relationship between resources used, throughput ratios and efficiency was explored. For example, in the Yong et al.[41] two-stage analysis to estimate the efficiency of hospitals in Victoria which has already been mentioned, the authors selected the occupancy rate, the number of beds, and the number of medical staff per unit of WIES (Weighted Inlier Equivalent Separations) as explanatory variables. These variables, as the authors have pointed out, were guided by the literature and data availability. After regressing inefficiency scores against explanatory variables, the study concluded that hospital size (proxied by the number of beds) and the number of medical staff per WIES are positively related to inefficiency. However, the hospital occupancy rate was inversely related to hospital inefficiency.

Therefore, it could be argued that, there are several possible operating environmental factors that influence hospital efficiency. It is worth noting that, in employing regression analysis to identify factors influencing hospital performance, studies have first to identify explanatory variables that appear to be the most important factors affecting hospital efficiency. To deal with this limitation, other studies have used qualitative methods in order to cover a greater range of possible factors.

[xv] Simar L, Wilson PW. Estimation and inference in tow-stage semi-parametric models of production processes. Journal of Econometrics 2007; 136: 31-56.

In a study of Kenyan hospitals, Owino et al [34] carried out a survey using focus group discussions and questionnaires to explore the factors leading to inefficiency. The authors have shown that a shortage of professional staff, a poor combination of inputs, non-functional laboratories or theatres, transport problems, a poor distribution of medicines, and inadequate servicing of equipment are main reasons for inefficiency in public hospitals in Kenya. Somanathan et al [107] conducted a study to identify institutional and behavioural factors affecting efficiency in public hospitals in Sri Lanka. The authors employed in- depth interviews with hospitals managers to reveal the effects of their behavioural and environmental characteristics on the level of operation of the facility. They suggested that managers' personal attitudes, their educational qualifications and working experience, and a lack of authority are factors that affect the efficiency of facilities.

2.4.2 Patient characteristics

The second category of possible influential factors on hospital efficiency is the patients' characteristics and socioeconomic background. Thirty-five years after the introduction of the "Inverse Care Law" first suggested by Hart, stating that medical services are distributed inversely to the need of the population served, it has been argued that the law still alive and powerful.[331] This implies that, people in more need (for example, socioeconomically deprived patients) have less access to health care services. This can adversely affect the efficiency of health care providers, because they are unable to meet social needs. The impact of patient characteristics on hospital efficiency has been noted by other studies as well. Hughes et al [108] demonstrated different needs for hospital resources between patients in different education and income classes. Similarly, Martin et al [109] showed a significant and positive relation between socioeconomic indicators and length of stay as a throughput variable. On the other hand, some studies have focused on the association between patients' demographic characteristics and their preferences. For example, Gary et al [110] demonstrated that age and race consistently have a statistically significant effect on patient satisfaction. This evidence shows that the appropriate use of knowledge and available resources does not always lead to better health outcomes.

2.5 Summary of the main findings

The present literature review has revealed a number of key issues in hospital efficiency studies, namely the concept of efficiency itself, the variables selected and methods used to measure efficiency, and factors affecting hospital efficiency. A summary of these issues is presented in the following parts.

- **Type of efficiency measured in hospital efficiency studies**

  Almost all hospital efficiency studies focused on the measurement of technical and operational efficiency with a prominent focus on outputs. Adopting these notions of efficiency and these variables implies that hospital efficiency studies fail to incorporate health outcomes, and individual and societal preferences in efficiency measurement, leading to suboptimal recommendations.[111] Thus, to consider individual and societal perspectives, another type of efficiency, allocative efficiency, is needed. Allocative efficiency involves making sure that health organisations are supplying the amount and type of services that the members of society prefer. Because of problems in valuing inputs and outputs and also societal preferences, few studies of this type have so far reported allocative efficiency.

- **Variables used**

  The input variables in the existing literature have focussed on human factors, capital, and consumables resources. The number of staff or the number of working hours, or monetary values i.e. salaries have been used as human resource input variables. In terms of capital inputs, studies have mainly used "number of beds", "net plant assets", or "depreciation charges". A few studies have employed variables relevant to consumables such as the monetary value of drugs.

  Output variables have been mainly based on hospital treatment services such as outpatient visits, (adjusted) inpatient separations, inpatient days, laboratory tests and emergency visits. The number of inpatient separations or outpatient visits have been commonly employed as proxies for hospital outputs, perhaps because these variables can reflect the major services that are being offered.

- **The importance of procedural complexity**

  Almost all the studies have emphasised the importance of the complexity of the mix of procedures when attempting to identify outputs. Due to data limitations, some studies used only the numbers of separations and outpatient visits as output variables. It is clear that these types of variable fail to address the complexity of hospital procedures.

To compensate for that, a group of studies divided inpatient separations into non-surgical and surgical interventions, or intensive and non-intensive services, apparently because surgical interventions or intensive care services need extra equipment. These classifications, however, cannot capture enough of the complexity of the mix of procedures. For example, some medical procedures such as hemodialysis or chemotherapy are quite resource-intense interventions.

To address service complexity while allowing for shortcomings in data availability, the studies reviewed used the relative values to distinguish between minor and major interventions or, more validly, the adjusted number of separations such as DRGs or WIES based separations.

- **Selection of the variables**

  There has been little attention to any framework for selecting the most appropriate variables in hospital efficiency studies. This, however, is an important issue, because the validity of efficiency studies highly depends on the choice of appropriate variables, which must be justified with reasoned argument.[112]

- **Methods used**

  Despite appearing complicated at first sight, the basis of efficiency is the relationship between inputs and outputs. Consequently, it seems that some simple ratios including average length of stay, occupancy rate, the ratio of staff numbers to beds, and the number of beds to people in a target area can provide a generally useful but inevitably limited overview of the data structure before turning to more complicated procedures.

  To respond to the shortcomings associated with simple ratio analysis, frontier-based techniques are being used increasingly to measure the efficiency of health care services. The present literature review has revealed that DEA is the most common frontier-based method in current use. This can be attributed to its relative advantage over other methods applied in the health sector.

- **Factors affecting hospital efficiency:**

  Hospital efficiency studies have used different methods to determine possible causes of hospital inefficiency. A group of studies, by using regression analysis, attempted to identify plausible factors influencing efficiency scores. However, others employed qualitative methods like focus group discussions and in-depth interviews to identify influences on efficiency. The present literature review has revealed that market competitiveness, profit orientation, the payment system, managerial behaviours and characteristics, the degree of authority, support from voluntary and community organisations, individual characteristics and the socioeconomic background of patients can be regarded as major factors influencing hospital efficiency.

Although the studies reviewed in this chapter provided a range of information about hospital efficiency, still two issues need to be explored in more detail. First, most studies reported results from the USA, UK or other developed countries, with a little attempt to measure hospital efficiency in developing countries in general, and the Iranian hospitals in particular. This is important, because some studies have shown that, compared with developed countries, hospital costs take a greater share of health care expenditures in developing countries, generally between 50% to 80%.[4] Second, the variables employed in most studies have predominantly been concerned with the quantity and/or cost of the services provided, reflecting a narrow view of hospital functions, namely patient care. However, a growing body of literature has documented different functions for hospitals apart from patient care, namely, among others, protective care, preventive care, and health promotion activities that each of them can play a crucial role in improving population wellbeing. Exploring these two issues in more depth will provide a conceptual and practical basis to identify gaps of the literature (section 2.6), leading subsequently to the objectives of the present study (section 2.7).

2.6 Identification of the gaps in the literature

Based on the main findings from the literature review, two gaps in the literature have been revealed. These two gaps - practical or geographical, and conceptual - are discussed in the following sections (2.6.1 and 2.6.2).

2.6.1 Practical (geographical) gap

While numerous studies have been undertaken in developed countries, there have been only a few attempts at measurement of hospital efficiency in developing countries. However, there has so far been no systematic attempt, using frontier-based methods, to measure the efficiency of Iranian hospitals, and to analyse factors affecting efficiency. This thesis is the first systematic attempt to examine the efficiency status of the health sector in this country using frontier-based methods. The study is also one of the few attempts to measure hospital efficiency in countries of the Middle East.

Many countries are being challenged with an escalating trend in health services costs, particularly in public hospitals. Iran as a developing country is no exception. Inpatient services in Iran are provided by the following sectors:

1. The public sector
    - The Ministry of Health (MOH)
    - The Social Security Organization (SSO)
    - The military forces
2. The private sector
3. The charitable sector

The Iranian constitution emphasizes extending social benefits. The most important elements include retirement, unemployment, disability benefits, and health services provided through insurance or other means. To achieve these goals, insurance activities have been established in two different types. The SSO, the Civil Servant Retirement Organization, the Armed Forces' Pension Funds and the Organization of Health Insurance are responsible for a contributory system. The non-contributory system includes social assistance organizations such as the Iranian Red Crescent and the Welfare Organization.

The SSO plays an important role by providing social benefits for 40% of the Iranian population (28 million). The SSO, after the Ministry of Health (MOH), is the main institutional source in hospital care in Iran. In the financial year 2002-03, the SSO operated 59 hospitals with around 8,200 beds (10% of the total available beds in Iran). [11]

The SSO uses substantial financial and human resources in its hospitals and clinics to provide health services. Hospital expenditures represent an important proportion of the SSO health budget. In 2001, more than 66% of all health care expenditures in the SSO were spent on its hospitals.[11] This represents a 10% increase in the hospitals' costs when compared with the share in 1993 (Table 2.1).

Year	Share of hospital expenditure in the SSO health budget
1993	56%
1997	59%
2001	66%

Table 2.1: Share of hospital expenditure in the SSO total health budget
Source: Annual Statistics Report SSO, 2002

The growing trend in hospital costs and the anecdotal evidence of inefficiency (such as overstaffing, a lack of data regarding the burden of disease, etc.) are a concern for the SSO. Inefficient use of the hospital resources can lead to less being available for other health programs that may improve population wellbeing. Despite such a general concern, there has been no systematic attempt to measure the efficiency of the Iranian and the SSO hospitals, and to analyse factors affecting efficiency. The present research is motivated to cover this gap in the literature.

2.6.2 Conceptual gap in the literature

Considering the imperative to select the most appropriate variables in hospital efficiency studies, and the absence of a well-defined framework in the literature (particularly in the literature related to the developing countries), the second motivation behind this study is to propose a framework to cover a full range of hospital functions.

The specification of input and output variables is a key step in an evaluation of comparative performance because the results of any efficiency measurement depend heavily on the variables used.[113,114] For example, in an attempt to measure the efficiency of Norwegian hospitals, Magnussen [115] has shown that the hospitals' rankings were subject to a substantial variation due to changes in the specification of output variables. This phenomenon has also been noted by other studies.[116]

The present literature review has shown that the rationale for the choice of input and output variables is not of sufficient depth. In selecting variables, a majority of studies rely on pragmatic criteria; a phenomenon described by Parkin et al [116] as 'common-sense rules'. Such 'common-sense rules' lay emphasis on covering the full range of resources used and capturing all relevant activity levels.[117] However, what is meant by 'full range of resources' and 'relevant activities' awaits clarification. This is evident from the fact that, when using the 'common sense rules', different studies have selected different sets of variables. The variables employed in most studies have predominantly been concerned with the quantity and/or cost of the services provided. This approach assumes a relationship between the episodes of service provision and improvement in health. From here onward, I use the term "service-oriented approach" for efficiency studies that rely on output and input variables that are concerned mainly with the quantity of clinical services provided and resources used. The service-oriented approach suffers from at least two drawbacks.

Firstly, and most importantly, the use of a service-oriented approach reflects a narrow view of hospital functions, especially for the developing countries. This approach emphasises the curative care (or therapeutic) function of the hospital. Although, curative care is the core function, there is a growing emphasis on a broader set of hospital functions and objectives.[2] Understanding of the hospital's role has widened from patient care alone to a range of functions that include protective and preventive care, health promotion, health workforce development, and interaction with and support for other components of the health care system.

Secondly, the service-oriented approach only partially takes into account the quality of the care provided. The trade-off between resources used and quality of care, and the use of quality variables in hospital efficiency studies and their impact on efficiency scores might be regarded as a contentious point. There has been a long debate about this.[118] Newhouse[119] has pointed out that a quantity-quality trade-off is always present when resources are constrained. As some studies have shown, it is possible that a hospital providing better quality care may need relatively more resources compared to a hospital providing relatively poor quality care.[97] This might be particularly true when the higher amount of an input in one hospital compared with other hospitals (for example the number of doctors, which is frequently used in hospital efficiency studies as an input variable), affects the quality of care with little impact on the number of services provided by that hospital. An efficiency analysis focussing only on the quantity of services may spuriously suggest quality-oriented hospitals to be inefficient. Despite this, as pointed out earlier, only a few hospital efficiency studies have employed variables that reflect the quality of care. In not addressing the quality of care and a full range of hospital functions, hospital efficiency studies may run the risk of making biased comparisons, resulting in misleading findings.

2.7 Statement of research objectives

This study has set out to rectify the apparent practical and conceptual gaps in the literature on hospital efficiency measurement.

Overall, the principal aim of this thesis is to enhance hospital performance with a focus on the Iranian hospitals (and SSO hospitals in particular) by meeting the following objectives:

1. to propose a framework to identify the most appropriate variables for measuring hospital efficiency;
2. to determine deficiencies in the current hospital database and to identify new data that are required to enhance efficiency measurement in the Iranian SSO hospitals;
3. to identify the relatively efficient and inefficient SSO hospitals;
4. to measure the magnitude of inefficiency of the inefficient hospitals;
5. to analyse factors affecting hospital efficiency, by using qualitative methods, both from within the hospital and from its surrounding environment;
6. to identify options, by using qualitative methods, for actions that would make an inefficient hospital more efficient.

2.8 Concluding remarks

It has been argued that hospital efficiency measurement is an important public health issue, because it is a valid measure for improving hospital management, rationalizing resource allocation, and mobilizing additional inputs (or reducing them). These outcomes of efficiency measurement can enhance hospital performance in attaining their ultimate goal, the improvement of population wellbeing.

The breadth of literature related to hospital efficiency studies is variable. While numerous studies have been undertaken in developed countries, there have been only a few attempts at measurement of hospital efficiency in developing countries. In Iran, the subject has not been prominent in the literature. This is particularly evident in the SSO hospitals where there is some anecdotal evidence about the existence of important inefficiency.

The variables employed in the majority of hospital efficiency studies are almost all measures of the episodes of health care, reflecting only one function of hospitals, namely curative care. This service-oriented approach focuses only on one hospital function ignoring other functions. Furthermore, this approach does not allow the distinction between inefficiency and higher quality services, mainly because of problems in valuing quality of care. Few published studies of hospital efficiency have offered a framework for selecting the most appropriate variables for measuring hospital efficiency using frontier-based techniques.

The present study has set out to rectify these apparent gaps in the literature on hospital efficiency measurement. Because of the paucity of literature, such an investigation into hospital efficiency measurement is an appropriate and justifiable area of research.

CHAPTER 3

METHODS

Chapter overview

In chapter 2, I presented a formal statement of the research objectives. This chapter (chapter 3) describes the methods used in the thesis to meet the objectives. It should be stressed that I am only going to outline the methods and provide signposts to where the details on the methods can be found in the subsequent chapters. This chapter has three sections. Section 3.1 is a discussion of the general framework of the thesis. Section 3.2 addresses the methods, focusing on the data (for the quantitative component) and the selection of participants (for the qualitative component), and the data analysis for both quantitative and qualitative components. Finally, section 3.3 discusses ethical issues.

3.1 General framework of the thesis

The general framework of the present study is outlined in Figure 3.1. To meet all research objectives, this thesis can be conceptualized in three components. The first component begins with a review of the peer-reviewed literature on hospital functions and performance measurement in order to propose a framework for choosing the most appropriate input and output variables. The availability of the variables proposed can be examined in order to determine deficiencies in the current SSO hospital database. The second component (quantitative) involves an analysis of selected variables in order to measure SSO hospital efficiency and identification of the magnitude of inefficiency using DEA. The third component (qualitative) involves an analysis of factors affecting efficiency and possible actions to improve efficiency using qualitative methods.

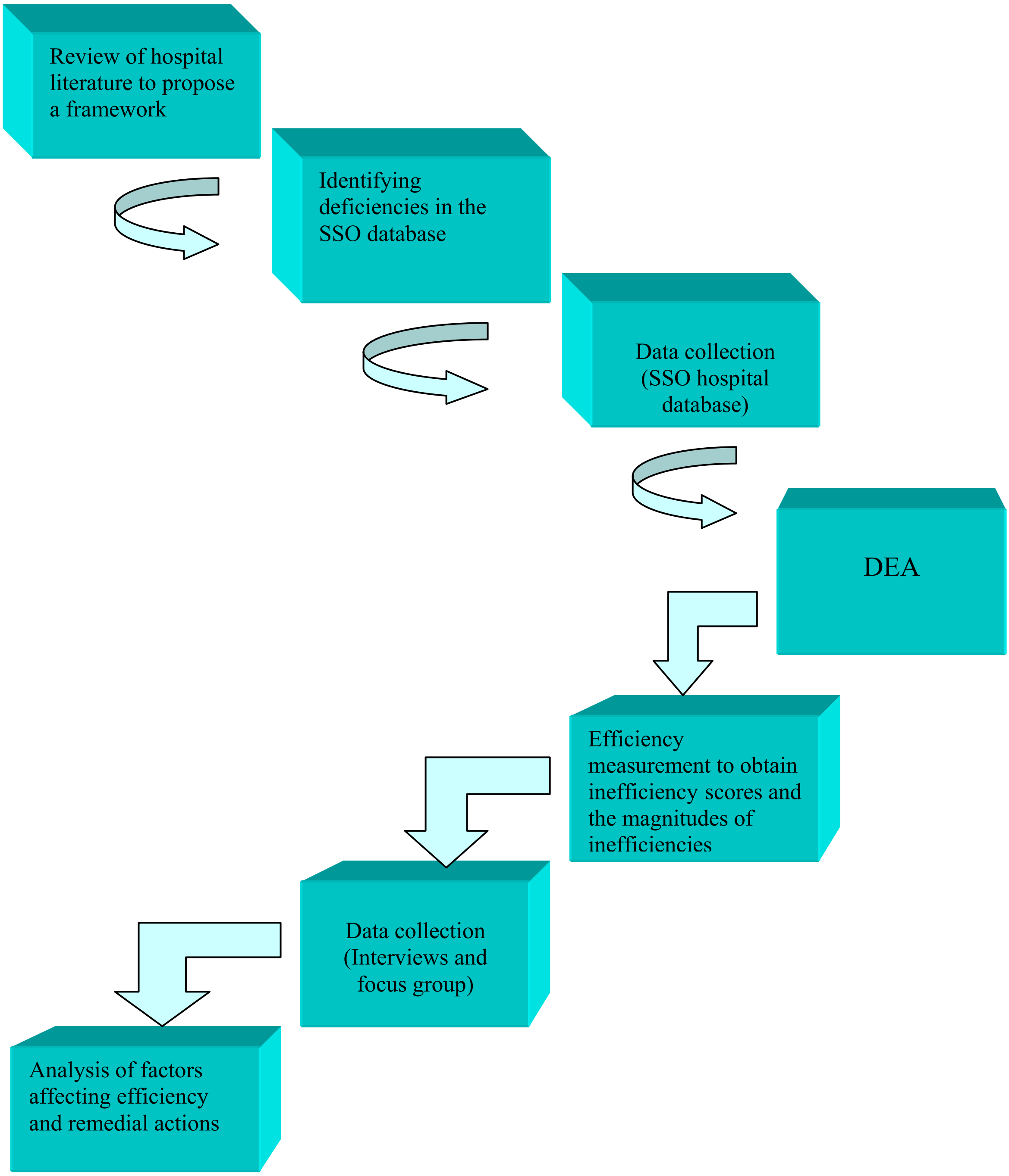

Figure 3.1*:* The main steps involved in this thesis

3.2 Methods

3.2.1 First component: method for proposing a framework for selecting variables

A review was conducted of the published peer- reviewed literature on the main objectives of a hospital, the full range of hospital functions, and hospital performance measurement. To propose such a framework, this thesis builds on (i) Health Promoting Hospital concept [136] (ii) recent well-developed quality-oriented reviews of hospital performance measurement (such as The World Health Organisation literature on hospital performance assessment, and reports published by the Agency for Healthcare Research and Quality). To retrieve these documents, the main strategies were: Internet search engines, official website search, the search of electronic databases, and a check of references from selected documents. This component proposed a framework for selecting variables that reflect a full range of hospital functions and quality of care, focusing on the Iranian hospitals (and SSO hospitals in particular). I did not, however, identify new variables in measuring hospital efficiency. Rather, using a system-based framework, I identified the most appropriate set of variables in addition to the existing appropriate variables used by other researchers- based on a full range of hospital functions and the quality of care- that can be employed in evaluation of hospital efficiency. To achieve that, the following criteria were used (see chapter 4, section 4.2.1 for more detail). First, the variables to be selected are those that reflect the values of the various stakeholders including patient, staff, and community. This criterion reflects a holistic approach to different hospital roles and functions. Furthermore, emphasis was placed on the variables that reflect performance on key hospital functions. Finally, efforts were made to choose variables that are under the actual control of the hospitals themselves.

After proposing the most appropriate variables, those variables for which data were available in the current SSO database were used in measuring the efficiency of the SSO hospitals. The variables that were unavailable from the database represent new variables whose capture will necessitate enhancement of the SSO hospital database.

3.2.2 Second component: method for identifying relatively efficient and inefficient SSO hospitals

This component concerns the analysis of selected variables using DEA to measure the SSO hospitals' efficiency and to estimate the magnitude of possible inefficiencies. However, before turning to more complicated procedures of efficiency measurement (DEA), the following points should be noted.

First, as the literature review in chapter 2 has revealed, there exist some internal and external factors such as size, mission, and patient characteristics that can influence hospital efficiency. From this standpoint, in order to avoid confounding by these basic factors, the stratification of the sample of hospitals into more homogeneous subgroups is crucial (see chapter 6, sections 6.2.1 and 6.4.4 for more detail). Accordingly, hospitals were categorized according to their size, because studies of economies of scale (how size affects average costs) for hospitals have shown that diseconomies of scale became apparent as hospital size increases.[57] Furthermore, some SSO hospitals are teaching hospitals requiring a different mix of the resources affecting their efficiency. Thus, another classification for the SSO hospitals was based on their mission. Finally, using Human Development Index (HDI) values to capture a social picture of patients and population needs in the target area, the SSO hospitals were classified according to their location (hospitals located in low and high HDI value regions).

Second, simple ratios were examined initially because they could provide a general overview of the data structure, pointing to the relative efficiency of hospitals for a given ratio. For the present study, staffing ratios such as the number of FTE staff employed classified into craft groups (medical and paramedical doctors, nurses, diagnostic and allied health professionals, and administrative and clerical staff), number of beds per medical doctor, and number of separations per medical doctor were computed. Then, outputs were addressed by measuring the number of outpatient visits, the number of surgical and non-surgical interventions, and the proportion of major surgical interventions (reflecting the complexity of services provided by the SSO hospitals). Finally, throughput measures such as the Bed Occupancy Rate (BOR), Bed Turnover Rate (BTR), and simultaneous assessment of BOR and BTR were explored in more detail and compared across the SSO hospitals (see chapter 5, section 5.5 for more detail).

Having established the limits posed by simple ratio analysis in dealing with multiple inputs and multiple outputs, this thesis used DEA to measure SSO hospital efficiency and the magnitude of the inefficiencies identified. In the following section, I will briefly discuss frontier-based methods with a focus on DEA. For more information on the technical aspects of DEA, see chapter 6, section 6.2.

3.2.2.1 Frontier-based techniques

Broadly, there are two types of frontier-based techniques. These two types are Stochastic Frontier Analysis based on a regression method and DEA as a non-parametric method. Both methods compare the performance of individual units against an estimated efficient frontier.

SFA as an advanced econometric method uses statistical methods to fit a frontier. The method is able to recognize the possibility of measurement error. In SFA the form of the cost or production function is assumed to be known or is estimated statistically. SFA generates efficiency measures, computed in terms of the distance that lies between the observation and the estimated function. However, in many cases there is no known functional form. This is especially true in the case of public sector organizations such as a health service provider.[120] DEA, on the other hand, as a non-parametric method, makes no assumption about the form of the underlying production function or the distributions of errors. DEA was first introduced into the literature in 1978 as a generalization of a framework due to Farrell.[121] DEA calculates the efficiency of an individual organization in a group relative to the best performing organization in that group. These individual units are also referred to as Decision Making Units (DMUs). The DMU for which an efficiency score is measured can be a whole agency such as a hospital, or units within organizations such as separate hospital wards. DEA uses a linear programming model to estimate the efficient production frontier, comparing a particular DMU’s performance with the efficient frontier. In the process, some units achieve 100% efficiency and are referred to as the relatively efficient units, while other units with efficiency ratings of less than 100% are considered inefficient units. For each inefficient unit (one that lies below the frontier) DEA identifies the sources and level of inefficiency for both inputs and outputs.

The review of the literature has shown that the extent of agreement between these two methods (paramedic and non-parametric) for a given set of hospitals using the same variables is inconclusive. Bryce et al [122] used SFA and DEA on 585 hospitals in the USA on panel data from 1985 to 1994, concluding that different methods lead to different results. Computing the Spearman Correlation Coefficient for DEA and SFA efficiency estimates, the study found a significant difference in ranking of the hospitals. Jacobs [82] ran SFA and DEA on a sample of 232 UK hospital trusts. According to the findings of this study, the SFA mean ranged from 0.64 to 0.93 and the DEA mean from 0.831 to 0.876. This study has also found that the correlations between DEA and SFA models are generally low. However, there are some studies indicating agreement across the methods. For example, Linna et al [123] compared SFA and DEA methods for a sample of 48 Finnish hospitals concluding that there was a broad agreement on the average of the respective efficiency scores. Computing correlations, this study has found an agreement between two methods in ranking individual hospitals.

Finding like those above make it premature to close the debate over the choice of frontier-based methods in hospital efficiency studies. However, there are some compelling reasons that have convinced me to employ DEA. First, unlike parametric methods, DEA does not require explicit specification of the functional forms relating inputs and outputs. This is the main concern of researchers using parametric methods, because in some situations like public sector organizations, there is no known production or cost function.[117] Furthermore, and especially for measuring efficiency in health care services, DEA provides a simple tool to deal with multiple inputs and multiple outputs. This is clearly an asset when analysing the hospital sector, where proxy variables employed for outputs and inputs consist of different elements of curing, caring, and other hospital functions. Finally, as Chaffai[124] states, a deficiency of all of the regression approaches is their inability to identify the sources of inefficiency (inputs and outputs) and estimate the inefficiency amounts associated with these sources. In contrast, DEA provides both the sources and amounts of any inefficiency. Through DEA, it is possible to estimate which and how many of the inputs were utilized inefficiently, and which and how many of the outputs were not produced. This characteristic of DEA is necessary for the present study which is seeking to identify the magnitude of possible inefficiencies.

The above theoretical and practical advantages of DEA over SFA can explain, at least in part, the dominance of DEA in hospital efficiency studies as has been revealed by the literature review discussed in chapter 2.

3.2.2.2 Sample and data

The sample for this component (quantitative) of the study covered all 59 SSO hospitals. The data upon which this study is based were obtained from the Annual Statistical Report [11] published by the SSO, the most recently available being for the year April 2002 to March 2003 (the Iranian fiscal year). This report is published annually by the Department of

Statistics of the SSO and contains administrative, operational, and clinical information on all the SSO hospitals.

3.2.2.3 Data analysis

The data generated in the quantitative component were formatted and analysed using the software known as Performance Improvement Management; DEA Soft – V1 (PIM DEASOFT- V1).[125] The first stage of analysis involved the estimation of hospital-specific technical and scale efficiency levels and the mean efficiency for all hospitals. Thereafter, target levels for inefficient hospitals which would render them efficient were determined (magnitude of inefficiencies). Furthermore, given the fact that in any DEA analysis some Decision Making Units (DMUs) are always classified as efficient units relative to others, the thesis provided a full assessment of efficient units. Additionally, appropriate statistical tests were used to compare the population means of the efficient and inefficient hospitals in different clusters based on hospital size and location. Finally, to demonstrate the discriminative power of DEA, and in order to show the comparability of commonly used simple ratio analysis with DEA, comparisons of some simple ratios with the DEA findings were carried out (see chapter 6, section 6.4 for more detail on data analysis).

3.2.3 Third component: method for analysing factors affecting hospital efficiency and identifying options for action

The third component of the research focuses on determining possible causes of inefficiencies and options for actions to improve efficiency. To fulfil these objectives, I used qualitative methods (see chapter 7, section 7.1 for more detail). The main purpose in qualitative research is to realize a process or event in depth.[126] Furthermore, qualitative methods are useful when relevant variables are unknown or could not easily be collected through quantitative surveys, or when researchers want to reveal the importance of context, culture, and local factors.

A qualitative interview approach is appropriate to explore the personal and managerial experiences of hospital executives and health professionals involved in the SSO health system. To achieve this, in-depth interviews with 11 health professionals involved in the SSO health system were conducted (see chapter 7, section 7.2.1 for more detail on sampling techniques, sample size, and inclusion criteria). A benefit of utilizing this method is that participants are able to express their experiences, feelings, and opinions of an issue, in this case the factors affecting hospital inefficiency and possible actions to improve efficiency, in their own terms.[127] However, to ensure that all relevant topics, according to the findings from the first phase, are covered and that comparable information are obtained from a number of people, an interview guide were utilized (see chapter 7, section 7.2.2 for more detail on the methods of data collection). In addition, a focus group discussion was held with eight key informants involved in the SSO or national health system to obtain their assessment of the issues (see chapter 7, section 7.2.2 for more detail).

3.2.3.1 Sample and data

The qualitative component of the present study used the guidelines provided by Patton.[127] These guidelines provide a useful framework for thinking about how to select a study sample. In general, the present study used purposive sampling to allow a realistic pursuit of information (see chapter 7, section 7.2.1 for more detail). It means that the researcher selects those participants whom he thinks will provide the best and most relevant information. From this perspective, purposive sampling can include various types of sampling techniques to achieve real representation from a study population. First, I identified key informants based on inclusion criteria (deliberate and direct choice of participants) (see chapter 7, section 7.2.1 for more information on inclusion criteria). It is clear that the most appropriate participants for the study are people who, when interviewed, are able to provide information that is highly relevant or to suggest other people the researcher may want to interview to obtain relevant information. The initial group of participants (a mix of policy makers, experts, physicians, and administrative staff) that I identified were used as key informants to direct me to other participants (snowball technique). I stopped adding to the sample when new information became infrequent.

3.2.3.2 Data analysis [xvi]

To assist in gathering the qualitative data from both the in-depth interviews and the focus group discussion, an audio-recorder was used. However, I explicitly approached participants with the option to decline to be recorded if they so wished. The use of tape recording was agreed by all participants. Then, the material was transcribed and prepared for analysis. The data were analysed in several steps. First, I personally translated all interviews into English and transcribed them. I then read the materials as a whole to note my general impression.

[xvi] See chapter 7, section 7.2.3 for more information on data analysis

Then, transcripts were re-read to look for areas of text that were related to each of the main categories identified based on the research objectives. Thereafter, transcripts were coded by short text descriptors. This made the analysis easier to identify sections of interest. The final stage consisted of synthesizing the findings, and developing ideas arising out of the data, looking for similarities and differences in the responses in more depth.

3.3 Ethics

This research did not involve any experimentation on patients. To collect primary quantitative and qualitative information as required, I took every practicable measure to ensure the confidentiality of research participants.

The variables that were used for the quantitative component provided an aggregated view of hospital facilities and services (such as the number of beds, the number of staff, total number of separations, total number of surgical interventions, etc.) and did not include any information on individual persons.

For the qualitative component, the privacy of research participants and personal information was kept in a secure location and electronic data were kept in a password protected computer, on the password protected network of the Discipline of Public Health. In addition, I considered the autonomy of all persons who may be involved in the research. I also prepared the information sheet (Appendix B) describing the purpose of the study, nature and procedures of the research, the likely duration of interviews, the anticipated use of the data, issues relating to data storage and security, and possible consequences as fully as possible and in terms meaningful to the participants. Those approached were given information regarding their right to refuse participation for whatever reason. When audio-recorders were used those studied were made aware of the capacities of such devices and were free to reject their use. I also designed a consent form to be signed by each participant (Appendix C).

This study obtained ethics approval from the Human Ethics Committee of the University of Adelaide. Approval to obtain quantitative data and to conduct interviews with SSO health professionals was also obtained from the Deputy of the Iranian SSO Health Affairs, and the General Director of the Iranian SSO International Affairs.

CHAPTER 4

A HEALTH-ORIENTED CONCEPTUAL FRAMEWORK FOR SELECTING THE MOST APPROPRIATE VARIABLES FOR MEASURING HOSPITAL EFFICIENCY WHEN USING FRONTIER-BASED METHODS

Chapter overview

The purpose of this chapter is to propose a conceptual framework for selecting the most appropriate variables to measure hospital efficiency when using frontier-based methods. As pointed out earlier in chapter 2, the variables employed for measuring hospital efficiency in the majority of studies have been mainly based upon a narrow view of hospital functions and the quantity and/or costs of services provided and resources used. This means that there has been little attention to a broader set of variables reflecting a full range of hospital functions and the quality of care provided. Inattention to these functions can affect the results of the studies as, without an understanding of the main objectives of the organization under assessment and all relevant functions, measured efficiency runs the risk of being misleading.

Believing that a hospital is the hub of an integrated health care system contributing to the improvement of overall population health status[128], and basing its foundations on an enhanced understanding of what "ought to" be the objectives and functions of a hospital, this chapter is an attempt to propose a framework for choosing variables to measure hospital efficiency. This framework should recognise the importance of quality of health care and reflect a coherent set of key hospital functions with an emphasis on their applicability to Iran (particularly hospitals owned by the Iranian SSO). To achieve this, the chapter will review the literature published on hospital functions and performance (for more detail, see chapter 3, section 3.2.1). It should be stressed that this chapter does not aim to identify new variables. Rather, it suggests the most appropriate variables for measuring hospital efficiency.

The chapter is structured in four sections. Section 4.1 will describe a comprehensive list of hospitals functions. Inspired by a full range of hospital functions defined in section 4.1, section 4.2 will propose a health-oriented conceptual framework for hospital efficiency measurement, and the criteria for selecting the most appropriate variables. Section 4.3 will provide a detailed description of variables relevant to various steps in the proposed framework. Conclusions will be presented in section 4.4.

4.1 Hospital functions as the basis for a health-oriented framework for hospital efficiency measurement

To propose a coherent framework for selecting variables, an understanding of a wider set of hospital functions is required. Dyson[129] has suggested that, to properly manage an organisation, the set of performance variables should reflect all relevant objectives and functions of that organisation. Designing a coherent framework and selecting appropriate variables should reflect what a hospital ought to achieve and how it carries out its functions.[130] This immediately raises a concern regarding the difficulty in specifying any hospital's objectives, functions and valued products.[131,132]

The World Health Organisation (WHO) states that hospital functions should meet the needs of the target population considering the resources available, and be coordinated with services provided by other health care organisations.[133] It is likely that such a statement will contain different elements depending on the nation's stage of socioeconomic development.

Since 1970, efforts have been made to find an acceptable framework within which to define a hospital, and its main functions and outputs. The last few years have witnessed substantial growth in understanding about what hospitals ought to do. WHO projects on hospital performance assessment define satisfactory performance as the maintenance of a state of functioning corresponded to societal, patient, and professional norms.[5] From this standpoint, the main objectives of health care systems and their subcomponents should be based on optimal contribution to health outcomes, minimal risk to the patient, staff development, responsiveness to community needs, interaction with other health care providers, and commitment to health promotion.[5,134,135] Hospitals should be assessed by the extent to which they achieve these. This statement is in line with the objectives of the hospitals located in Iran (particularly the SSO hospitals) or other developing countries, where the hospital's contribution to population health is important.

To achieve the above objectives, a set of appropriate functions needs to be identified. Traditionally, the hospital has been regarded as a centre for offering a wide range of curative services. These services could be divided into two main categories, namely clinical and diagnostic services. The services were discussed in chapter 2, section 2.3.4.2. These services, although considered to be core functions, do not wholly reflect all hospital functions.

"Population health" in contrast to "individual health" requires working beyond the provision of curative care for individuals. Additionally, such population services should address health as "a state of complete physical, mental and social well-being and not merely the absence of disease."[134] This view of health has been considered in the Health Promoting Hospitals (HPH) concept.

The concept of an HPH requires hospitals to promote health, to foster participation of target groups including patients, staff, and community, to offer education and information to target groups, and to improve communication with other types of health care provider.[136,137,138,139] To develop this idea in the context of a hospital environment, some authors indicate a number of general tendencies.[140] First, the hospital organization needs to be repositioned in order to redefine the specific range of new functions. Hospitals have to show their awareness of the patient's life before and after admission, provide an educational program for patients and staff, run disease prevention activities, offer a healthy work-place for staff, provide high quality services for patients, and cooperate with other health service providers and the community. This is especially so for hospitals in developing countries. Second, the hospital should be committed to improving and assuring the quality of its services.

Adopting the above perspective, a comprehensive list of hospital functions can be classified into *productive* and *interactive* functions. This thesis places all functions related to the hospital's internal environment which contribute to producing health amongst its productive functions. Then, all of those hospital functions reflecting its capacity for interaction with its surrounding environment are considered to be its interactive functions. The discussion is centred around the situation of hospitals in Iran (and in a social organisation such as the SSO) and in other developing countries comparable to Iran.

4.1.1 Productive function

The productive function refers to how the hospital directly improves patient health and ameliorates sickness through fundamental roles that include curative, preventive, and protective services. This function is about the performance of various internal elements within any hospital, and about the hospital's capacity to integrate these elements in order to *produce* health. Some measures of curative care include output volumes (such as the number of surgical procedures) and quality of services provided (such as unplanned readmission rates). Preventive care involves interventions such as health education programs particularly for patients with chronic conditions such as diabetes mellitus, asthma, and hypertension. Protective care is about providing an error-minimal service to patients (measured, for example, by the number of postoperative sepsis) and a healthy working place for the staff. Other examples of productive functions include staff training and development (for example, the provision of training workshops).

4.1.2 Interactive function

This function is attributed to the capacity of the hospital in providing an effective *interaction* with its surrounding environment which is required to fulfil its role as a health promoting hospital. In the past, hospitals were mainly concerned with their productive functions. More recently, under the influence of movements such as the HPH, there is an emerging imperative to form an effective relationship between the hospital and other levels of the health care system, and with society at large. This function refers to the co-ordination by which the hospital deals with other parts of the health system (for example, a primary health care network). It also refers to the hospital's responsiveness to societal needs ensuring that the hospital is appropriately responding to the population health related issues. The interactive function of the hospital can impact upon patient health outcomes. For example, an association has been found between collaboration amongst health providers and mortality and quality of life.[141]

Considering a full range of hospital functions potentially has a marked impact on hospital efficiency measurement. If efficiency measurement is to be used as a tool to manage effectively an organization such as a hospital, the variables used to measure efficiency should cover a full range of functions which are needed to attain the hospital's objectives. This ensures that there is a link between variables used and hospital functions, leading to the enhancement of the validity of efficiency studies.

Inspired by the productive and interactive functions defined above, and the values of various stakeholders, including patient, staff, and community, a conceptual health-oriented framework for hospital efficiency measurement especially in developing countries is proposed in the following section (4.2). However, before developing the framework, the following points should be noted. Firstly, this framework proposes those variables that are relevant to the standards which are promoted by the European HPH Network. There is a growing body of literature to support the effectiveness of the HPH standards and functions that ought to be provided within the hospital setting.[xvii] Further research is now required to assess these for cost-effectiveness.

Secondly, it should be stressed that definitions of hospital missions and functions have to be addressed in the context of the type of hospital and of the overall health system. For example, non-profit hospitals (such as SSO hospitals) may have different institutional constraints, missions, and subsequently different functions compared with private hospitals.[xviii] These hospitals are expected to provide more community-oriented services, including preventive care and health promoting activities. In many developing countries, a substantial amount of health funds is spent on building new hospitals or developing existing hospital facilities with little attention to PHC capacities. Yet the PHC movement encourages hospitals in developing countries to reach out to the community, offering preventive care as well as curative care.[2] Thus, providing these community-based services by hospitals in developing countries in general, and the SSO hospitals in particular is appropriate.

4.2 A conceptual framework for selecting appropriate variables

For the sake of clarity, variables that are commonly used in the existing hospital efficiency literature are called ‘conventional [service-oriented] variables’ in this thesis. These variables are often those most readily associated with episodes of service provision, for example, the total number of separations. On the other hand, variables proposed for addition to the

[xvii] Groene O, Jorgenson SJ. Health promotion in hospitals: a strategy to improve quality in health care. Euro J Public Health 2005, 15: 6-8.
[xviii] M. V. Pauly, Nonprofit firms in medical markets, The American Economic Review 77 (1987) 257-262.

framework, based on a comprehensive set of productive and interactive functions, are called 'non-conventional [development-oriented] variables'.

Figure 4.1 proposes non-conventional [development-oriented] variables for each of hospital structure, throughput, output and outcome in parallel with conventional [service-oriented] variables.

At the level of structure, conventional variables relate to inputs of personnel (for example, the number of staff), capital (for example, the number of beds), and consumable (for example, the cost of drugs). Although there is little doubt that these inputs have a major impact on patient outcomes, there is a growing body of literature indicating the crucial role of other factors such as the characteristics of the organization.[142,143] Hospital organizational characteristics refer to the capacity of the hospital to achieve the best interaction between various inputs in order to obtain optimum value for patients and staff, and to achieve beneficial collaboration with the community and other health care providers to attain better population health. Therefore, I consider it important to include variables that relate to concepts such as preparedness for an effective response to community needs (a detailed description of all the proposed variables is available in section 4.3.1).

Following the development of the HPH project by the WHO based on the principles of the Ottawa Charter on Health Promotion (1986), and a subsequent workshop in Vienna in 1997,[144] the role of structural characteristics and supportive culture as prerequisites in providing high-quality health care has attracted considerable interest. Although the concept seems to be contemporary, some historians have found evidence about health promoting activities in the history of health care back many centuries. Indeed, long ago, hospitals carried out some health promoting activities. By the 12th century, the hospital had become a very advanced institution. In Cairo, in 1285, Sultan Qalaun al-Mansur built a hospital, described by Durant:[145]

> *Treatment was given* gratis *to men and women, rich and poor, slave and free; and a sum of money was disbursed to each convalescent on his departure, so that he need not at once return to work. The sleepless were provided with soft music, professional story- tellers, and perhaps books of history.*

This quotation from Durant provides evidence of a historic perspective on the role of a supportive environment in improving the quality of care, thus leading to better health outcomes.

The impacts of organisational characteristics on health outcomes have been discussed in a number of studies. Aiken et al[146], by using three subscales reflecting the organizational characteristics within a hospital (nurse autonomy, nurse control over the practice setting, and the relationship between nurses and physicians), have pointed out that the hospitals which valued professional nursing expertise[xix] had a better patient outcome in terms of a high patient satisfaction and a low mortality rate. This suggests that these organisational capacities have a worthwhile impact on outcomes. More importantly, the findings imply that the impact of organisational capacities is independent of the staffing pattern. Similar impacts have also been noted by other studies.[147,148]

The next stage is entitled 'throughput or process' (the transformation of inputs into outputs). According to the service-oriented approach, the variables describing throughput relate to the extent to which hospitals are busy. One example is the length of stay, which is used in hospital efficiency measurement. However, it is known that the use of such variables may lead to perverse incentives, because hospitals may thereby have an incentive to admit patients with uncomplicated illnesses or to discharge patients too early in their convalescence. In responding to this deficiency in the existing service-oriented approach, the proposed framework suggests a broader range of process variables, such as health education programs and quality-oriented procedures (a detailed description of all the proposed variables is available in section 4.3.2). Since existing service-oriented efficiency measurement studies do not emphasise such processes, these run the risk of labelling a health promotion and quality-oriented hospital as an <u>in</u>efficient hospital, because promoting health and improving quality may require additional resources.

The next stage in Figure 4.1 is about 'outputs'. In the existing hospital efficiency literature, output is considered in terms of activities such as the number of separations. This approach, however, relies mainly on the actual number without due regard to quality. The use of the number of services provided may encourage managers to increase efficiency scores at the

[xix] Gaining a higher score for the three variables, adjusted for confounding factors such as staffing, size, and ownership.

expense of quality, affecting adversely the health outcomes. Here, I argue that, in addition to the conventional output variables which are about the number and types of separations, there are particular types of output variables with a quality dimension that influence health outcomes. For example, a hospital performing a large number of caesarean deliveries, some of which may not be medically indicated, could still be labelled as an efficient hospital. Yet an overutilisation of procedures, such as caesarean delivery, could lead to adverse effects or at least may not add to any population health benefits. The proposed framework introduces the concept of quality for output variables (a detailed description of all the proposed variables is available in section 4.3.3).

The last stage of the proposed framework (Figure 4.1) is about health outcomes – both individual-based and population-based. 'Individual-based outcomes' could be grouped into 'biological' and 'patient-centred' outcomes. A reduction in blood pressure resulting from treatment is an example of a biological outcome. Clinicians place a heavy emphasis on such biological outcomes.[149] A bio-medical approach to health, however, may not fully cover the patient's best interest. For example, Guyatt et al[150] have found that in patients with chronic heart and lung disease, exercise capacity in the laboratory is only weakly related to exercise capacity in daily life. Thus, some studies aim to identify and include variables that reflect the likely benefits from the patient's point of view.

Taking a broader perspective, 'population-based outcomes' is an expression of health services in terms of improvement in population health status and wellbeing. Very few hospital efficiency studies have used variables related to this type of health outcome measure. This is largely because of difficulties in quantifying the extent of change in health status produced by the hospital as compared to the next best alternative form of treatment. The proposed framework has offered a set of variables as proxies for health outcomes (a detailed description of all the proposed variables is available in section 4.3.4).

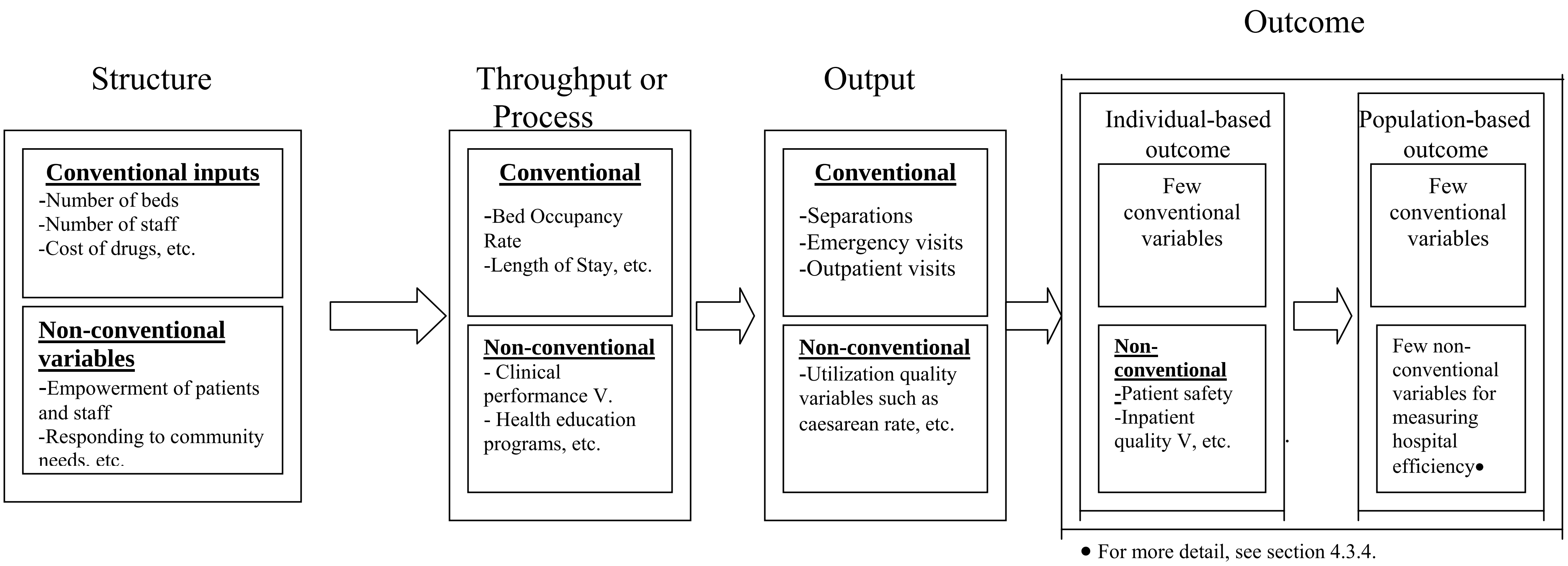

Figure 4.1: A health-oriented framework to guide in selecting the most appropriate variables for hospital efficiency measurement

4.2.1 Criteria for selecting variables

The above discussion contrasting the conventional and development-oriented approaches, environmental factors, and individual factors can help in defining criteria for exclusion and inclusion of variables for hospital efficiency measurement.

Firstly, it is necessary to consider a full range of hospital functions which influence quality of care. As Sheldon[151] has pointed out, when poorly conceptualized variables are used, they lead to misleading results which can affect evaluation and planning. Secondly, it is important to select variables that directly relate to those aspects of health and health care which are under hospital control. Jolley [152] states that one of the criteria for assessing the usefulness of variables is that they are under the control of those organizations which are being evaluated. Both individual and environmental factors can influence the health production pathway, and individual- based and population-based health outcomes. These factors are usually beyond the control of individual health care providers such as hospitals. Nevertheless, environmental (and social) factors are too important to lose sight of, and they will be explored in chapter 7, which is about factors affecting hospital efficiency.

The selection of variables should reflect:

- key hospital functions from patient, population, and health systems perspectives;
- values of various stakeholders including patients, staff, and community;
- the extent to which the desired outcomes are under hospital control;
- the quality of the processes and how they lead to desired outcomes;
- that these functions can be most efficiently delivered through hospitals;
- scientific evidence of validity and reliability;
- ease in defining and collecting at regular intervals

4.3 Non-conventional [development-oriented] variables proposed to measure hospital efficiency

This section provides a detailed description of non-conventional variables relevant to each of the four stages- structure, process, output, and outcome (Figure 4.1). Conventional variables were discussed in chapter 2 (sections 2.3.3 and 2.3.4).

4.3.1 Structural variables: health promotion activities

Due to an overwhelming outcomes and outputs research agenda, hospital structural characteristics and their role in efficiency measurement have received little attention. As pointed out earlier, hospital organisational structure refers to the capacity of the hospital in attaining the best interaction between various resources to achieve the optimal value for all target groups including patients, staff, and community. It also refers to the ethos of the hospital in providing a beneficial collaboration with its surrounding environment. Aiken et al [153] have found that in addition to adequate nurse staffing, there are some organizational structure- related factors such as good working relationships with physicians and a better working environment which improve the nurse job satisfaction and can result in better patient health outcomes.

Efficiency measurements could benefit from the inclusion of structural variables. According to the HPH concept, hospitals should have a holistic approach to the health of all people including their patients, staff, and community. To achieve this, hospital services should be reoriented to a more integrated proactive approach including health promotion and prevention. This can only be attained by developing new structures that are capable of providing a supportive and healthier working environment for staff, with the potential to meet overall health development through changing people's health behaviour, leading to the improvement of population health. For this reoriented process, three main target groups can be identified, namely patients, staff, and community. Evaluators who agree to use variables related to hospital organisational structure in the processes of performance measurement tend to consider a fuller range of hospital functions (other than curative care) including the preventive function, health promoting activities, human resource development, responsiveness to community needs, and cooperation with other health providers.

Almost all studies focusing on the development of these variables emanate from WHO and its European Office for Integrated Heath Care Services. Out of the four reports in which standards and strategies for health promotion in hospitals have been explored by WHO, the report of the 4th WHO Workshop provides a revised format to define the health promoting activity standards and associated variables. [154] Those variables include, among others, the level of patient awareness, the prevalence of work-related injuries to staff, and the availability of lifestyle education programs for the public. Additionally, the collaboration between hospitals and other health care providers can also be evaluated (see Table 4.1 for the full list). These variables are particularly appropriate for hospital efficiency studies in Iran or in other countries at a comparable stage of economic development. These hospitals suffer from the lack of health promoting activities targeting various stakeholders, including patients, staff, and community.

The Report (Standards for Health Promotion in Hospitals) is the first systematic attempt to develop a self-assessment tool for health promoting hospitals by developing measurable elements. The authors have made a lot of effort to cover the main target groups and standards in health promoting hospitals. However, still there are other areas which need to be taken into account. I argue that the following initiatives and related variables can be used in hospital efficiency studies as well.

Firstly, through various interventions, a hospital can optimize the population health in its catchment area. For example, the existence of counselling services and a health information centre about community access, and lifestyle education programs (such as monthly public sessions), smoking cession programs for general population (staff and patients) can be regarded as community-centred health promotion activities.

Secondly, as hospitals are producing large amounts of infectious wastes that may result in serious adverse effects, an ecological management of wastes, and having a proper waste deposit policy can contribute to community health.

Thirdly, it has been argued that the physical environment can affect patient satisfaction.[155] Thus, activities such as providing a cleaner environment for patients and staff or healthier food can increase patient and staff satisfaction leading to better health outcomes.

Finally, initiatives such as the provision of gym facilities, and staff access to the hydrotherapy pool can increase job satisfaction. Moreover, as a result of the demanding nature of their work, physicians and nurses are subject to risk factors which can make them stressed. This in turn can influence the quality of the technical care they provide. From this point of view, the existence of counselling services for staff to offer an effective stress management plan can be regarded as another structural feature.

Variables	Target group	Numerator	Denominator
Self-management	Patient	Number of patients who can name actions for self-management for their conditions	Total number of separations
Patient awareness	Patient	Number of patients who can name their disease, symptoms and risk actors	Total number of separations
Healthier organization for patients	Patient (mothers and infants)	Providing a cleaner environment and healthier food for patients, Baby Friendly Hospital	
Health promotion training	Staff	Number of staff who received training for health promotion skills	Total number of staff
QC training	Staff	Number of staff who received training for QC	Total number of staff
Staff absenteeism	Staff	Total number of days out of work, excluding planned holidays	Total number of days contracted
Work-related injuries	Staff	Total number of declared work-related injuries	Total number of staff
Healthy working place	Staff	The existence of gym facilities, hydrotherapy pool, counselling service to offer stress management plan, providing a cleaner environment for and healthier food for staff, and smoking cessation programs	
Community health and responding to community needs	Community	- The existence of counselling services and health information centre for community access, - The existence or the number of lifestyle education programs for public (such as monthly public sessions) - Smoking cession programs - Properly managing hospital waste	
Cooperation with other health care providers	Patient and community	Discharges letters sent to GP within 2 weeks	All discharge letters
Cooperation with other health care providers	Patient and community	Total number of separations with referral letter from other health care providers	Total number of separations
Nutrition and Dietetics advises	All target groups	The existence of Nutrition and Dietetics Department	
Budget for health promotion	All target groups	Direct costs for all activities dedicated to staff and patient s health promotion	Total operating budget

Table 4.1: Non-conventional structural variables

4.3.2 Non-conventional process variables

While outcome and output quality variables largely concentrate on the patient care and protection functions, the majority of process variables focus more on the disease prevention and health education functions. In hospital performance measurement, some studies prefer to use process variables, for example B-blockers after myocardial infarction, as they are easier to identify, they are under the control of health professionals, and, literarily, there is more consensus on the appropriate process of health care.[156,157]

Generally, process variables assess the capability of health professionals to make appropriate choices in order to achieve desired outcomes for their patients.[158] Two commonly suggested dimensions for non-conventional process variables are, firstly, clinical performance and the extent of the evidence-based nature of the clinical care process, and, secondly, health education programs adopted from the Health Promoting Hospital (HPH) concept.[159,160,161,162]

Clinical performance variables

Clinical performance variables (eg, use of aspirin within 24 hours of admission for patients with acute myocardial infarction) are based on medical guidelines. This thesis relies on well-developed process quality variables set by the Centres for Medicaid and Medicare Services (CMMS). For these clinical conditions, the CMMS has developed process-of-care variables whose validity and reliability are supported by professionally developed, and widely accepted standards and medical guidelines.[xx] The findings of other studies support the validity of the variables developed by the CMMS. For instance, using an extensive review process, the OECD Health Care Quality Indicators Project (HCQIP) has supported the validity of these variables. [163] Because these variables are based on standard medical guidelines, the variables proposed by this thesis can be used for measuring hospital efficiency in Iran or other developing countries as well.

Table 4.2 summarizes the clinical performance variables proposed for measuring hospital efficiency along with the associated inclusion and exclusion criteria for each.

[xx] Detailed information on scientific evidence supporting variables has been summarized in the CMMS publications. (http://www.cms.hhs.gov) (Last access 03/06/2007)

Process quality variables		Numerator	Denominator	Exclusion	Validity
AMI	Administration of Aspirin within 24 h of admission for patient with Acute Myocardial Infarction (AMI)	Number of discharged patients with AMI (principal code of 410) who received aspirin within 24 h of admission	Total number of discharged patients with the same code without aspirin contraindication	Patients with Aspirin contraindications	CMMS, American College of Cardiology[164]
	Administration of aspirin at discharge for patients with AMI	Number of discharged patients with AMI who are prescribed aspirin at hospital discharge	Total number of discharged patients with the same code without aspirin contraindication	Patients with Aspirin contraindications	CMMS, Ryan et al[165], European Society of Cardiology[166]
	Administration of B-blockers at discharge for patients with AMI	Number of discharged patients with AMI who are prescribed beta-blockers at hospital discharge	Total number of discharged patients with the same code without beta-blockers contraindication	Patients with Beta-blocker contraindications	CMMS, Jencks et al.[167], Bowker et al[168]
	Administration of Angiotensin Converter Enzyme inhibitors (ACE) at discharge for patients with AMI	Number of discharged patients with AMI and with left ventricular systolic dysfunction who received ACE inhibitors	Total number of discharged patients with left ventricular systolic dysfunction without ACE inhibitor contraindication	Patients with ACE inhibitor contraindications	CMMS

Table 4.2: Clinical performance variables

Process quality variables	Numerator	Denominator	Exclusion	Validity
Administration of ACE inhibitor at discharge for patients with Heart Failure (HF)	Number of discharged patients with HF and with left ventricular systolic dysfunction who received ACE inhibitors	Total number of discharged patients with CHF and left ventricular systolic dysfunction without ACE inhibitor contraindication	Patients with ACE contraindications	CMMS, Lee et al.[169], American Medical Association[170]
Warfarin for patients with stroke who have arteria fibrillation	Number of discharged patients with stroke and atrial fibrillation who received warfarin	Total number of discharged patients with stroke and atrial fibrillation without warfarin contraindication	Patients with Warfarin contraindications	CMMS, Lindsay et al[171]

Table 4.2. Continued

In summary, the validity of all clinical performance variables mentioned in this section is supported by strong evidence. Furthermore, they reflect key hospital functions including curative as well as preventive care. Finally, any deviation from these guidelines (which affects the quality of care) can be traced and fixed by the hospital. These features indicate that these variables can be regarded as appropriate for hospital efficiency studies since they meet the criteria developed in the present study (section 4.2.1).

Variables related to health education programs

These variables can be divided into (i) education programs targeting risk factors such as smoking, and (ii) educations programs targeted at preventing complications of chronic diseases.

Individuals with AMI who smoke are at particular risk for increased mortality.[172,173] This effect is reversible, and mortality in patients with AMI due to smoking can be significantly reduced with quitting.[174] CMMS has considered smoking cessation counselling given during hospitalization as a part of the management of patients with AMI. From this can be constructed a potential process variable reflecting the quality of care which influences health outcomes. This hospital-based smoking cessation consists of bedside counselling followed by seven telephone calls over the six months following discharge.

Health education programs in hospital particularly target groups of patients suffering from chronic diseases, which due to their lifelong nature need a special approach. Diabetes mellitus, hypertension, and chronic obstructive pulmonary disease are regarded as conditions whose prognosis is highly dependent on involving patients in education and skill development programs. [175] From this standpoint, patient education about risk factor modification and disease treatment options could be considered for hospital efficiency measurement. This variable can be measured as the number of patients who can name actions in self-management for their condition divided by all patients diagnosed with that specific condition. This definition might suffer from technical difficulties (e.g. using surveys for data collection) in measuring such variables. Health education could be alternatively measured as a categorical variable (existence or lack of a health education program in the hospital).

The validity of variables reflecting health education programs is supported by WHO working groups of experts who are responsible to develop health promotion standards in hospitals.[154]

4.3.3 Non-conventional output variables

Variables reflecting the number of services may not be an appropriate determinant of health outcomes, and should not be regarded as development-oriented variables for the purpose of the present study. However, some studies have shown an association between utilization measures such as the caesarean section rate and better quality and patient outcome. Amid various utilization variables, the caesarean delivery rate is widely used as an indicator of the quality performance of a health service. Low caesarean section rates correlate with fewer unnecessary surgeries, a lower cost of care, and greater patient satisfaction, leading to a better health outcome.[176] Nevertheless, given the varying risk profiles in a catchment population, there is no gold standard for an optimal rate of caesarean delivery. Despite this, the WHO states that no region in the world is justified in having a caesarean rate greater than 15 percent.[177] Generally, hospital efficiency measurements focus on the extent of output, with little attention to the quality of that output. In the light of the WHO recommendation, a general hospital that performs more than 15 caesarean section for every hundred births might be suspected of performing unnecessary procedures.[xxi]

Considering that a large output in terms of a higher number of caesarean sections will not necessarily be a sign of high efficiency, I suggest that the caesarean section rate as a quality-oriented output variable should be used in hospital efficiency studies. I also consider this variable appropriate for measuring hospital efficiency in Iran, because of the high rate of unnecessary caesarean delivery.[178]

4.3.4 Non-conventional outcome variables

Achieving better health for an individual may not necessarily lead to better health at the population level (for example, very high cost treatment for a single individual). For this reason it is desirable that a hospital's success is measured in terms of both the health of individuals (individual-based outcomes) and population health (population-based outcomes) in the target area.

It has been argued that variables such as Quality Adjusted Life Years (QALYs), and Disability- Adjusted Life Expectancy (DALE) measure both dimensions of health outcome

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[xxi] This hospital-based rate needs to be evaluated in the context of the frequency of non-hospital delivery. In chapter 6 (section 6.3.2.2), I argue that caesarean delivery rate is an appropriate variable for the SSO hospital efficiency measurement, as the unskilled birth attendants are very low, indicating little adverse effect on this variable.

(i.e. health per se and the value of health) and reflect the health status of the population.[179,180] However, for a number of reasons such variables may not be appropriate for hospital efficiency measurement. Patients' self reported health-related quality of life strongly depends on various individual and environmental conditions such as socio-cultural, economic, and political factors, many of which are not well known and/or are beyond the control of the hospital. This implies that, without adjustment for these contextual circumstances, the use of such variables may not yield valid results.[181] It has also been argued that there can be a long delay between the provision of care and the final population-level outcome.[182] This can lead to uncertainty in identifying which intervention or health provider is responsible for the actual outcome measured.[183] Therefore, it is difficult to establish a link between these variables and the efficiency of any one hospital.

For all these reasons, hospital efficiency studies have to step back to examine variables that represent individual-based outcomes. As discussed earlier in this thesis (section 4.2), individual-based outcomes can be classified into two categories: (i) biomedically-centered, and (ii) patient–centred variables. Biomedically-centred variables focus more on the functions of organs and organ systems. In this approach, some studies develop condition-specific variables, indicating an intrinsic relation between these variables and quality of care.[184] These variables benefit from the explicit criteria adopted from clinical evidence to assess to what extent the observed results are consistent with the criteria.[185] An example of a biomedical variable is "effective management of placenta praevia" in which standards for initial management and timely referral of patients are identified.[186] However, due to professional uncertainty and disagreements on accepted standards for most medical conditions, the use of such variables in efficiency studies is arguable.[187]

Patient-centred variables in current use typically focus on patient satisfaction. In these types of variables, patients select the dimensions and the weight attached to each dimension to rate the likely benefit from the intervention.[188] These variables are subjective, depending on individual and environmental factors that might be beyond hospital control,[189] so that efficiency studies have tended to avoid them.

It has been shown that achieving the quality indicator targets (for example, an effective hypertension management plan in diabetic patients) can lead to better health outcomes (for example, prevention of cardiovascular events among diabetic patients).[190] Because "quality of care" translates into better health outcomes, I argue that, quality of care variables can provide insight into health outcomes, and could be measured routinely to allow study of changes over time.

For the purpose of my thesis, I have used the classification of quality variables presented by the Agency for Healthcare Research and Quality (AHRQ).[191] The AHRQ has grouped quality variables in a hospital setting into two main categories, namely patient safety variables and inpatient quality variables. Some of these variables could be utilised for efficiency studies since they fulfil the selection criteria discussed in section 4.2.1. These variables have been developed for international use. Hence, they are appropriate for the purpose of this thesis that particularly emphasises their applicability to countries at a comparable stage of economic development to Iran.

These variables provide a perspective on quality of care in performance of key hospital functions (for example, a patient safety variable reflecting a hospital's protection function). Furthermore, the AHRQ has proposed variables found in existing hospital administrative data. Hence, these variables can be used readily at regular intervals. Most importantly, the validity and reliability of the AHRQ quality variables were examined using an extensive review process. The AHRQ has provided a full technical report including how validity was assessed[xxii]. These procedures have convinced me that the quality variables developed by the AHRQ benefit from an acceptable level of validity.

4.3.4.1 Patient safety variables

According to AHRQ, patient safety variables screen for preventable problems that a patient may experience as a result of exposure to the health care system.[192] The final version of the AHRQ Report has provided a comprehensive list of patient safety variables (ibid). However, not all of them are appropriate for hospital efficiency studies, because some do not appear to fulfil all components of the definition of a patient safety variable. Taking obstetric trauma (3rd and 4th degree lacerations) after vaginal or caesarean delivery, or post-operative wound infection as examples, there are studies indicating doubt as to how preventable these conditions are.[193,194] Examples of those variables that fulfil the inclusion criteria developed by this thesis (section 4.2.1), and hence can be used in efficiency studies, include the

[xxii] Full technical information including the validity of quality variables in the AHRQ Report can be downloaded from http://www.qualityindicators.ahrq.gov (Last access 02/06/2007)

incidence of Decubitus Ulcer, Iatrogenic Pneumothorax, and Postoperative Sepsis. Table 4.3 provides a detailed description of these variables along with the associated inclusion and exclusion criteria for each.

PS variable	Numerator (ICD 9 diagnosis codes)	Denominator	Exclusion	Validity
Decubitus Ulcer	7070-70700-70701-70702-70703-70704-70705-70706-70707-70709	All Medical and surgical separations	PDX	AHRQ, Keeler et al[195], Berlowitz et al[196]
Iatrogenic Pneumothorax	512.1	All Medical and surgical separations	PDX, T, TS	AHRQ, Miller et al[197]
Postoperative sepsis	0380- 0381- 0382-0383- 03810-03811- 03819-	All elective surgical procedures	PDX, IC, CA	AHRQ, Geraci et al.[198], Best et al[199]

Table 4.3: Patient Safety (PS) variables algorithms and their application in hospital efficiency studies

PS: Patient Safety; PDX: Primary Diagnosis; T: Trauma; TS: Thoracic Surgery;
IC: Immunocompromised; CA: Cancer.

All these patient safety variables have a clear advantage in terms of providing a tool to recognize medical errors in order to increase the safety of patients who are in contact with a hospital. They can also be regarded as outcome quality variables, because they reflect some consequences of care provided by the hospitals, and thus represent an advance over the existing information. However, they suffer from some limitations in their application. There is a concern about coding accuracy, imperfections in risk adjustment, and limited insight into the timing of events.[200] This in turn may increase the risk of error underestimation and underreporting, leading to misleading results for performance measurement. Furthermore, these variables may capture zero values. In its current level of development, DEA is unable to handle zero values. This underlines the importance of possible changes in the mathematical framework of DEA.

In summary, considering their limitations, patient safety variables (Table 4.3) should be used for hospital efficiency studies, because they reflect quality of care as well as different hospital functions such as protective care, human resource development, and patient satisfaction.

4.3.4.2 In-patient quality variables

Inpatient quality variables reflect the quality of care provided within the hospital walls, and are mainly about mortality rates and re-admission rates. The variables proposed for measuring hospital efficiency include: (i) the avoidable mortality rate, (ii) the post-operative mortality rate, (iii) the non-operative mortality rate, and (iv) unplanned readmissions for specific conditions.

It has been argued that avoidable death rates should vary inversely with the quality of care.[201] The notion of avoidable mortality has been adopted from the work of Rutstein, who initially proposed a list of causes of deaths that can be potentially avoided.[202] The most recent list of avoidable deaths consists of 17 amenable causes of death with consideration of different age groups, and the health care sector bearing the most responsibility.[203] For example, primary health care is considered to be a main responsible agent for death due to cervical cancer – because of missed screening opportunities. The list was designed for international use, not only for use in developed countries. Studies in less developed countries have shown comparable figures when compared with developed countries.[204] For the purpose of the present study, what it is important is to select the avoidable causes for which the hospital is accounted as the main responsible agent.

Table 4.4 shows avoidable deaths which can be used in assessing hospital efficiency.

Avoidable causes	ICD (9)	Age Groups	Responsible Health Care Sector
Maternal mortality	630-676	All ages	**Hospital** Primary care
Perinatal mortality	All Causes	Perinatal age	**Hospital** Primary care
Appendicitis, Cholelithiasis, Cholecystitis, Abdominal hernia	540-543,574 575.1, 576.1 550-553	5-64	**Hospital** Primary care
Peptic ulcers	531-534	25-64	**Hospital** Primary care

Table 4.4: Selected avoidable causes of deaths

Regarding avoidable death rates, some points should be noted. Firstly, as time marches on we expect to observe improvement in pharmaceuticals and treatment strategies both leading to changes in the causes of mortality which can be potentially avoided. It can be expected that some causes of deaths that have not been listed in Table 4.2 will be added in the near future. Further, it has been argued that death is the final outcome of a complex chain that includes several socio-cultural and economic factors, and lifestyle behaviour.[205] Thus, it is still not clear to what proportion the health care system (and the hospital for the purpose of the present study) can be considered as mainly responsible.

It has also been argued that mortality rates are the result of both disease incidence and the case-fatality rate, and that the health care system responds only to the latter.[334] However, despite such a concern, the avoidable death rate could be used to measure the *relative* efficiency of hospitals in comparable groups. There are different approaches to adjusting for confounding factors. For example, in Australia, Piers et al [335] used the Index of Relative Socio-economic Disadvantage (IRSD) to adjust for income, educational attainment, and unemployment, and the Accessibility/Remoteness Index of Australia (ARIA) score to interpret remoteness as accessibility to service centres.

Other in-patient quality variables include postoperative mortality rate, non-operative mortality rate, and readmission rate. Table 4.5 provides a detailed description of all in-patient quality variables which are appropriate for hospital efficiency studies.

Mortality rate variable	Numerator (ICD 9 diagnosis codes)	Denominator	Exclusion	Validity
Avoidable mortality rate	All in-hospital avoidable deaths (Table 4.2)	Number of separations		AHRQ, Rustien [206] Holland [207]
Post operative mortality rate	All deaths within 30 days of selected surgeries*	Separations with the same codes		AHRQ, Scottish Executive[208]
Non operative mortality rates (AMI, GH, P)	Number of deaths with principal diagnosis codes of AMI, GH, P	Separations with the same codes	Age 18 years and younger	AHRQ, Rockall et al[209], Gleason et al [210]
Unplanned readmissions for specific conditions (hypertension, diabetes and COPD)	The total number of unplanned readmissions for specific conditions identified by related ICD codes within 28 days	The total number of separations for specific conditions		AHRQ, Madge et al[211], Aubert et al[212]

Table 4.5: In-patient quality variables proposed for measuring hospital efficiency
GH; Gastrointestinal Haemorrhage; P: Pneumonia, COPD: Chronic Obstructive Pulmonary Disease.
*Aortic aneurism repair, cataract extraction, mastectomy, knee replacement, hysterectomy, gastrectomy, hip replacement, esophagectomy, and prostatectomy.
Note: It is strongly recommended that all mortality rates be adjusted for confounding.

It should be noted that, overemphasis on mortality rates (particularly postoperative mortality rate) as a performance measurement can increase perverse incentives faced by hospital managers and physicians.[213] Surgeons may respond to mortality measurement by avoiding performing high-risk surgical interventions, leading to the improvement of their individual mortality scores without any improvement in population health outcomes.

To sum up, in-patient quality variables are consistent with the criteria developed by this thesis. It has been shown that they are valid and reliable outcome measures which after appropriate adjustment can reflect a better quality of care.

4.4 Concluding remarks

For hospital efficiency literature using frontier-based methods, this chapter has presented a conceptual framework for selecting the most appropriate variables with a focus on its applicability to Iran and to the SSO hospitals in particular.[xxiii] Using this framework, I have discussed variables that reflect a full range of hospital functions which need to be incorporated into efficiency measurement formulae. I also discussed the merits and difficulties of using various non-conventional (development-oriented) variables in hospital efficiency studies. In order to enhance hospital efficiency studies, I argue that both conventional (service-oriented) and non-conventional (development-oriented) variables should be taken into account in hospital efficiency studies. I have also argued that, due to the nature of the variables proposed, all variables can be used for hospital efficiency studies in Iran. It would have been more beneficial if I could illustrate the difference- and hence the benefits- of applying development-oriented variables in relation to the existing service-oriented models using actual data. However, the data were not available.

The importance of quality variables, especially those which can reflect a full range of hospital functions, has been acknowledged by some hospital efficiency studies. However, the majority of the studies to date have defined hospital outputs as the volume of interventions, and focused predominantly on curative care. Such an emphasis on the volume of interventions and curative care can lead to misleading findings, because the product [health] in this industry [hospital] is heterogenous and multidimensional. The proposed framework allows for incorporating a broader set of variables some of which could be used to strengthen efficiency studies. This approach will enhance the validity of the studies, which will support hospitals aiming to achieve the greatest possible health outcomes with the use of available resources.

It should also be noted that, the framework proposed fits quite well with the characteristics of social organisations such as the Iranian SSO that are concerned with meeting social objectives. The SSO database does not report a majority of the development-oriented variables discussed in this chapter. Proposing this framework and the necessity of the use of a broader set of variables are valuable in revealing deficiencies in the current database which must be dealt with in order to enhance efficiency measurement in the SSO hospitals. This will help in developing proposals to identify new data that are required to enhance efficiency measurement.

[xxiii] The applicability of these variables in SSO hospital efficiency measurement using DEA will be discussed in chapter 6, section 6.3.1.

CHAPTER 5

THE HEALTH SERVICES OF THE IRANIAN SOCIAL SECURITY ORGANISATION (SSO): APPLICATION OF SIMPLE RATIO ANALYSIS FOR MEASURING SSO HOSPITAL EFFICIENCY

Chapter overview

The aim of this chapter is to describe the Iranian Social Security Organization (SSO) and its various activities[xxiv] with an emphasis on the efficiency assessment of its hospitals using simple ratios.

Simple ratio analysis is useful for a first look at a set of hospitals and provides a general overview of the dataset. This helps in identifying outlying hospitals, those that merit further investigation. Then, in the next chapter (chapter 6), the results of this efficiency assessment by simple ratios will be compared with the findings from efficiency measurement using DEA to provide a thorough analysis of the efficiency of these hospitals and of the strengths and limitations of DEA. Furthermore, because the simple ratio analysis (particularly throughput ratios) is the only method used in monitoring SSO hospital performance, this chapter is an attempt to present a constructive critique of this SSO policy.

This chapter consists of seven sections. Sections 5.1 and 5.2 will briefly introduce Iran and its health care system respectively. Section 5.3 will introduce the social security arrangements in Iran with a focus on the SSO. Section 5.4 will discuss SSO hospitals in detail. Section 5.5 will present the results of analysing input, output, and throughput ratios. Section 5.6 will summarize key findings. Concluding remarks will be presented in section 5.7.

5.1 Iran: general information

Iran covers an area of 636,000 square miles, and is located in the northern hemisphere, and in the Asian continent. Its border countries, clockwise from the north-east are: Turkmenistan, Afghanistan, Pakistan, Iraq, Turkey, Armenia, and Azerbaijan. The Persian Gulf is situated long the full expanse of southern Iran, and in the north the Caspian Sea lies directly above the

[xxiv] In chapter 2 (section 2.6.1), I briefly introduced the SSO and its activities.

Alborz Mountains. Iran is considered as one of the Middle Eastern countries. According to the Statistical Centre of Iran[214], the total population of Iran based on the census of 2002 was around 66,480,000.[xxv]. According to this census 28.6 percent or about 19 million of the population are under 15 years of age. The population growth rate in Iran is nearly 1.4 percent. The sex ratio is 1.05 male(s)/female. The capital city of Iran is Tehran with population of around 7.5 million. Based on the Divisions of State, Iran consists of 28 provinces. Each province is governed by a province governor. Figure 5.1 shows the administrative divisions of the country.

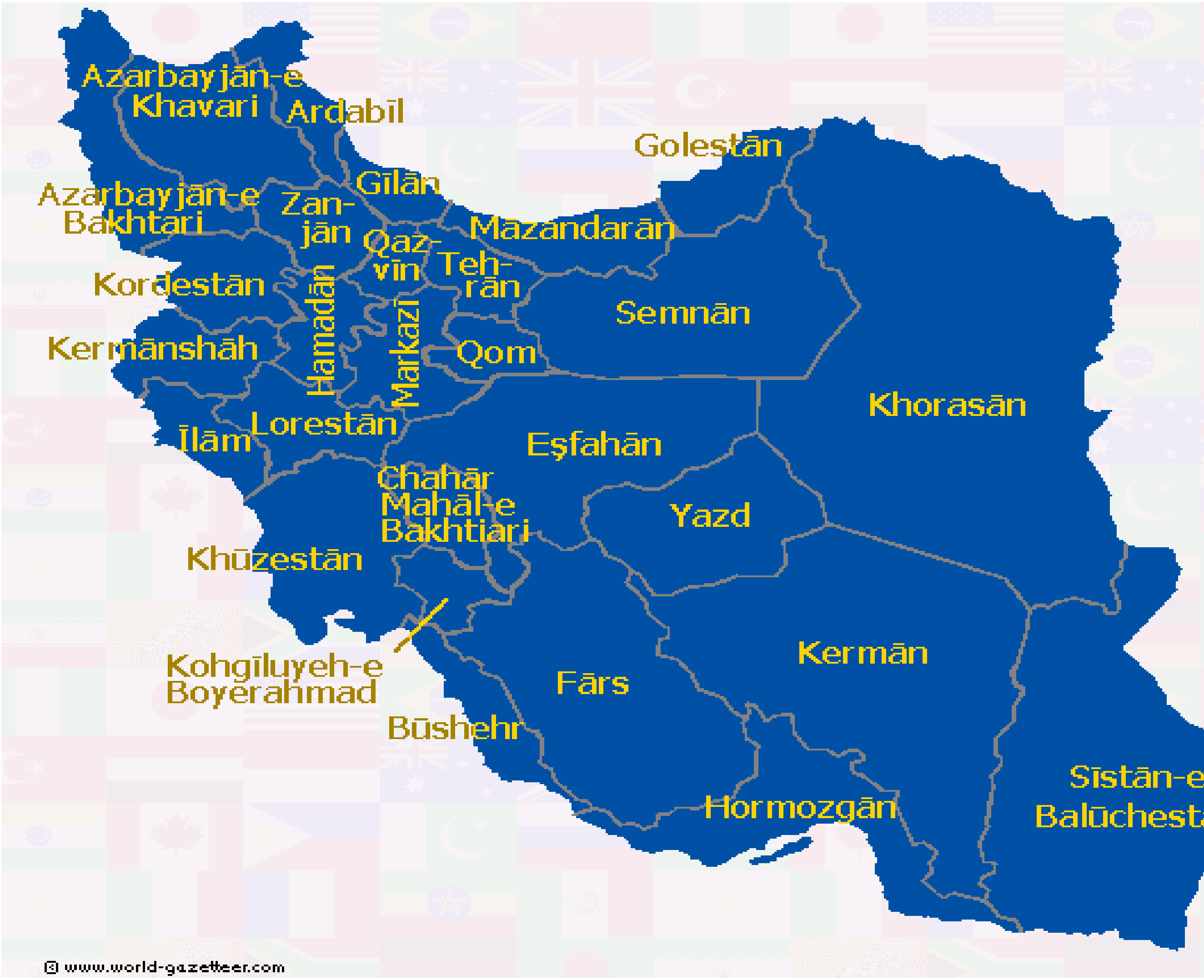

Figure 5.1: Map of the Islamic Republic of Iran: Administrative Divisions

xxv From here onwards, information in this section (4.1) has been obtained from the Statistical Centre of Iran unless indicated

The economic system consists of two sectors: private and public. Iran's economy is a mixture of central planning, state ownership of oil and other large enterprises, village agriculture and small-scale private trading and service ventures. In 2002, the major macroeconomic indexes were; inflation rate: 17.3%, unemployment rate: 15.7%, and economic growth rate compared with 2001: 6.3%. In 2002, adult literacy rate was 79%, and 94% of total population had access to local health services. In that year, 21% of the total population were living below the national poverty line, and the per capita income in Iran was USD 1,648.

5.2 Iranian health care system

The right of all citizens to health care is embodied in the Constitution of Iran. During recent years, Iran has experienced a considerable improvement in health status. By 2002 Iran had reduced its Infant Mortality Rate (IMR) to 28.6 per 1,000 live births and its Maternal Mortality Rate (MMR) to 3.7 per 10,000 live births. The Middle East & Africa Region of the World Bank[215] has reported that, except for some Gulf States, Iran has the lowest IMR and MMR ratios in the region. Its life expectancy had increased to 66.5 and 71.7 years at birth for men and women respectively, placing it slightly above the regional average (ibid.). Table 5.1 shows some commonly used health indicators.

Health Indicators	**2001**
Life expectancy rate at birth	
-Female	71.7
-Male	66.5
Crude birth rate	16.3
Infant mortality rate (per 1,000 live births)	28.6
Maternal mortality rate (per 10,000 live births)	3.7
Under five mortality rate	36
Total health expenditure per capita	USD 422
Total health expenditure as % of GDP	6.3

Table 5.1: Iran: Health indicators
Source: Statistical Centre of Iran

The Iranian health care system consists of three levels, namely primary health care, secondary and tertiary level curative care. Over the past few decades, an emphasis has been placed on essential health care financed from the public budget and delivered to all Iranians through a primary health care system run by the Iranian Ministry of Health (MOH). Secondary and tertiary level curative care is financed through the SSO for formal sector workers and their dependants, through the Armed Forces Medical Services Organization (AFMSO) for members of the military and their dependents, and through the Medical Service Insurance Organization (MSIO) for employees working in governmental sectors, rural households, and others. In addition, there is a non-contributory system to provide health insurance coverage for the poor. Private health insurance generally is supplemental to these public programs. In 2000, apart from two million people, all Iranians were covered by the various financing agencies including the SSO, the AFMSO, and the MSIO.

Health care in Iran comprises public and private sectors. Health care is delivered through hospitals, outpatient care centres, and a primary health care network. The MOH is the main organisation responsible for public services. Organizations such as the SSO and the military forces have own health care facilities to cover their own insured persons. However, all insured people are free to use any health facility owned by the MOH. Private health care services consist mainly of ambulatory services provided by private practitioners, medical laboratories, and pharmacies. However, there is a small but growing private hospital sector.

5.3 Social security scheme in Iran

Under the social security law in Iran, two main schemes are active, namely contributory and non-contributory. The non-contributory system, where insured clients are not required to pay for their care, covers the vulnerable groups of society who are not eligible for the contributory system. The contributory system is based on compulsory and voluntary payments by individuals. The main aim of this system is to support employment and removal of the obstacles in the way of production. The SSO is one of the main organisations under the contributory system. This organization covers all workers and employees covered by the Labour Law. It does so by means of compulsory insurance contributions from workers as well as the self-employed. Long and short-term financial benefits, and health care are provided to the insured people. More details in terms of the SSO organisational structure, source of fund, and benefits are discussed in section 5.3.1.

5.3.1 The SSO

In 1975, the Social Security Law was ratified and replaced the existing Social Insurance Law. By this approval and its following amendments, the SSO has been supervised by the Ministry of Health. Based on the Social Security Law, the SSO is considered as a public and non-profit organization.

This organization is expected to adopt a consistent system for social security plans and also for collecting funds. The most important duties of the SSO are as following:

- ✓ collecting contributions and generating income through investment;
- ✓ providing different kinds of health and welfare services;
- ✓ investment of the financial resources of the SSO.

5.3.1.1 Organizational structure of the SSO

The organisational structure of the SSO consists of the High Council (with representatives from the government, employers and insured people), the Board of Directors, the Managing Director, the Deputies, and the Provincial Offices. The members of the Board of Directors and the Managing Director are appointed by an offer made by the Minster of Health subject to approval of the Council of Ministries. In chapter 7 (section 7.3.2.2), I argue that, this governance structure of the SSO can adversely affect the SSO hospital efficiency. Within the SSO, there are six deputies. These include Administrative and Financial Affairs, Health Affairs, Investment and Planning Affairs, Technical and Income Affair, Parliament and Legal Affairs, and Coordination Assistancy Office for Province Affairs. In each province (and also in two non-provincial areas), two general offices of the SSO have been set up; the Office of Social Security and the Office of Health Affairs Management. The former is responsible in providing non-health insurance activities including short and long-term benefits. The latter is responsible for all health insurance activities at provincial level.

Figure 5.2 shows the organizational chart of the SSO and its provincial offices. The Health Affairs Management Offices are under the supervision of the Deputy of Health Affairs.

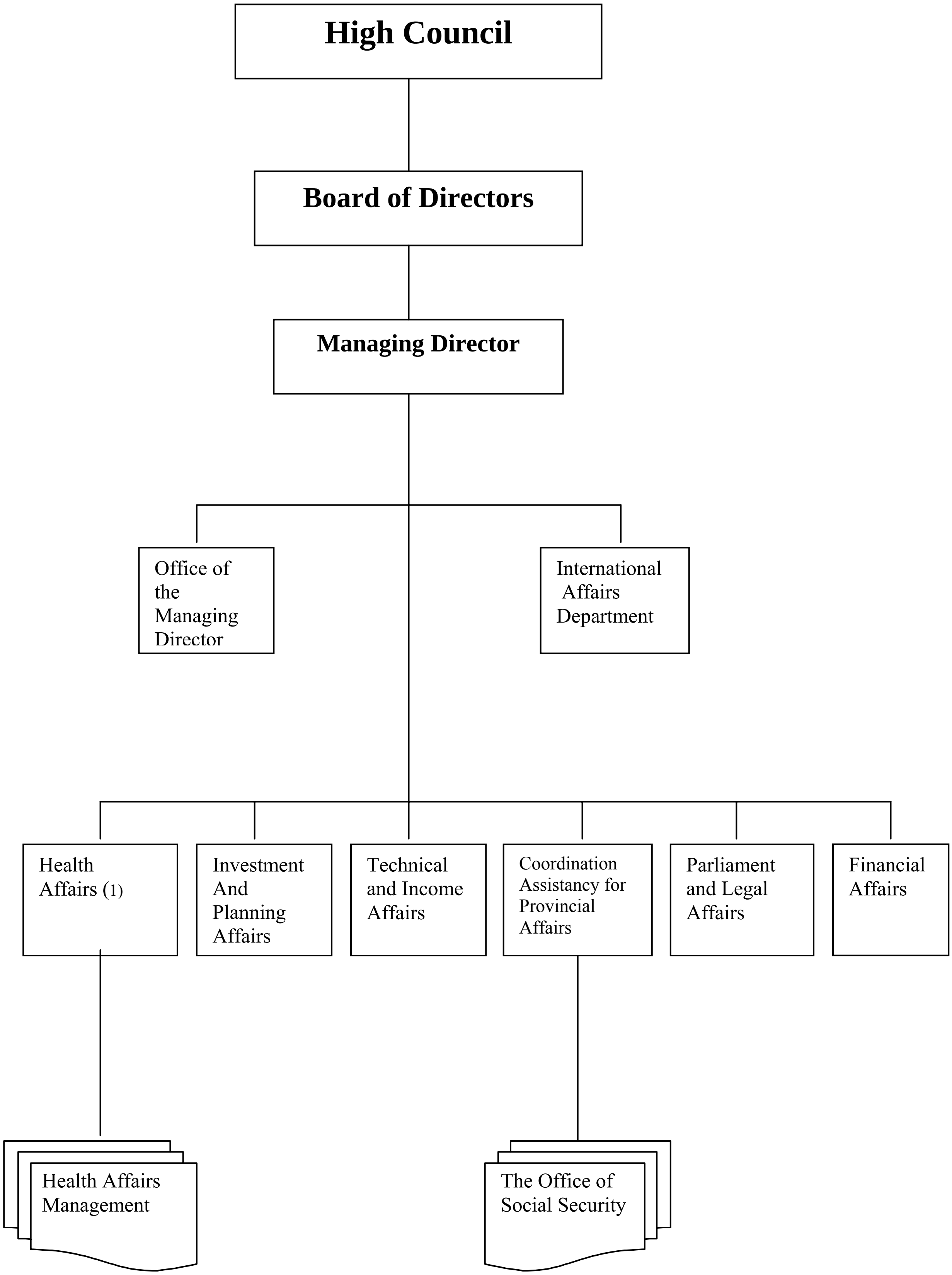

Figure 5.2: Organizational chart of the SSO

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(1) Before taking leave to pursue the present study in Australia, I was the Head of the Department of Statistics in the Health Affairs Department

5.3.1.2 Population covered by the SSO

According to the Annual Report of the SSO Statistics Department[216], in March 2002 (Iranian financial year), the total number of people covered by the SSO was about 26,000,000 (40.2% of total population). Moreover, the ratio of insured to un-insured persons varies from province to province. For example, 76% of people living in Tehran province are covered by the SSO. However, only 16% of people in Systan-e Balouchestan are covered. The reason for this difference is that most people in Systan-e Balouchestan are farmers, and hence are not eligible to be covered by the SSO.

The SSO insured people include the main insured persons and dependents of the main insured persons.

According to the SSO Statistical Report[217], more than 90% of main insured people are either employees of firms or construction workers.[xxvi] The employers are obliged to insure their employees by the SSO[xxvii]. Employees contribute, a percentage of the insured person’s salary which he or she pays to take the advantage of the benefits mentioned in the Social Security Law. From 1975, the contribution rate has been 30% of salary (employee 7% of earnings, employer 20% of payroll, government 3% of payroll).

The family members of main insured persons and pensioners (spouse, children less than 18 years of age, and parents more than 60 years of age) are described as subordinate insured persons and covered by the SSO.

5.3.1.3 Financial resources of the SSO

To implement the social insurance plan, there should be a reliable source of funds. Based on Article 28 of the Social Security Law, the income of the SSO consists of contributions (90% of total income in 2002), investments (8% of total income in 2002), penalties (for example, due to delay in the payment of contributions), and miscellaneous (for example, donations).

[xxvi] Other main insured people include self-employed and employers, foreign nationals working in Iran, and employees of the SSO.
[xxvii] This obligation is only for firms and workshops with more than five employees.

5.3.1.4 Benefits

A variety of benefits are provided by the SSO. These benefits include retirement pension, disability pension, survivors pension, short-term benefits (such as wage compensation for any sickness period, maternity compensation, and unemployment benefits), and health care benefits.

Health services are provided directly to patients through medical facilities belonging to the SSO (direct service provision). Additionally, medical services are provided through physicians, public and private hospitals, and clinics that have a contractual relation with the SSO (in-direct service provision).

The SSO Deputy of Health Affairs is responsible for providing health services to insured persons. To fulfil the above objective, three general offices (Direct Service Provision, Indirect Service Provision, and Administrative) have been established. The bureau also includes two other departments, namely Statistics and Programming that are responsible for gathering and analysing all health data that is required for planning the health care provided through the SSO owned and contractual health care facilities. Based on Article 11 of the Social Security Law, a Health Affairs Management Office must be established in every province. These offices are responsible for providing health care services to local insured persons at the provincial level. Figure 5.3 shows the organisational chart of the SSO Deputy of Health Affairs.

According to the Social Security Law, all insured persons can use the SSO health care services in case of any illness or accident. These services include outpatient services, and any services provided in hospitals, pharmacies, imaging centres, rehabilitation centres, laboratories, and pathology centres. These services are carried out in two ways, direct and in-direct service provision.

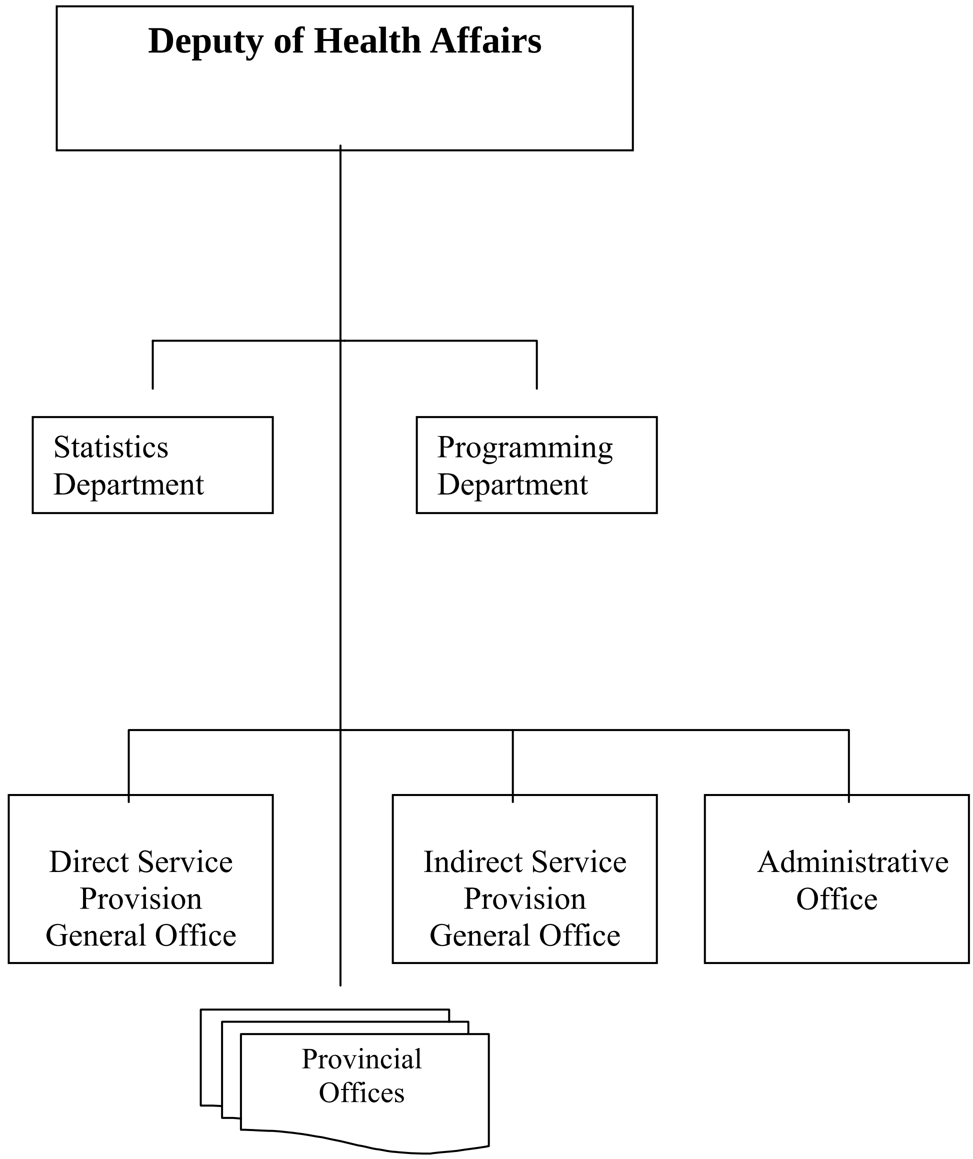

Figure 5.3: The organizational chart of the Deputy of Health Affairs

According to direct service provision, patients can use health care facilities owned by the SSO including clinics and hospitals. In this method, all services are provided free of charge at the point of delivery for both the main insured person and dependents of insured persons. According to the SSO Annual Statistics Report (ibid.), the SSO owns and runs 59 hospitals and 267 clinics across 30 provinces and regions.[xxviii, xxix] In these centres, a variety of clinical

[xxviii] According to the large number of insured persons and some political debate in the regions of Kashan and Karaj located in Tehran and Esfahan provinces, the SSO High Council decided to establish separate regional offices for these two regions.

[xxix] All health care information has been adapted from the SSO Annual Statistics Report (March 2002- March 2003)

(general and different specialities) and paraclinic services are offered to insured persons. Information on the number of full-time equivalent staff employed in the health facilities owned by the SSO shows that across all the SSO health care centres including hospitals and clinics, and the Health Management Offices, 29,617 staff were employed in 2002. In this year (2002), 596,902 patients were separated from the SSO hospitals (inpatient services). Furthermore, 32,819,655 patients were visited (outpatient services) by doctors (both general practitioners and specialists).

Under indirect service provision, the insured person is free to choose a physician, pharmacy, hospital, laboratory, and imaging centre or any other health care centre. In order to provide this service, the SSO has contracted with public and private health services. At the end of March 2003, 42,789 health care providers had a contract with the SSO, including 27,298 physicians, 631 public and private hospitals, and 14,860 pharmacies and paraclinic centres. Under indirect service provision, the health care services are not free of charge at the point of delivery. Insured persons must pay 10% of their total inpatient expenditures and 30% of their total outpatient expenses. However, if insured persons choose non-contracted health care centres, they must pay all their health care expenditures. The only exception is when referred to non-contracted hospitals to receive inpatient services. In this case, after paying all expenditures by insured persons, the SSO with reference to medical documents offices located in the provincial Health Management Offices and based on approved medical tariffs, will reimburse 90% of the expenses.

Table 5.2 summarizes the number of separations and physician visits as two major health care activities for two service provisions.

Service provision / Activities	**In-direct**			**Direct**		
	2001/2002	2002/2003	Change	2001/2002	2002/2003	Change
Separations	1,080,720	1,098,809	1.6%	550,993	598,902	8.6%
Physicians visits	43,345,098	45,941,364	3.6%	31,954,654	32,819,655	2.7%

Table 5.2: Summary of admissions and physician visits for different types of service provision in the SSO health care system
Source: Annual Statistics Report, SSO

As can be seen from Table 5.2, insured persons use inpatient services through indirect service provision nearly twice as often as they do through direct service provision. This seems reasonable, however, considering that the SSO runs and operates a relatively small number of health care facilities which makes them less accessible compared with contracted health care centres. Furthermore, some contracted hospitals and clinics (private or teaching hospitals) offer super-specialty services that are not offered by SSO hospitals. Table 5.2 also shows that, compared to the previous year, in 2003 inpatient separations increased by 8.6% and 1.6% in direct and indirect services respectively and all physician visits increased by around 3%.

5.4 SSO hospitals

SSO hospitals consume the largest share of total health expenditures in the organisation. From 1997 to 2001, the share of hospital expenditures as a proportion of all SSO health care costs increased from 59% to 66%.[11] This trend is a concern for the SSO. Given the importance of hospitals in any health system, and before analysing input, output, and throughput ratios, this section introduces the SSO hospitals in more detail, including their location, the availability of hospital beds, and their classification.

Data were drawn from the Annual Statistical Report [11] published by the SSO. The reference period of the study is the financial year from April 2002 to March 2003 (Iranian financial year). Each SSO hospital transmits and certifies a monthly report of activities to the Statistics Department. This department includes experts in the field of statistics. As data reliability is paramount to any analysis, during the past few years the SSO has made several efforts to improve data accuracy by employing at least one Statistical Officer (with a health statistics background) for each hospital, by running ongoing training workshops (two workshops annually), by using similar equipment and statistical programs for all the SSO hospitals, and by applying similar definitions for all key variables such as the Bed Occupancy Rate (BOR), the Average Length of Stay (ALOS), and the Bed Turnover Rate (BTR). Furthermore, Statistical Officers working in the SSO hospitals are rewarded or sanctioned (in terms of career advancement) by the SSO Statistics Department. This is because of diminishing possible pressures posed by the hospital managers for data manipulation.

To calculate simple ratios, this study uses separations rather than admissions for a number of reasons. First, the number of separations is the most commonly used measure of the utilization of hospital services. [218] Furthermore, the SSO hospital abstracts for inpatient care

are based on information gathered at the time of discharge. Finally, a patient transferred from one ward to another ward in the hospital may be counted twice in the admission record. This can lead to a discrepancy between the number of admissions and separations.

Table 5.3 presents information on the distribution of insured persons, hospitals and available beds. Because of the importance of the inpatient services, there is usually at least one hospital in each province. The only exceptions are Ilam, Kohgiluyeh-e Boyerahamad, and Quam in which there is no hospital.

The absence of an SSO hospital in the first two provinces is largely related to the small number of insured persons living there. As can be seen in Table 5.3, only 0.52% and 0.63% of the total Iranian insured population live in Ilam and Kohgiluyeh-e Boyerahamad respectively, making them the two provinces with the fewest insured persons. However, this is not the case for Quam. According to the SSO Statistics, around 1.08% of the total insured population live in this province, comparable with provinces such as Kordestan and Semnan with 1.10% and 1.12% insured persons respectively. However, the SSO runs one hospital in Kordestan and two hospitals in Semnan. This apparent paradox is related to the administrative divisions within the country. Before 1998, Quam was a part of Tehran province. After separation, the Board of Directors of the SSO received approval to build a hospital in this province. However, due to some financial constraints, this still has not happened.

Provinces or regions	Population of province or region	The number of insured persons	The ratio of insured persons to province's total population	The ratio of insured persons in province to total insured population	Number of SSO hospitals	Number of SSO beds	Number of SSO beds per 1000 insured persons
Ilam	532,428	138,510	26.01%	0.52%			
Kohgiluyeh	654,142	169,299	25.88%	0.63%			
Quam	1,013,047	287,723	28.40%	1.08%			
Fars	4,259,547	1,633,325	38.34%	6.11%	1	203	0.12
Khuzestan	4,209,137	2,157,564	51.25%	8.07%	4	342	0.15
Azerbaijan.S	3,463,419	1,081,703	31.23%	4.05%	1	187	0.17
Boushehr	800,453	575,642	71.91%	2.15%	2	126	0.21
Mazandaran	2,772,063	1,228,841	44.32%	4.60%	3	289	0.23
Gilan	2,367,919	742,261	31.34%	2.78%	1	171	0.23
Hormozgan	1,255,155	440,211	35.07%	1.65%	1	106	0.24
Tehran	8,619,678	6,543,117	75.90%	24.48%	9	1718	0.26
Zanjan	955,503	328,862	34.41%	1.23%	1	91	0.27
Kermanshah	1,903,696	494,335	25.96%	1.85%	1	166	0.33
Semnan	568,310	300,420	52.86%	1.12%	1	102	0.33
Chahar-Mahal	823,626	311,828	37.86%	1.17%	1	106	0.33
Kerman	2,328,616	1,105,976	47.49%	4.14%	3	376	0.33
Khorasan	6,386,119	1,966,278	30.78%	7.36%	5	671	0.34
Yazd	923,225	568,909	61.62%	2.13%	1	203	0.34
Systan	2,150,009	337,105	15.67%	1.26%	1	135	0.40
Esfahan	3,893,074	1,963,218	50.42%	7.35%	3	839	0.42
Markazi	1,328,419	607,891	45.76%	2.27%	3	261	0.42
Azerbaijan.G	2,843,484	454,716	15.99%	1.70%	1	205	0.43
Golestan	1,589,722	321,875	20.24%	1.20%	1	140	0.43
Karaj	3,094,002	785,021	25.37%	2.84%	4	356	0.45
Ardabil	1,236,449	353,712	28.60%	1.32%	2	171	0.48
Kordestan	1,518,546	294,479	19.39%	1.10%	2	158	0.53
Lorestan	1,719,931	457,174	26.58%	1.71%	2	261	0.57
Hamedan	1,724,754	429,186	24.88%	1.61%	2	251	0.58
Quazvin	1,103,695	485,974	44.03%	1.82%	2	285	0.58
Kashan	441,998	186,065	42.09%	0.70%	1	338	1.81
Sum/average	**66,480,166**	**26,751,220**	**40.23%**	**100.00%**	**59**	**8257**	**0.30**

Table 5.3: Distribution of the SSO's insured persons, hospitals and beds

Table 5.3 also shows the ratio of available SSO beds per 1,000 insured persons as a comparative measure across provinces and regions. Nationally, on average, there were 0.31 beds per 1,000 insured population (Median: 0.35, SD: 0.31) in that year. This ratio ranged from 0.12 beds per 1,000 insured population in Fars to 1.81 beds per 1,000 population in Kashan. This suggests that there is not close geographic fit between the size of the insured population and the distribution of SSO hospital beds. However, two points should be noted. First, hospitals located at the boundary between two provinces can serve patients who live in neighbouring provinces. For example, some patients from Fars refer to hospitals located in Esfahan or Kerman for which the number of beds per 1,000 insured persons is greater than the national average. Second, this ratio should be adjusted by the number of contracted hospitals and beds, as it is likely that in some provinces with low beds per population, insured persons are able to use more contracted hospitals.

The above argument can be applied to Khuzestan and Azerbaijan S with a number of beds per 1,000 insured persons of 0.15 and 0.17 respectively. However, Table 5.3 cannot provide any rationale to justify the substantial difference between Kashan with 1.81 beds per 1,000 insured persons and other provinces. To examine possible reasons more information about service utilization is needed.

Table 5.4 presents the number of separations per 1,000 insured persons by province for both direct and in-direct service provision for 2003. Nationally, through direct service provision there were 22 separations per 1,000 insured persons (SD: 25.74). Among different provinces and areas, Kashan had the highest rate of separations with 86 separations per 1,000 insured. This table also shows that Azerbaijan S with 8.23 has the lowest number of separations per 1,000 insured persons.

On the other hand, separations from in-direct service provision nationally were almost twice that of the direct method (Max: 76 in Semnan; Min: 22 in Boushehr; SD: 34). This, however, is not surprising because the number of beds which are actually run by the SSO account for only a small proportion of contractual beds. Moreover, contractual hospitals, particularly MOH hospitals, provide a variety range of super-speciality services which are not routinely available in the SSO hospitals.

Comparing the two types of service provision, there are only six provinces or regions where separations are higher under direct rather than under in-direct service provision. These are Kashan, Quazvin, Hamedan, Lorestan, Ardabil, and Golestan. This is related to the availability of beds owned by the SSO in these provinces and regions. This can be supported by the data provided by table 5.3, the number of available beds per 1,000 insured persons, as these provinces and regions have a high number of available beds. However, this variable should be adjusted by the number of contractual beds. In these provinces and regions the SSO has a lower number of contractual beds per insured population than other provinces.[11] It can be also related to the better quality of health care provided in the SSO hospitals located in these provinces and regions, and a subsequent higher level of patient satisfaction which encourages them to use the SSO beds more than the contractual beds.[xxx] Kashan has a special feature in terms of the utilization of the SSO in-patient service.

[xxx] The SSO database does not report appropriate quality variables. However, the hospitals located in these provinces and regions benefit from a very low number of complaints.

Provinces or regions	Number of insured persons	Direct service provision		Indirect service provision		Total separations Per 1,000 insured persons
		Number of separations	Separations per 1,000 insured persons	Number of separations	Separations per 1,000 insured persons	
Ilam	138,510	-	-	5,073	36.63	36.63
Kohgiluyeh	169,299	-	-	8,759	51.74	51.74
Quam	287,723	-	-	19,812	68.86	68.86
Fars	1,633,325	14,883	9.11	58,734	35.96	45.07
Khuzestan	2,157,564	30,750	14.25	89,283	41.38	55.63
Azerbaijan.S	1,081,703	8,901	8.23	58,366	53.96	62.19
Boushehr	575,642	8,752	15.20	12,665	22.00	37.21
Mazandaran	1,228,841	22,147	18.02	61,403	49.97	67.99
Gilan	742,261	17,112	23.05	34,650	46.68	69.74
Hormozgan	440,211	6,250	14.20	14,372	32.65	46.85
Tehran	6,543,117	94,996	14.52	210,649	32.19	46.71
Zanjan	328,862	11,245	34.19	16,925	51.47	85.66
Kermanshah	494,335	13,662	27.64	15,896	32.16	59.79
Semnan	300,420	6,666	22.19	22,994	76.54	98.73
Chahar-Mahal	311,828	9,315	29.87	14,107	45.24	75.11
Kerman	1,105,976	43,254	39.11	43,605	39.43	78.54
Khorasan	1,966,278	42,069	21.39	78,704	40.03	61.42
Yazd	568,909	14,866	26.13	37,460	65.85	91.98
Systan	337,105	8,612	25.55	10,814	32.08	57.63
Esfahan	1,963,218	61,942	31.55	106,111	54.05	85.60
Markazi	607,891	19,730	32.46	23,894	39.31	71.76
Azerbaijan.G	454,716	17,000	37.39	18,291	40.23	77.61
Golestan	321,875	18,515	57.52	12,396	38.51	96.03
Karaj	785,021	26,652	33.95	34,701	44.20	78.15
Ardabil	353,712	12,487	35.30	11,681	33.02	68.33
Kordestan	294,479	11,042	37.50	13,870	47.10	84.60
Lorestan	457,174	17,717	38.75	16,110	35.24	73.99
Hamedan	429,186	20,504	47.77	15,436	35.97	83.74
Quazvin	485,974	23,767	48.91	21,820	44.90	93.81
Kashan	186,065	16,066	86.35	10,228	54.97	141.32
Sum/average	**26,751,220**	**598,902**	**22.31**	**1,098,809**	**41.08**	**63.46**

Table 5.4: The number of annual separations and separations per 1000 insured persons by province for both Direct and Indirect service provision

This region has the highest number of separations per insured person in direct service provision, with 86 separations per thousand. Kashan also ranks fourth in the utilization of inpatient services through in-direct service provision, with 54 separations per 1,000 insured persons. This illustrates that the number of separations per insured person for this particular region is remarkably higher than national average for both types of service provision, a characteristic that is rarely seen for other provinces and regions.

It should be noted that the number of separations can be affected by several factors. One possibility is related to the burden of disease. [xxxi] However, looking at this variable for Esfahan (Kashan is a region located in Esfahan province) or neighbour provinces such as Markazi with similar Human Development Index (HDI) values reveals that the burden of disease is not a prominent issue in this particular case. Supply-related factors such as unnecessary admissions can affect the number of separations. However, in order to explore the role of this factor, more information in terms of casemix-based separations, and the complexity of procedures is required. Moreover, there are some other factors such as the availability and the quality of non-hospital services that can affect separation rates. After analysing the procedural complexity, factors influencing separation rates of the SSO hospitals will be examined in more depth in section 5.5.3.1.

To sum up, the data from the last two tables (5.3 and 5.4) have shown that Kashan, Semnan, Golestan and Quazvin have total separation rates per 1,000 insured persons (both direct and in-direct service provision combined) about 1.5 to 2.2 times of national average. For Kashan, Quazvin and Golestan, insured persons used direct service provision more than in-direct. This is consistent with the number of available beds per insured population for these provinces and areas, particularly for Kashan and Quazvin. However, in Semnan more than 85% of separations are through in-direct service provision.

5.4.1 Categorization of the SSO hospitals

Given a wide range of health services offered by the SSO hospitals, analysis of any ratio needs stratification in order to classify the hospitals into more homogeneous subgroups.

[xxxi] Due to the lack of data on the needs of the population in the catchment area and burden of disease, I used HDI values as a proxy. See section 5.5.3.3 for more information on HDI values.

There are different types of hospital classification. The selection of an appropriate stratification strongly depends on local factors and the social environment in which each hospital is operating. For example, district hospitals in high-income countries may have separate teams specializing in thoracic or gastrointestinal surgery. In contrast, in the hospitals of less-developed countries a general surgeon may operate for all of these conditions. Thus, the nature and the complexity of the services provided by district hospitals vary between countries. Furthermore, to choose an appropriate classification in performance measurement studies, it should be kept in mind that the size of the each stratum should be large enough to allow meaningful statistical inferences to be drawn.[219] For instance, classification of the SSO hospitals based on their location (rural and urban-based hospitals) would not be an appropriate classification, because it would not provide a sufficient sample size for each group as almost all SSO hospitals are located in cities. A similar argument can be applied to the classification of the SSO hospitals based on governance or payment system, as all hospitals have the same owner and a similar payment system.

A commonly cited classification in hospital performance measurement studies is according to teaching and non-teaching status. It has been pointed out that teaching hospitals with their different mission in terms of providing teaching services to medical residents are more costly than non-teaching hospitals requiring a different mix of resources.[106] Moreover, due to their mission, it is highly possible that these hospitals admit more-complicated patients. These variations can lead to different organizational behaviour resulting in different efficiency scores gained. Hence, it has been suggested that teaching hospitals should be classified in a separate group to provide a more accurate examination of their performance.[220] Among the SSO hospitals, there are only two of teaching status.[11]

The complexity of the services offered by hospitals is another factor that can influence their performance. One aspect of complexity is the number and type of specialities.[2] Moreover, the existence of (for example) a psychiatric ward in a hospital can affect some service utilization variables such as ALOS and BTR.[xxxii] From this standpoint, the SSO hospitals are divided into four strata as follows:

level 1: if the hospital offers at least one super-speciality service (such as oncology);

[xxxii] None of the SSO hospitals have psychiatric wards.[11]

level 2: if the hospital offers at least four specialized services (such as general surgery, internal medicine, etc.), and has one or both following units; Intensive Care unit (ICU) and Cardiac Care Unit (CCU);
level 3: Similar to level 2 with no ICU and CCU;
level 4: any hospital which has none of the above facilities

Table 5.5 shows the number and classification of the study population.

Classification		**Number of hospitals**
Teaching hospitals		2
Non-teaching hospitals*	Level 1	4
	Level 2	39
	Level 3	9
	Level 4	5

Table 5.5: Categorisation of the SSO hospitals
*Non-teaching hospitals have been classified into four levels based on the complexity of services provided.

A further stratification is to classify the SSO hospitals according their size as proxied by the number of available beds. The logic behind this classification is that larger firms by increasing the scale of production can reduce costs per unit of output (i.e. achieve economies of scale) by specialisation, spreading overheads, and bulk buying.[19] However, it is clear that there is a limit to the operation of economies of scale. There will come a point beyond which average costs begin to rise despite a further increase in the scale of activity. This underlines the importance of the identification of the optimal size for a hospital. Systematic reviews of the literature on economies of scale have argued that scale economics are fully exploited in the range of 100-200 beds.[221,222] These studies state that diseconomies of scale will happen in hospitals where the number of beds is above 400. However, these studies are not able to identify specific criteria to define the optimal size of a hospital.

To sum up, given the above arguments, each stratum of table 5.5 is divided into three groups according to the number of available beds. Table 5.6 shows the final classification of the SSO hospitals used in this thesis. It can be seen from this table that 12 hospitals have more than 200 beds. Of those two hospitals (Fayazbakhsh and Shariati Esfahan) have more than 400 beds (Table 5.7). Considering the cited evidence on the relationship between the number of beds (more than 400) and diseconomies of scale, the performance of these two hospitals should be carefully monitored.

	Less than 100 beds (A)	100-200 beds (B)	More than 200 beds (C)	Total
Teaching hospitals		1	1	**2**
Level 1			4	**4**
Level 2	7	25	7	**39**
Level 3	9			**9**
Level4	5			**5**
Total	**21**	**26**	**12**	**59**

Table 5.6: Final classification of the SSO hospitals

5.5 Simple ratio analysis

5.5.1 Input ratios analysis

The data collection by staffing category is consistent across all SSO hospitals. The hospital staff can be grouped into four categories:

- ✓ Medical doctors include specialists, general medical doctors (plus interns and residents for teaching hospitals);
- ✓ Nurses include nurses, midwifes, and nurse assistants;
- ✓ Diagnostic and allied health professionals (DAHP) include experts in the field of nutrition, imaging, laboratory, physiotherapy, and pharmacy;
- ✓ Administrative and clerical staff.

Information on the number of full-time equivalent staff employed in the SSO hospitals, and some staffing ratios are presented in Table 5.7, as the average available staff for 2002-2003. Across all the hospitals, there were 2,529 medical doctors and 7,497 nurses in that year.

Figure 5.4 shows the share of different technical staff categories employed in the SSO hospitals. The figure shows that nurses constituted the greatest proportion, followed by administrative staff and medical doctors.

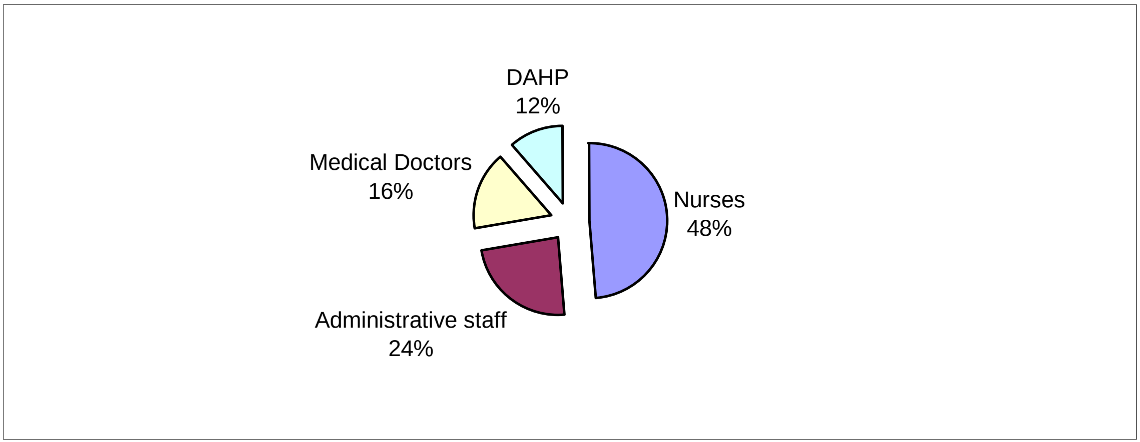

Figure 5.4: Proportion of different technical staff categories for the SSO hospitals

The mean of the number of medical doctors employed in the SSO hospitals varies across different categories. There are 99 doctors (including interns and residents) for each teaching hospital, 93.75 for level one, 42.61 for level two, 22.3 for level three, and 20.6 for level four. This shows that in the hospitals which offer more complicated services, the number of medical doctors are more than other hospitals. Figure 5.5 represents the relationship between the mean of the number of doctors (per hospital) and the level of the SSO hospitals' complexity.

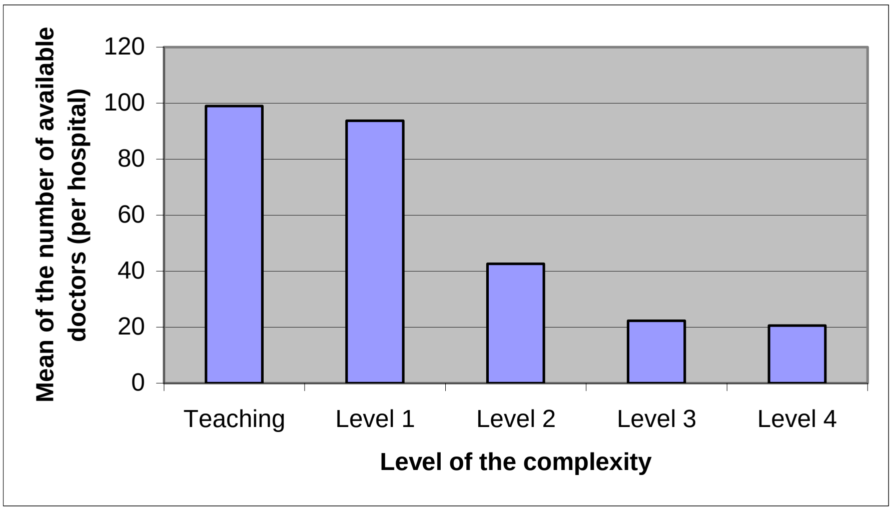

Figure 5.5: Relationship between the level of the complexity and number of doctors in the SSO hospitals

From Table 5.7, it can be seen that the nurse-doctor ratio is 2.96 across all the hospitals, with the minimum being 1.11 for Kosar (level 3A), and the maximum being 5.79 for Gonbad Golestan (level 2B). In general, this ratio is higher in teaching and high level hospitals (1C), and lower in hospitals from levels three and four.

Table 5.7 also presents some inequalities in the distribution of inputs, for example, the ratio of the total number of beds to the total number of medical doctors. Nationally, there were 3.26 beds per medical doctor. Interestingly, this ratio varies considerably across the SSO hospitals. While there are some low-staffed hospitals, such as Gonbad Golestan and Shafa Semnan with 7.37 and 7.29 beds per one doctor respectively, in Amirkabir hospital there is one doctor per 1.13 beds. Comparing staffing ratios reveals that Gonbad Golestan and Shafa Semnan have a specific feature in terms of the number of doctors. These hospitals have the greatest nurse/doctor ratios as well (5.79 and 5.64 respectively). Considering the number of beds and nurses, there is a low number of medical doctors employed in these hospitals relative to other hospitals. This may well be partly due to the living standards in the cities in which the hospitals are located. On the other hand, some hospitals such as Amirkabir, Kosar Broujerd, and Saghez have the lowest bed / doctor ratios (1.13, 1.22, and 1.27 respectively) and nurse / doctor ratios. These hospitals lie in levels 2 and 3. This reveals a counterintuitive finding as it is expected that more sophisticated hospitals such as level 1 hospitals should have more doctor per available bed. It is important to further explore this because of the relevance of the input ratios for efficiency and that there might be some confounding factors that may have been operating for these hospitals, leading to such situation.

To explore this issue further, more information about the number of separations, and the intensity of interventions is required. The next step for performance assessment of the SSO hospitals should be based on an investigation of the relationship between inputs and major outputs, such as the number of separations, to examine the consistency between simple ratios. This issue will be discussed in more detail in section 5.5.2.

Classification of hospitals	Hospital	Number of beds (B)	Medical Doctors (MD)	Nurses (N)	DAHP	Administrative staff (A)	N / MD	B / MD
Teaching hospital	Kashani	124	103	162	75	52	1.57	1.20
	Labaffi	286	95	344	88	34	3.62	3.01
Total for group	**2**	**410**	**198**	**506**	**163**	**86**	**2.56**	**2.07**
1C	Valiasr Mazandran.	201	51	197	28	134	3.86	3.94
	Fayazbakhsh	496	162	411	96	113	2.54	3.06
	Shariati Esfahan	538	78	365	55	167	4.68	6.90
	Lavasani	304	84	302	51	79	3.60	3.62
Total for group	**4**	**1,539**	**375**	**1,275**	**230**	**493**	**3.40**	**4.10**
2A	Zarand	66	21	86	19	55	4.10	3.14
	Razi Chalus	49	14	54	16	12	3.86	3.50
	Chamran Saveh	73	42	64	18	30	1.52	1.74
	T. Haydarieh	67	17	71	15	29	4.18	3.94
	Bojnoord	76	16	52	15	28	3.25	4.75
	Amirkabir Ahvaz	51	45	81	29	49	1.80	1.13
	Takestan	92	24	84	19	58	3.50	3.83
Total for group	**7**	**474**	**189**	**492**	**131**	**261**	**2.60**	**2.51**
2B	Gharazi Malayer	116	20	82	20	48	4.10	5.80
	Atyeh Hamedan	135	28	127	34	62	4.54	4.82
	Khalij	126	38	135	21	57	3.55	3.31
	Emam Arak	140	20	102	26	46	5.10	7.00
	Shariat Tehran	114	60	92	42	84	1.53	1.90
	Eslamshar	104	71	137	50	81	1.93	1.46
	15 Khordad	125	84	161	71	91	1.92	1.49
	Alinasab Tabriz	187	55	176	43	86	3.20	3.40
	Sabalan Ardabil	135	53	106	18	63	2.00	2.55
	Gharazi Esfahan	182	55	179	39	75	3.25	3.31
	Najaf abad	119	43	103	30	69	2.40	2.77
	Salman Bousher	110	45	115	22	40	2.56	2.44

Table 5.7: Staffing availability, mix, and ratios for the SSO hospitals

Classification of hospitals	Hospital	Number of beds (B)	Medical Doctors (MD)	Nurses (N)	DAHP	Administrative staff (A)	N / MD	B / MD
	Sanandaj	116	18	84	23	47	4.67	6.44
	Kashani Kerman	191	54	188	42	132	3.48	3.54
	Gharazi Sirjan	119	39	111	24	86	2.85	3.05
	Sh. Kermanshah	166	43	140	26	110	3.26	3.86
	Gonbad Golestan	140	19	110	28	39	5.79	7.37
	Rasoul Rasht	171	34	151	28	62	4.44	5.03
	Shahryar Karaj	127	36	128	29	60	3.56	3.53
	Alborz Karaj	171	35	176	40	89	5.03	4.89
	Shahr Kord	106	24	87	23	50	3.63	4.42
	Amiral Ahvaz	154	69	157	31	41	2.28	2.23
	Shafa Semnan	102	14	79	17	19	5.64	7.29
	Zahedan	135	41	144	26	69	3.51	3.29
2B	Razi Ghazvin	193	53	160	32	106	3.02	3.64
Total for group	**25**	**3,464**	**1,043**	**3,204**	**785**	**1,692**	**3.07**	**3.32**
	Emam Uremeyeh	205	61	200	41	78	3.28	3.36
	17 Sh. Mashad	285	44	133	34	107	3.02	6.48
	Farabi Mashad	217	51	163	42	59	3.20	4.25
	Beheshti Fars	203	67	241	58	55	3.60	3.03
	Beheshti Kashan	338	102	207	21	129	2.03	3.31
	Khoramabad	228	69	136	32	85	1.97	3.30
2C	Kargar Yazd	203	44	179	35	89	4.07	4.61
Total for group	**7**	**1,679**	**438**	**1,259**	**263**	**602**	**2.87**	**3.83**
	Aras Ardabil	36	14	35	13	25	2.50	2.57
	Birjand	26	12	31	15	15	2.58	2.17
	Abadan	67	24	56	13	46	2.33	2.79
	Behbahan	70	26	69	16	37	2.65	2.69
	Emam Zanjan	91	30	97	17	34	3.23	3.03
	Shazand Arak	48	12	38	13	28	3.17	4.00
	Saghez	42	33	53	14	31	1.61	1.27
	Kosar Broujerd	33	27	30	10	34	1.11	1.22
3A	Neka	39	12	40	13	25	3.33	3.25
Total for group	**9**	**452**	**190**	**449**	**124**	**275**	**2.36**	**2.38**

Classification of hospitals	Hospital	Number of beds (B)	Medical Doctors (MD)	Nurses (N)	DAHP	Administrative staff (A)	N / MD	B / MD
	Moayari	94	22	89	37	39	4.05	4.27
	Hedayat	71	44	105	17	33	2.39	1.61
	Mehr Borazjan	16	8	40	8	18	5.00	2.00
	Ershad Karaj	33	10	43	10	40	4.30	3.30
4A	Hashtgerd K.	25	12	35	10	23	2.92	2.08
Total for group	**5**	**239**	**96**	**312**	**82**	**153**	**3.25**	**2.49**
Total	**59**	**8,257**	**2,529**	**7,497**	**1,778**	**3,652**	**2.96**	**3.26**

Table 5.7: Continued

5.5.2 Staff / Output ratio analysis

After reviewing input ratios (staff and beds), this section examines the relationship between human resources (as a major input) and a major hospital output (separations) providing a fuller range of performance characteristics of the SSO hospitals. Table 5.8 shows the relationship between the number of doctors and the number of separations.

In 2002, nationally there were 237 separations per medical doctor for the SSO hospitals. This ratio varies considerably across the hospitals. Gonbad Golestan, Emam Arak, Rasoul Rasht, and Shafa Semanan have the highest separations per doctor (974, 525, 503, and 476 respectively). In these hospitals, relatively fewer doctors are providing health care services to a large number of patients. Given that the payment system for all SSO hospitals is similar, the low number of medical doctors in these hospitals can be at least in part due to the socioeconomic status of the cities in which the hospitals are located. In other words, cities such as Gonbad, Semnan, and Arak may not be attractive for physicians and their families to live and work. Furthermore, examining Table 5.7, the above-mentioned hospitals had great number of beds per medical doctor. Putting these two together, in these hospitals not only the number of doctors per bed is low compared to other hospitals, but these doctors admit and treat more patients than do their counterparts in other hospitals.

On the other hand, ignoring Kashani with 96 and Labaffi with 111 separations per doctor[xxxiii], Hashtgerd Karaj and Mehr Borazjan (both in class 4A) with 95 and 110 respectively, have the lowest number of separations per doctor. Interestingly, all hospitals in class 4A have a low number of separations per doctor. These hospitals offer services related to only one or two specialities. The extent to which the above issue can justify the low number of separations per doctor in these hospitals (class 4A) is not clear. From Table 5.8, it can also been seen that doctors in teaching hospitals and hospitals in class 1C admit a lower number of patients compared with less sophisticated hospitals.

The information on the number of insured persons in the catchment area of each hospital could provide more insight into the relationship between the number of doctors and separations. However, the SSO database does not report such information.

[xxxiii] Kashani and Labaffi are teaching hospitals. Thus, the main reason for the low number of separations per doctor can be related to the high number of doctors, including interns and residents.

Although comparing inputs and hospital activities (see Table 5.8) is one of the most commonly cited performance assessments, it cannot provide a multidimensional approach to hospital performance, as it ignores the complexity of procedures and the quality of care. For example, it is possible that the good performance of Gonbad Hospital in terms of the number of separations per bed is due to the admission of non-complicated cases. To compensate for that, the next section (5.5.3) discusses output ratios with a focus on the complexity of services provided.

Classification of hospitals	Hospital	Number of separations	Separations per doctor
Teaching hospital	Kashani	9,837	96
	Labaffi	10,562	111
Total for group	**2**	**20,399**	**103**
	Valiasr Mazandran.	15,259	299
	Fayazbakhsh	23,223	143
	Shariati Esfahan	33,056	424
1C	Lavasani	15,530	185
Total for group	**4**	**87,068**	**232**
	Zarand	8,557	407
	Razi Chalus	4,191	299
	Chamran Saveh	6,480	154
	T. Haydarieh	8,450	497
	Bojnoord	5,823	364
	Amirkabir Ahvaz	4,790	106
2A	Takestan	7,647	319
Total for group	**7**	**45,938**	**243**
	Gharazi Malayer	7,867	393
	Atyeh Hamedan	12,637	451
	Khalij	6,250	208
	Emam Arak	10,495	525
	Shariat Tehran	6,370	112
	Eslamshar	9,999	141
	15 Khordad	9,497	113
	Alinasab Tabriz	8,901	162
	Sabalan Ardabil	9,676	183
	Gharazi Esfahan	18,047	328
	Najaf abad	10,839	252
	Salman Bousher	7,875	175
	Sanandaj	6,576	365
	Kashani Kerman	26,014	482
	Gharazi Sirjan	8,683	223
	Sh. Kermanshah	13,662	318
2B	Gonbad Golestan	18,515	974

Table 5.8: Relationship between the number of medical doctor and separations by the SSO hospitals

Classification of hospitals	Hospital	Number of separations (A)	Separations per doctor
	Rasoul Rasht	17,112	503
	Shahryar Karaj	11,653	324
	Alborz Karaj	11,891	340
	Shahr Kord	9,315	388
	Amiral Ahvaz	13,693	198
	Shafa Semnan	6,666	476
	Zahedan	8,612	210
2B	Razi Ghazvin	16,120	304
Total for group	**25**	**286,965**	**275**
	Emam Uremeyeh	17,000	279
	17 Sh. Mashad	20,232	460
	Farabi Mashad	4,949	121
	Beheshti Fars	14,883	222
	Beheshti Kashan	16,066	158
	Khoramabad	14,741	214
2C	Kargar Yazd	14,866	338
Total for group	**7**	**102,737**	**240**
	Aras Ardabil	2,811	201
	Birjand	2,615	218
	Abadan	5,587	233
	Behbahan	6,680	257
	Emam Zanjan	11,245	375
	Shazand Arak	2,755	230
	Saghez	4,466	135
	Kosar Broujerd	2,976	119
3A	Neka	2,697	225
Total for group	**9**	**41,832**	**220**
	Moayari	4,182	190
	Hedayat	5,796	132
	Mehr Borazjan	877	110
	Ershad Karaj	1,972	197
4A	Hashtgerd K.	1,136	95
Total for group	**5**	**13,963**	**145**
Total	**59**	**598,902**	**237**

Table 5.8: Continued

5.5.3 Output ratio analysis

Hospital outputs are usually expressed as units of services, e.g. number of interventions. Examination of the relation between inputs and some unweighted outputs such as the number of separations and outpatient visits (section 5.5.2) has shown a wide range. However, to provide a more accurate interpretation of hospital activities, knowledge of the hospital outputs in terms of the complexity of the procedures and the quality of care is necessary.[223] This is important as low levels of activity might be related to the admission of more complicated patients requiring more resources. The SSO database does not report appropriate quality variables (see chapter 4 for the list of appropriate quality variables). Moreover, in the database, the separation classification is not based on case-mix measures such as Diagnosis Related Groups (DRGs). To address these issues, this section focuses on variables such as surgery ratios and major surgical interventions.

Considering the available data, I used two variables to capture procedural complexity, namely the surgery ratio and the number of major surgical interventions. The reason for selecting the proportion of surgical interventions to all hospital separations is because surgeries need some extra inputs, in terms of both human resources and capital, when compared with non-surgical interventions. Furthermore, the outcome of surgical interventions could be more problematic compared with non-surgical interventions. This ratio has been used in some studies to capture procedural complexity.[224] To define surgical interventions, the SSO database uses the National Medical Tariffs released by the Iranian Ministry of Health (MOH) in which all inpatient activities are classified into two categories; surgery and non-surgery. While differentiation between medical and surgical interventions is not challenging, making a distinction between simple and complex cases is not always straightforward. As pointed out earlier, the SSO hospitals do not classify inpatient services according to DRGs. However, based on relative value scale, the degree of procedural complexity of some specific services (i.e. surgical interventions) is reported by SSO database, namely the number of major surgical interventions.

The relative value scale is an index assigning various weights to different medical services. Each weight represents a relative amount to be paid for each service. The weight for each service measures the relative costliness of the health care staff involved and the capital invested. In this system, the price value of each intervention is determined by two components; its weight and an index which is called "K". The index is a fixed amount which is identified and changed annually by the Iranian MOH. For example, National Medical Tariffs show that the price value for tonsillectomy is 4K. If for a hypothetical year, K for surgical interventions is 1,000 Rials (Iranian currency), the value of this intervention will be 4,000 Rials. In this system, any surgery for which the price value is more than 22 K is regarded as a major surgery. The use of this variable in hospital efficiency measurement is subject to limitations. In connection with this issue, I provide a full discussion in section 5.5.4.3.

Figure 5.6 shows the relationship between the proportion of surgical interventions to all separations and the level of the complexity of the SSO hospitals. The teaching hospitals have higher proportion of surgical interventions to all separations than do hospitals in class 1, 2, and 3 for which the ratio is roughly similar. The only exception is hospitals in level 4 for which the value of this ratio is even more than teaching hospitals. This is because these hospitals are offering medical services related to one or two specialities for which surgery forms the majority of interventions (orthopaedic, gynaecology, and obstetrics).

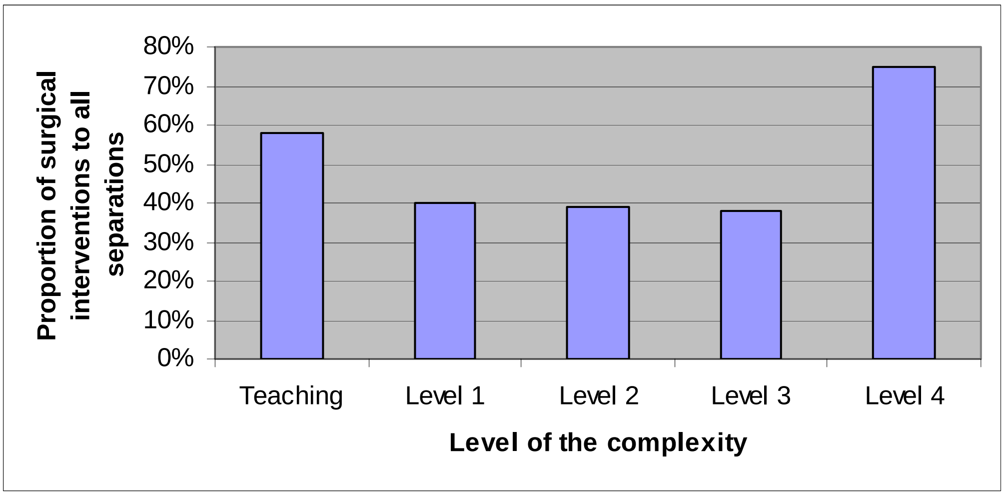

Figure 5.6: Relationship between the proportion of surgical interventions and the level of the complexity of the SSO hospitals

The figure is different when the proportion of major surgeries to the total number of surgical interventions is compared. Figure 5.7 shows that the ratio of major surgeries to surgical interventions is higher in more sophisticated hospitals in which more intensive services are offered.

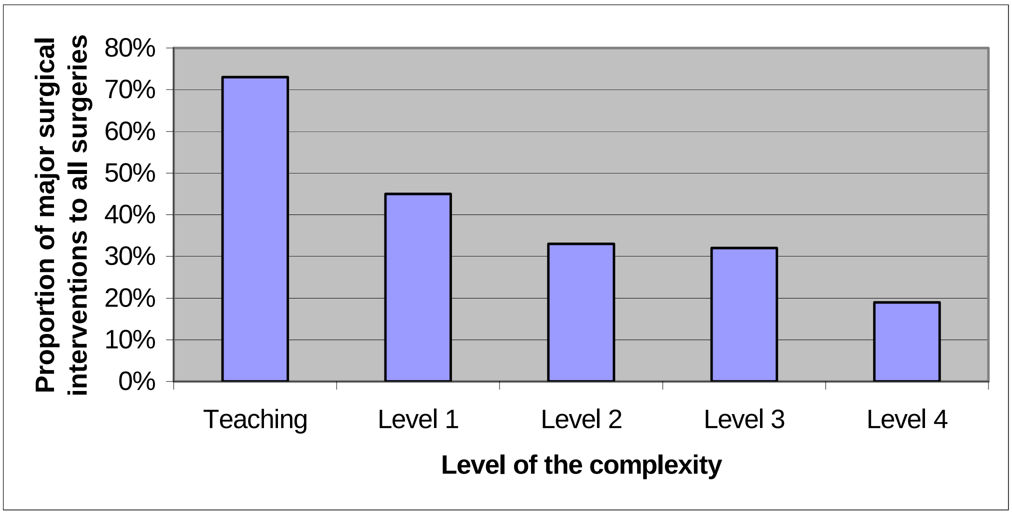

Figure 5.7: Relationship between the proportion of major surgical interventions to all surgeries and the level of the complexity of the SSO hospitals

However, there are differentials inside each group. Table 5.9 shows the data representing the intensity of surgical interventions for each SSO hospital. It can be seen from Table 5.9, that Labaffi as a teaching hospital has the largest proportion of major surgeries (90% of total surgical interventions). This is mainly because of the specific characteristic of this hospital as a referral centre for medical services related to urology, renal transplantation, and eye diseases. After Labaffi, Amirkabir Ahvaz (class 2A) with 82% has the highest proportion of major surgical interventions. On the other hand, only 4% of all surgeries carried out in Valiasr Mazandaran and Alborz Karaj can be regarded as major surgeries. It is interesting to note that Alborz Karaj has exactly the same wards as does Amirkabir Ahvaz (paediatrics, orthopaedic, urology, internal medicine, general surgery, gynaecology and obstetrics, CCU). Valiasr Mazandaran (class1C) in addition to the above-mentioned wards, offers medical services related to neurosurgery, paediatric surgery, and eye diseases. In general, these services have greater relative values than general surgical interventions such as appendectomy and cholecystectomy. It could be assumed that this situation should lead to the larger number of major surgeries. However, it did not. Sections 5.5.3.1-5.5.3.3 provide a full discussion about factors influencing the number of separations and major surgeries.

As for mortality, it can be seen from Table 5.9 that un-adjusted mortality rates are higher amongst the higher level hospitals, ranging from 19 deaths per 1,000 separations at teaching hospitals to 2 per 1,000 separations at class 4 hospitals. It can be anticipated that this observation might be due to the patients who are admitted to higher-level hospitals being more seriously ill. It should be noted that after teaching hospitals, the mortality rate is the highest in group 2C. Among the hospitals classified in this group, there are three hospitals (Khoramabad, Beheshti Fars, and Beheshti Kashan) for which the mortality rate is very high, resulting in a high mortality rate for group 2C. All three hospitals are the main referral hospital in their region, admitting a considerable number of complicated cases, i.e. a high proportion of major surgical interventions (43%, 49%, and 56% respectively). Furthermore, Beheshti Fars and Beheshti Kashan have cardiac surgery departments, which may lead to higher mortality rates.

Classification of hospitals	Hospital	Number of surgical interventions	Number and proportion of surgical interventions based on the level of intensity		Mortality rate (per 1,000 separations)
			Major	Minor	
Teaching hospital	Kashani	6,266	3,536 (56%)	2,730 (44%)	13
	Labaffi	5,659	5,182 (90%)	477 (10%)	25
Total for teaching hospitals	**2**	**11,925**	**8,718 (73%)**	**3,207 (27%)**	**19**
1C	Valiasr Mazandran	4,817	176 (4%)	4,641 (96%)	8
	Fayazbakhsh	12,291	6,766 (55%)	5,525 (45%)	21
	Shariati Esfahan	14,106	7,245 (51%)	6,861 (49%)	23
	Lavasani	3,491	1,508 (43%)	1,983 (57%)	17
Total for group 1C	**4**	**34,705**	**15,695 (45%)**	**19,010 (55%)**	**17**
2A	Zarand	1724	846 (49%)	878 (51%)	7
	Razi Chalus	1,782	346 (19%)	1,436 (81%)	9
	Chamran Saveh	2,041	500 (24%)	1,541(76%)	5
	T. Haydarieh	3,544	1,058 (29%)	2,486 (71%)	7
	Bojnoord	2,347	954 (41%)	1,393 (69%)	5
	Amirkabir Ahvaz	1,648	1,353 (82%)	295 (18%)	21
	Takestan	2,869	418 (14%)	2,451 (86%)	4
Total for group 2A	**7**	**15,955**	**5,475 (34%)**	**10,480 (66%)**	**8**
2B	Gharazi Malayer	3,060	977 (31%)	2,083 (69%)	20
	Atyeh Hamedan	6,261	975 (15%)	5,286 (85%)	9
	Khalij	1,996	213 (11%)	1,783 (89%)	5
	Emam Arak	5,098	475 (9%)	4,123 (81%)	7
	Shariat Tehran ∗	-	0	0	12
	Eslamshar	6,252	2,395 (38%)	3,857 (62%)	7
	15 Khordad	4,402	931 (22%)	3,471 (78%)	11
	Alinasab Tabriz	4,155	931 (22%)	3,224 (78%)	21
	Sabalan Ardabil	4,369	239 (5%)	4,130 (95%)	12
	Gharazi Esfahan	10,473	5,602 (53%)	4,871 (47%)	15
	Najaf abad	3,934	2,006 (51%)	1,928 (49%)	3
	Salman Bousher	4,182	698 (16%)	3,484 (84%)	16
	Sanandaj	3,634	1,154 (31%)	2,480 (69%)	12
	Kashani Kerman	9,092	2,254 (24%)	6,838 (76%)	8
	Gharazi Sirjan	3,498	626 (17%)	2,872 (83%)	9
	Sh. Kermanshah	9,558	4,004 (41%)	5,554 (59%)	7
	Gonbad Golestan	7,310	579 (8%)	6,731 (92%)	14

Table 5.9: Intensity of surgical interventions and mortality rates for the SSO hospitals

∗This hospital has only non-surgical wards such as paediatrics, internal medicine, and cardiovascular

Classification of hospitals	Hospital	Number of surgical interventions	Number and proportion of surgical interventions based on the level of intensity		Mortality rate (per 1,000 separations)
			Major	Minor	
	Rasoul Rasht	6,508	3,651 (56%)	2,857 (44%)	6
	Shahryar Karaj	2,132	105 (5%)	2,027 (95%)	9
	Alborz Karaj	5,520	227 (4%)	5,293 (96%)	11
	Shahr Kord	5,686	1,231 (21%)	4,455 (79%)	4
	Amiral Ahvaz	5,706	3,610 (63%)	2,096 (37%)	15
	Shafa Semnan	2,006	108 (5%)	1,898 (95%)	2
	Zahedan	4,185	2,942 (67%)	1,243 (33%)	24
2B	Razi Ghazvin	11,939	1,602 (13%)	10,337 (87%)	12
Total for group 2B	**25**	**130,956**	**37,435 (29%)**	**93,521 (79%)**	**11**
	Emam Uremeyeh	7,095	2,270 (31%)	4,825 (69%)	15
	17 Sh. Mashad	12,376	2,556 (20%)	9,820 (80%)	13
	Farabi Mashad	2,301	820 (35%)	1,481 (65%)	5
	Beheshti fars	7,932	4,074 (51%)	3,853 (49%)	27
	Beheshti Kashan	3,875	1,710 (44%)	2,165 (56%)	31
	Khoramabad	4,518	2,599 (57%)	1,919 (43%)	23
2C	Kargar Yazd	6,390	1,414 (22%)	4,976 (58%)	15
Total for group 2C	**7**	**44,487**	**15,443 (35%)**	**29,044 (65%)**	**18**
	Aras Ardabil	978	51 (5%)	927 (95%)	2
	Birjand	1,037	223 (21%)	814 (79%)	7
	Abadan	2,625	1,913 (72%)	712 (28%)	11
	Behbahan	2,470	704 (28%)	1,766 (72%)	5
	Emam Zanjan	3,256	228 (7%)	3,028 (93%)	8
	Shazand Arak	1,308	468 (35%)	840 (65%)	3
	Saghez	792	129 (16%)	663 (84%)	1
	Kosar Broujerd	1,668	894 (53%)	774 (47%)	9
3A	Neka	1,256	95 (7%)	1,161 (93%)	0
Total for group 3A	**9**	**15,390**	**4,705 (31%)**	**10,685 (69%)**	**5**
	Moayari	3,989	769 (19%)	3,220 (81%)	3
	Hedayat	4,078	571 (14%)	3,507(86%)	2
	Mehr Borazjan	597	149(25%)	448(75%)	3
	Ershad Karaj	1,441	417(29%)	1024(71%)	0
4A	Hashtgerd K.	814	174 (21%)	640 (79%)	0
Total for group 4A	**5**	**10,919**	**2080 (19%)**	**8839 (81%)**	**2**
Total	**59**	**264,337**	**89,297 (34%)**	**174,840 (66%)**	**11**

Table 5.9: Continued

5.5.3.1 Analysing factors influencing separation rates and the procedural complexity

Several factors appear to be responsible for the wide variation in separation rates and in the proportions of major surgical interventions across the SSO hospitals. In order to analyse these factors (sections 5.5.3.1- 5.5.3.3), I use particular examples rather than analysing the full range of variability in the database. This is mainly because of the limitation of simple ratio analysis in which all the variability of the data cannot be used.

These factors could be organized as follows.

- Underlying needs for hospitalization, for example, the burden of disease, are important in affecting separation rates. Although the identification of the real needs of any society is not always a simple issue, there are a few indices which can reflect overall population health and well-being. The Human Development Index (HDI) is one example (see section 5.5.3.3 for more detail). Considering HDI values for different provinces, it appears that the underlying needs for hospitalization are not prominent reasons to explain the variation observed in separation rates and the intensity of interventions provided by the SSO hospitals. For example, Amirkabir Ahvaz hospital with a very high and Valiasr hospital with a very low proportion of major surgeries are located in provinces (Khuzestan and Mazandaran respectively) which have a comparable stage of HDI values with an almost similar life expectancy (67.4 to 67), literacy rate (72% to 70%), and infant mortality rate (39 to 41 per 1000 live births).[225] A similar argument can be applied to some other hospitals as well.

- Supply-related factors in general, and admission policy in particular could be other reasons for variations observed in separation rates. Since 1997, the SSO policy makers have designed a framework to assess the SSO hospitals. This assessment is largely based on the hospitals' ability to increase their Bed Turnover Rate (BTR) and their Bed Occupancy Rate (BOR) and to decrease their Average Length of Stay (ALOS). Although desirable changes in these service utilization ratios can reflect, to some extent, an improvement in performance, an overemphasis on these types of ratios might be misleading. For example, by not admitting complicated cases, yet admitting simple cases, hospitals can reduce their ALOS while keeping their BOR and BTR at high levels. This argument underlines the importance of examination of procedural complexity in monitoring hospital performance; the issue that has received little attention in the SSO.

For the sake of clarity, Table 5.10 summarizes some key output ratios, including the number of separations per doctor and the proportion of major surgical interventions to all surgeries as reported by each province and region. The table shows that there is a considerable variation across provinces and regions. For example, separations per doctor in Golestan are approximately seven times higher than in Tehran. However, only 8% of surgical procedures in Golestan are classified as major compared with 41% in Tehran. Although it might be argued that the difference between ratios in these provinces can be related to the difference in the existing facilities in these two provinces, this is not true in other cases. For example, in Lorestan and Gilan with a comparable development of hospital wards and a comparable number of technical staff, the proportion of major surgeries is almost six times higher than in Golestan.

Provinces and areas	Hospital	Classification	Number of beds	Separations per doctor	Proportion of major surgical interventions to all surgical procedures
Tehran	Kashani	Teaching	124	96	56%
	Labaffi	Teaching	286	111	90%
	Fayazbakhsh	1C	496	143	55%
	Lavasani	1C	304	185	43%
	15 Khordad	2B	125	113	22%
	Shariat Tehran*	2B	114	112	0
	Eslamshahr	2B	104	141	38%
	Moayari	4A	94	190	19%
	Hedayat	4A	71	132	14%
Total / average	**9**		**1718**	**135**	**41%**
Khorasan	17 Sh. Mashad	2C	285	460	20%
	Farabi Mashad	2C	217	121	35%
	Bojnoord	2A	76	364	41%
	T. Haydarieh	2A	67	497	29%
	Birjand	3A	26	218	21%
Total / average	**5**		**671**	**332**	**28%**
Karaj	Alborz Karaj	2B	171	340	4%
	Shahryar Karaj	2B	127	324	5%
	Ershad Karaj	4A	33	197	29%
	Hashtgerd K.	4A	25	95	21%
Total / average	**4**		**356**	**239**	**14%**
Khuzestan	Amiral Ahvaz	2B	154	198	63%
	Behbahan	3A	70	257	29%
	Abadan	3A	67	233	72%
	Amirkabir Ahvaz	2A	51	106	82%
Total / average	**4**		**342**	**199**	**60%**
Esfahan	Shariati Esfahan	1C	538	424	51%
	Gharazi Esfahan	2B	182	328	53%
	Najaf abad	2B	119	252	51%
Total / average	**3**		**839**	**334**	**51%**
Kerman	Kashani Kerman	2B	191	482	24%
	Gharazi Sirjan	2B	119	223	17%
	Zarand	2A	66	407	49%
Total / average	**3**		**376**	**371**	**28%**
Markazi	Emam Arak	2B	140	525	9%
	Chamran Saveh	2A	73	154	24%
	Shazand Arak	3A	48	230	35%
Total / average	**3**		**261**	**303**	**21%**
Mazandaran	Valiasr Mazandaran	1C	201	299	4%
	Razi Chalus	2A	49	298	19%
	Neka	3A	39	225	7%
Total / average	**3**		**289**	**274**	**9%**

Table 5.10: Some SSO hospitals output analysis by province and area

***This hospital has only non-surgical wards such as paediatrics, internal medicine, and cardiovascular.**

Provinces and areas	Hospital	Classification	Number of beds	Separations per doctor	Proportion of major surgical interventions to all surgical procedures
Kordestan	Sanandaj	2B	116	365	31%
	Saghez	3A	42	135	16%
Total / average	**2**		**158**	**250**	**22%**
Lorestan	Khoramabad	2C	228	214	57%
	Kosar Broujerd	3A	33	119	53%
Total / average	**2**		**261**	**166**	**54%**
Hamedan	Atyeh Hamedan	2B	135	451	15%
	Gharazi Malayer	2B	116	393	31%
Total / average	**2**		**251**	**422**	**23%**
Ghazvin	Razi Ghazvin	2B	193	304	14%
	Takestan	2A	92	319	13%
Total / average	**2**		**285**	**311**	**13%**
Boushehr	Salman Boushehr	2B	110	175	16%
	Mehr Borazjan	4A	16	110	25%
Total / average	**2**		**126**	**142**	**19%**
Ardabil	Sabalan Ardabil	2B	135	183	5%
	Aras Ardabil	3A	36	201	6%
Total / average	**2**		**171**	**192**	**5%**
Kashan	Beheshti Kashan	2C	338	158	44%
Azerbaijan.G	Emam Uremeyeh	2C	205	279	31%
Yazd	Kargar Yazd	2C	203	338	22%
Fars	Beheshti Fars	2C	203	222	51%
Azerbaijan.S	Alinasab Tabriz	2B	187	162	22%
Gilan	Rasoul Rasht	2B	171	503	56%
Kermanshah	Sh. Kermanshah	2B	166	318	41%
Golestan	Gonbad Golestan	2B	140	974	8%
Systan	Zahedan	2B	135	210	67%
Chahar-Mahal	Shahr Kord	2B	106	388	21%
Hormozgan	Khalij	2B	126	208	11%
Semnan	Shafa Semnan	2B	102	476	5%
Zanjan	Emam Zanjan	3A	91	375	7%
Total / average	**59**	**-**	**8,257**	**237**	**34%**

Table 5.10 Continued

- In addition to the variation in underlying needs and supply-related factors, the separation rates and the intensity of interventions can be influenced by factors such as the quality and availability of non-hospital services and the Primary Health Care (PHC) network. For example, timely and high quality PHC and non-hospital services can prevent hospitalizations for several medical conditions such as asthma, diabetic complications, and dehydration and gastroenteritis. Unfortunately, there is no information to explore this issue in more detail.

- Variation in cultural issues across the Iranian provinces can be regarded as another possible factor influencing separation rates. For example, the majority of people living in provinces such as Kordestan, Kermanshah, Hormozgan, Systan, and Boushehr still prefer traditional treatment interventions offered by local people with no medical background. This can affect separation rates as these interventions may lead to more complications.

- Co-payment: All inpatient services offered by the SSO hospitals are free of charge at the point of delivery. [226] For this reason, and also because of the economic status and income level of the SSO insured people, the majority of them prefer to be admitted to the SSO hospitals rather than public hospitals (owned by the MOH) or private hospitals in which they are asked to pay a co-payment out of pocket (the gap between the scheduled fee and the private medical fee). However, it should be noted that the quality and variation in the types of interventions provided by non-SSO hospitals in different provinces can be regarded as a factor influencing separation rates and the proportion of major surgeries in the SSO hospitals. For example, in provinces such as Systan and Lorestan, there are no private hospitals. This can lead to the admission of all patients to the SSO or MOH hospitals.

- International and regional context: The Iran-Iraq War (1979-1988) and the Gulf War (1991) can be considered to have lead to mental and psychosomatic disorders which can affect underlying needs for hospitalization, particularly for people who were more involved. This issue is consistent with the fact that Khuzestan, Kermanshah, and Lorestan have high separation rates and high proportions of major surgery (for example, due to the complications of trauma or psychosomatic disorders).

5.5.3.2 Geographical variations in the intensity of interventions

To provide a more comprehensive picture of factors affecting the rates of major surgery, Figure 5.8 shows the geographical distribution of the provinces. Examining this figure, I argue that:

- A number of provinces and regions with a very low proportion of major surgical interventions (less than 25%) are close to referral hospitals located in Tehran and Esfahan (such as Karaj, Ghazvin, Mazandaran, Semnan, Zanjan, Golestan and Yazd). Their proximity can facilitate the referral of patients (mostly complicated cases) to Tehran and Esfahan. Moreover, some patients prefer to be visited (or operated on) by doctors in the hospitals which are located in major cities. Thus, in these provinces and regions, the low proportion of major surgeries can be due to the combined effect of supply-related factors (admission policies; referring complicated cases and admitting simple cases in order to increase the BOR and decrease the ALOS) and patient preference.

- Khuzestan, Lorestan, and Kermanshah have a high proportion of major surgical interventions (more than 40%). There are some possibilities to explain this trend in these provinces. One is their distance from referral centres. This is important because in these provinces, particularly in Lorestan and Kermanshah, the Human Poverty Index (HPI) exceeds the national level.[225] Economic disadvantage may well be a barrier to patients being referred to other provinces. Another reason may be differing admission policies (compared to provinces with a low proportion of major surgeries). Finally, it should be noted that there are two other provinces close to these three provinces in which the SSO does not run any hospital (white colour). Thus, it is possible that at least some complicated patients from these latter provinces are admitted in hospitals located in Lorestan, Khuzestan, and Kermanshah.

- The above argument can be applied to Systan with a very high proportion of major surgeries (62%). This province is very far from other referral centres. In addition, Systan has the highest HPI of all the provinces; and, as can be seen from the HDI Report, Systan has the lowest HDI, and the highest infant mortality rate.[227] This information suggests that in this province, the underlying needs for hospitalization may be higher than in the other provinces, leading to the admission of more complicated cases by hospitals located in this province.

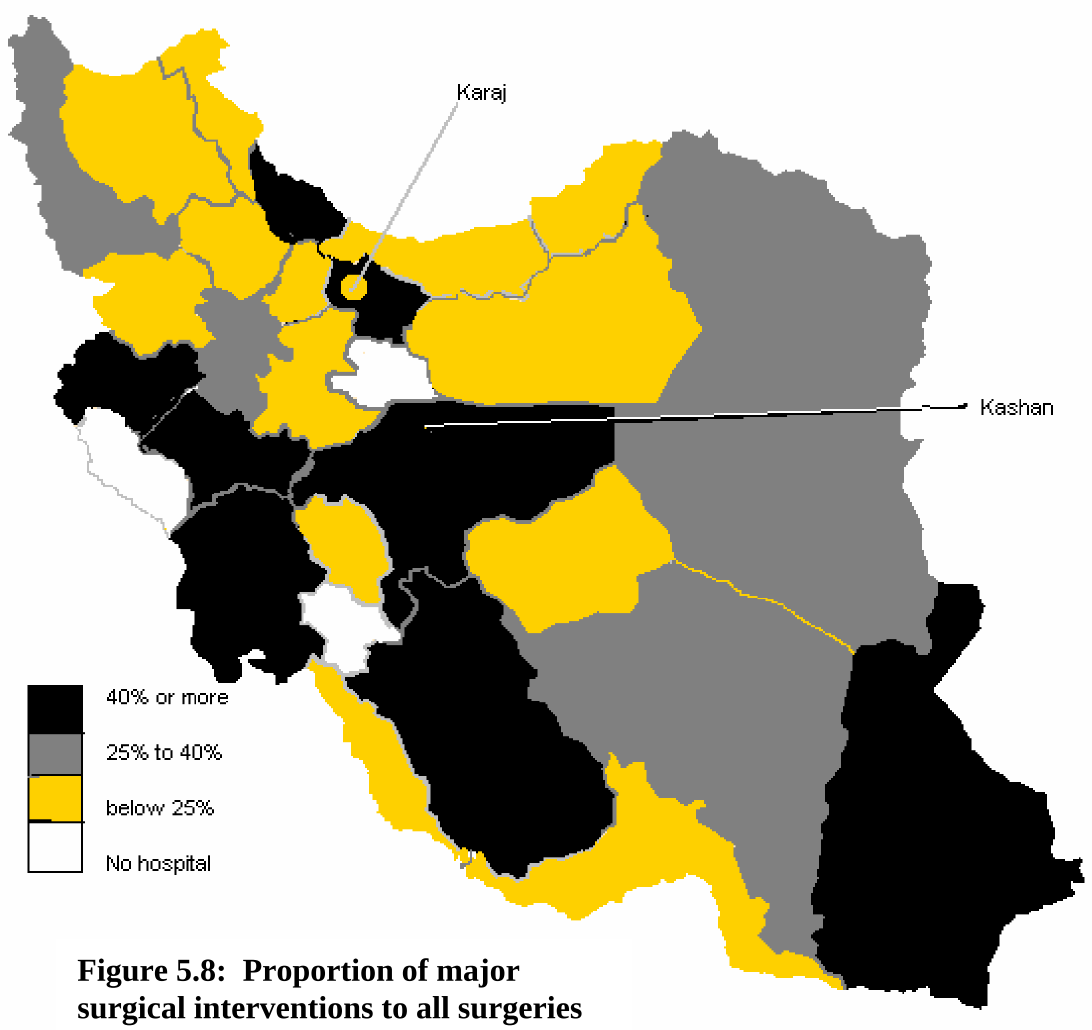

Figure 5.8: Proportion of major surgical interventions to all surgeries

5.5.3.3 Human Development Index (HDI) Value

As discussed earlier, the main concern about using the rate of major surgery as a variable to assess the performance of the SSO hospitals is that geographical variations may be due to factors other than those which are directly related to hospital activities. A full assessment of the effects of these factors is beyond the scope of this thesis, but I have examined whether the variation might be due to a disparity in the level of Human Development Index (HDI) values. The HDI value is a measure of development. It focuses on three measurable dimensions of human development, namely living a long and healthy life (measured by life expectancy at birth), knowledge (as measured by the adult literacy rate and the combined primary, secondary, and tertiary gross enrolment ratios), and having a decent standard of living (measured by GDP per capita).[227] Thus, it combines measures of life expectancy, school enrolment, literacy and income to allow a broader view of a country's development than does income alone. In fact, the HDI value can provide a social picture of the population reflecting the basic dimensions of human development which influence population health status. It is important to understand that a high HDI value reflects advantage.

Figure 5.9 shows the HDI value by province. It is measured on a scale from 0 to 1. Based on the latest profile of HDI in Iran released by the Iranian Planning and Budget Organization[225], there are considerable HDI value disparities among the provinces. In 2000, Tehran topped the list with an HDI value of 0.842, while the province of Systan with an HDI 0.545 was at the bottom.

Considering the link between underdevelopment and poor health, HDI values can, to some extent, reflect underlying needs for hospitalization. This, in turn can influence separation rates and the complexity of the intervention provided. By comparing Figures 5.8 and 5.9, it can be revealed that underlying need for hospitalization are not prominent reasons to explain the variations observed between the provinces in terms of the intensity of interventions. For example, Gilan, Mazandaran, and Semnan enjoy high HDI values. However, the proportion of major surgeries in Gilan is 6 times that of Mazandaran and Semanan. A similar argument can be applied to Zanjan, Karaj, and Markazi.

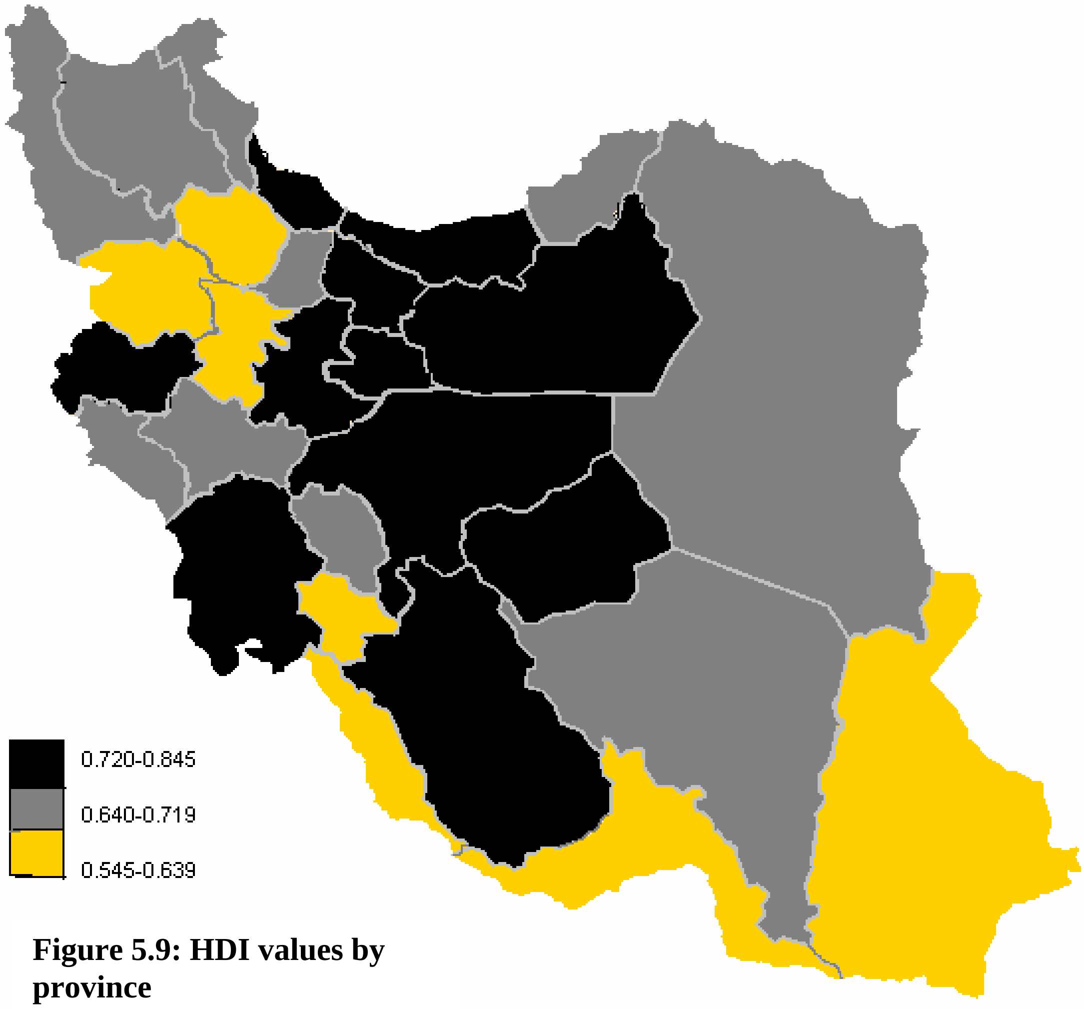

Figure 5.9: HDI values by province

For the sake of clarity, I grouped provinces (Figure 5.10) that are almost similar in their HDI values. Comparing Figure 5.10 with Figure 5.9, it is evident that there is a substantial variation for major surgery rates inside each group. This suggests factors other than the population underlying needs are affecting the proportion of major surgical interventions

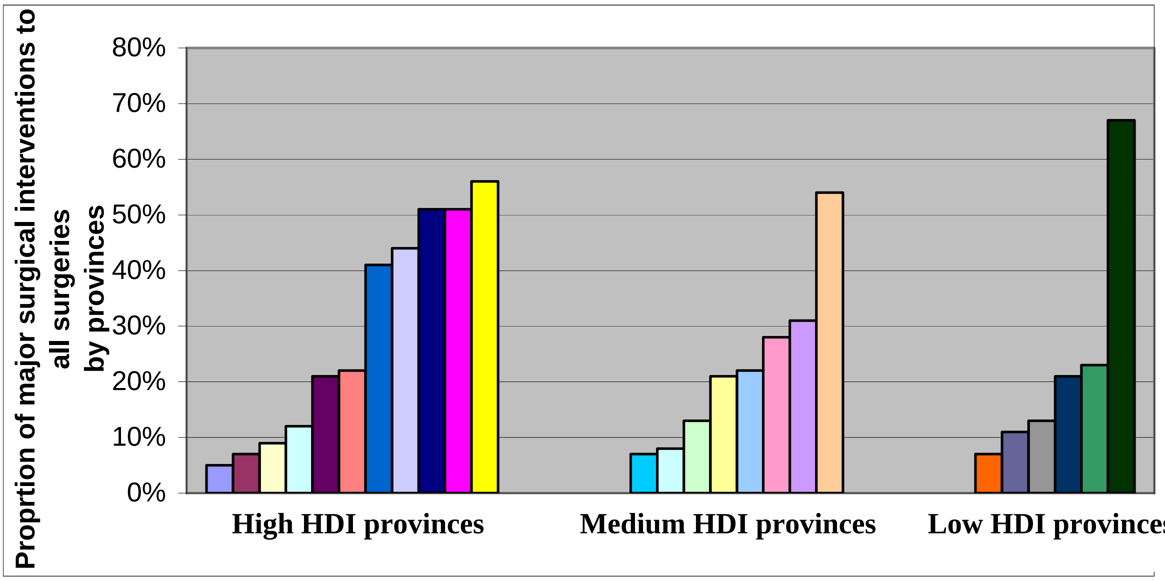

Figure 5.10: Proportion of major surgical interventions to all surgeries of different provinces grouped by their level of HDI values

5.5.4 Throughput ratios analysis (service utilization ratios)

After analysing input and output ratios, this section focuses on throughput (process) ratios to provide a more comprehensive picture of the performance of the SSO hospitals. Section 5.5.4.1 provides an overview of throughput ratios stratified by the different hospital levels. Then, section 5.5.4.2 presents descriptive statistics on SSO hospital activities using throughput ratios. The identification of outliers and discussion regarding throughput ratios and their imitations are presented in section 5.5.4.3. In this section (5.5.4.3), I also provide a constructive critique of the current policy in the SSO (pointed out in section 5.5.3.1) regarding the use of throughput ratios in assessing SSO hospital performance.

5.5.4.1 Overview

Throughput ratios are important as they can indicate how the severity of illness can affect the length of stay (Average Length Of Stay; ALOS), the total capacity being used (Bed Occupancy Rate; BOR), and the rotation index (Bed Turnover Rate; BTR)[228,229,230]

As the type of the hospital could influence throughput ratios, they should be analysed in different categories. Table 5.11 shows throughput ratios for the study hospitals. Ignoring level 4 hospitals with a BOR less than 55%, the occupancy rate in complex hospitals (teaching and level 1 with fairly similar BOR) is slightly higher than for less complicated hospitals (level 2 and level 3).

Level of the complexity / Service utilization ratio		Teaching hospital	Level 1	Level 2	Level 3	Level 4
BOR	Mean (Range)	71.4% (69.9-75.0)	72.8% (64.5-90.9)	68.1% (55.7-86.8)	66.2% (34.8-82.4)	54.9 (19.3-68.8)
ALOS	Mean (Range)	5.2 (3.4-6.9)	4.7 (3.7-6.5)	3.2 (1.9-5.3)	2.6 (1.4-3.4)	3.4 (1.5-5.6)
BTR	Mean (Range)	50 (37-79)	57 (47-76)	77 (48-136)	93 (69-124)	58 (44-82)

Table 5.11: Service utilization ratios for all SSO hospitals by the level of the complexity

BOR: Bed Occupancy Rate
ALOS: Average Length Of Stay
BTR: Bed Turnover Rate

As can be seen from Table 5.11, ALOS increases with hospital complexity, which is to be expected, the more seriously ill patients are more likely to be admitted to the more complex hospitals. The only exception is level 4 with even more days of stay than level 2. This is because Moayari Hospital with a high ALOS (5.65) is classified as level 4. This hospital offers only orthopaedic services with the natural requirement of a long stay for the majority of interventions. A similar argument can be applied to BTR, which decreases with hospital complexity except for level 4 hospitals. This is because of a negative association between ALOS and BTR.

5.5.4.2 Comparative assessment of hospital performance: descriptive statistics

As pointed out earlier (section 5.5.3.1), the current policy in the SSO for assessing hospital performance is mainly based on the comparison of throughput ratios such as BOR, BTR, and ALOS. Although desirable changes in these ratios can lead to a decrease in the proportion of unused beds, ignoring other related factors such as the quality of care and the level of the intensity of procedures can lead to obtain misleading findings.

To explore the issue in more detail, the three service utilization ratios (BOR, ALOS, and BTR) for SSO hospitals by province and area are shown in Table 5.12. As can be seen from this table, there are wide disparities in these ratios at the provincial level. While nationally BOR is 68.46% across all provinces and areas, Golestan (85.49%) and Yazd (81.28%) have the highest BOR, compared with Hormozgan (51.42%) and Khorasan (50.01%) at the other end of the scale.

Table 5.12 also shows that at the national level and on average, each admitted patient stayed 3.45 days in the SSO hospitals. Tehran reported the longest average length of stay for the SSO hospitals (4.82 days) and Kerman reported the shortest (2.25 days). This is not surprising as the majority of hospitals located in Tehran are teaching hospitals and/or admit more complicated patients. This can lead to a longer length of stay.

BTR is another important service utilization ratio. It presents the average annual number of discharges per bed. BTR also implicitly reveals the ALOS, as it can be calculated by dividing aggregated patient days by ALOS. Thus, BTR is inversely associated with ALOS. As indicated by Table 5.12, across all provinces and areas, Golestan with 132 has the highest and Kashan with 48 patients per bed per year has the lowest BTR. This is consistent with the observation that Golestan with 2.36 days and Kashan with 4.38 days have a very short and a very long ALOS respectively.

Provinces or regions	Number of hospitals	Bed Occupancy Rate (BOR)	Average Length Of Stay (ALOS)	Bed Turnover Rate (BTR)
Tehran	9	72.99%	4.82	55
Khorasan	5	50.01%	2.91	63
Karaj	4	72.21%	3.52	75
Khuzestan	4	76.31%	3.1	90
Esfahan	3	70.22%	3.47	72
Kerman	3	71.03%	2.25	115
Markazi	3	61.83%	2.99	76
Mazandaran	3	75.14%	3.58	77
Kordestan	2	71.32%	3.15	83
Lorestan	2	65.32%	3.51	68
Hamedan	2	70.46%	3.06	84
Ghazvin	2	72.04%	3.15	83
Boushehr	2	58.01%	3.05	69
Ardabil	2	71.83%	3.59	72
Kashan	1	55.09%	4.38	44
Azerbaijan.G	1	72.68%	3.2	83
Yazd	1	81.28%	4.05	74
Fars	1	70.96%	3.53	72
Azerbaijan.S	1	66.33%	3.46	49
Gilan	1	76.23%	2.78	100
Kermanshah	1	65.55%	2.91	82
Golestan	1	85.49%	2.36	132
Systan	1	64.70%	3.7	64
Chahar-Mahal	1	68.46%	2.84	88
Hormozgan	1	51.42%	3.18	59
Semnan	1	55.75%	3.11	65
Zanjan	1	81.85%	2.32	124
Total / average	**59**	**68.46%**	**3.45**	**73**

Table 5.12: Service utilization ratios for the SSO hospitals by province and region

5.5.4.3 Simultaneous assessment of throughput ratios; discussion

To provide a clearer picture for evaluating hospitals, Lasso[231] devised a technique for simultaneously representing BOR and BTR on a single graph. This method essentially involves plotting BOR on the x-axis of the graph, and BTR on the Y-axis. The graph is then divided into four sectors by two intersecting lines drawn from the average values of BOR and BTR. An interpretation of the reasons for a hospital falling in each sector is given by Lasso.[231]

Hospitals in Quadrant 1 (south-west) have low levels of BOR and BTR. This indicates that these hospitals have excess bed availability, and as a result capacity to admit more patients.

The low level of BOR despite the high BTR for hospitals in Quadrant 2 (north-west) implies excess bed availability, and the possibility of unnecessary and minor case hospitalization. Hospitals in Quadrant 3 (north-east) with a relatively high level of BOR and BTR have a small proportion of unused beds, indicating a desirable situation (all other things being equal). Finally, Quadrant 4 hospitals (south-east) with a high level of BOR and a low level of BTR are regarded as hospitals with a high proportion of severely ill patients. Figure 5.11 and 5.12 show the integrated analysis of the service utilization ratios (Lasso diagram) by the SSO hospitals and by province and region (provincial average) respectively.

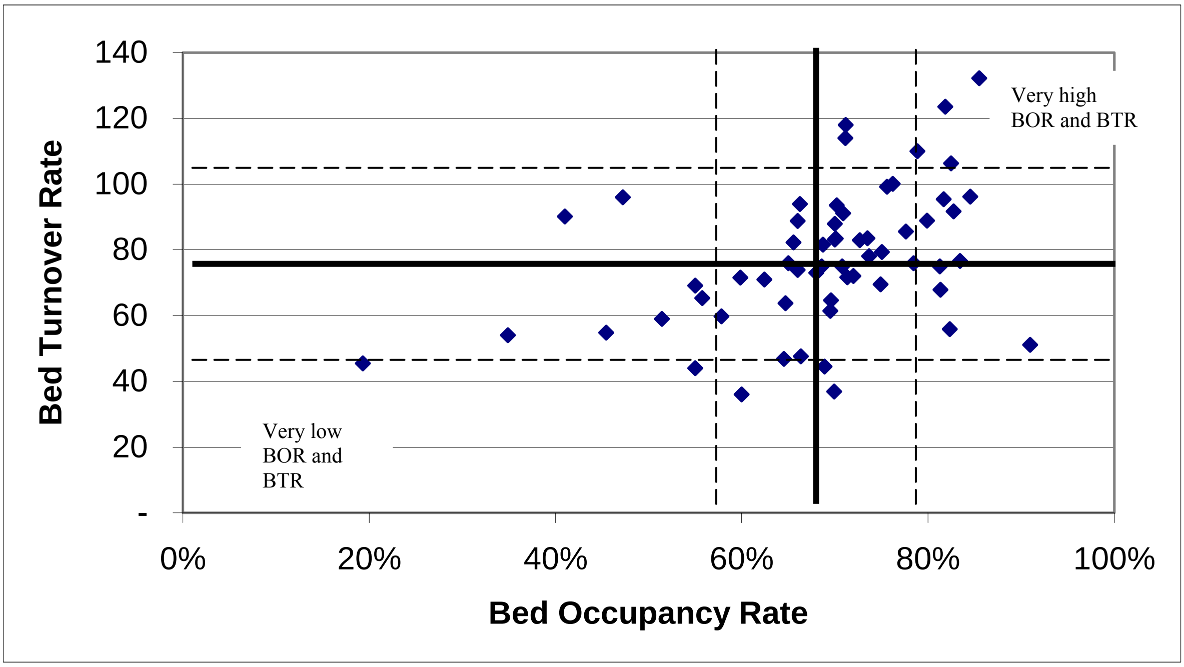

Figure 5.11: Service utilization ratio analysis (Lasso diagram) by all SSO hospitals
Note: Heavy lines indicate the mean values for BOR and BTR derived from 59 SSO hospitals. Dotted lines are one standard deviation each from the respective means.

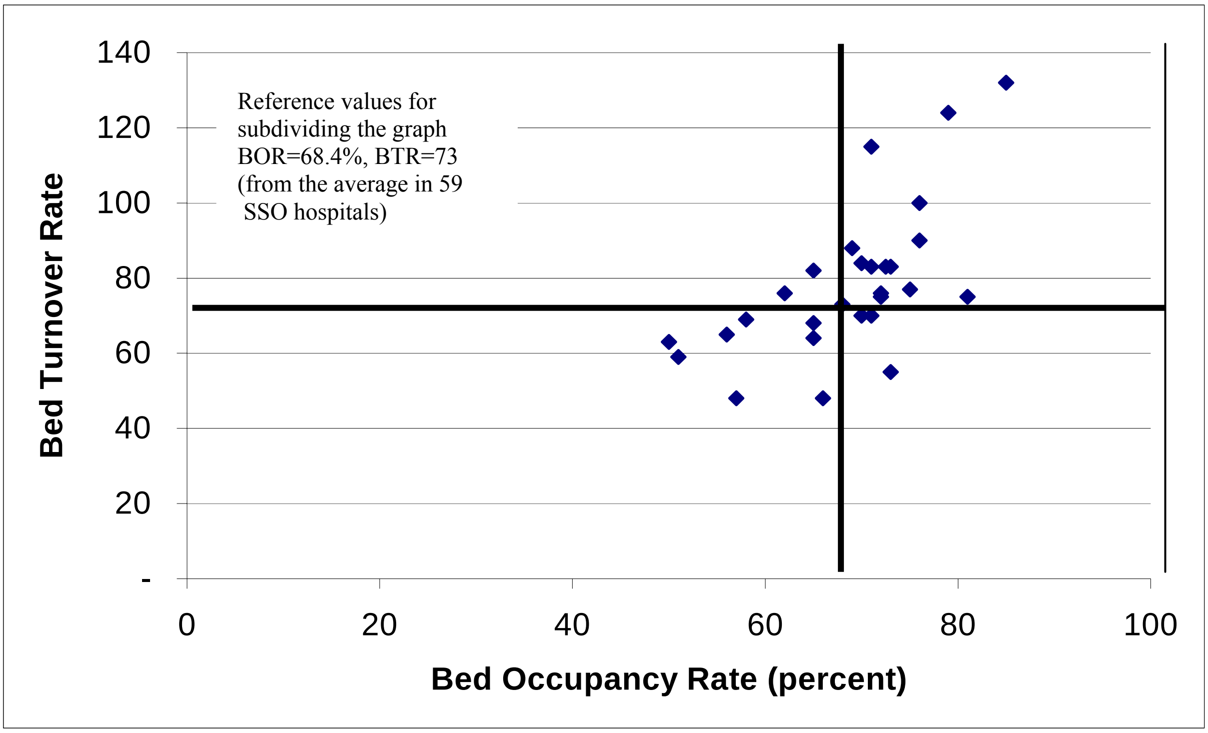

Figure 5.12: Service utilization ratio analysis (Lasso diagram) for all SSO hospitals by province (provincial average)

Analysis of these figures (5.11 and 5.12) in more depth reveals that in most cases simple ratio analysis is compatible with known facts about the hospital characteristics. The analysis has also shown a number of limitations of simple ratio analysis. I also present a critique of the current SSO policy in monitoring hospital performance.

- ✓ These figures provide a picture for the SSO to assess the performance of its hospitals. More specifically, they can show to what extent hospitals located in different provinces and localities, are close to or far from the average values. This, in turn, enables SSO policy makers to analyse factors affecting hospital performance and efficiency, and to identify possible options for actions to improve performance.

- ✓ As most hospitals located in Tehran, Esfahan, and Fars are referral and long-stay specialist hospitals, these provinces mainly fall into the south-east Quadrant (Quadrant 4) (Figure 5.12).

- ✓ In recent years the managers of the SSO Provincial Offices and hospitals have coped with the escalating pressure exerted by the SSO officials to reduce ALOS and to increase BTR in the SSO hospitals, while maintaining a high BOR. In other words, hospitals and provinces which lie in the Quadrant 3 of Figures 5.11 and 5.12 are supposed to have a good quantitative performance (with small proportion of unused beds) from the SSO officials' point of view. These assessment criteria have led to around 50% of all SSO hospitals and provinces falling into the north-east Quadrant (Figures 5.11 and 5.12). This is in line with the interpretation of different sectors of the Lasso diagram, indicating a desirable situation. However, the extent to which a good position on the Lasso diagram reflects better health outcomes for the population in the catchment area is a crucial point which needs to be taken into account.

  Focusing on these assessment criteria fails to distinguish hospitals performing a great deal of complicated medical or surgical interventions from those performing simpler and minor procedures. For example, Mazandaran, Golestan, Karaj, Ghazvin, Zanjan, Yazd, and Kerman (a group of provinces falling into the north-east Quadrant) are those for which the proportion of major surgical interventions (as a variable which reflects the intensity of interventions in the context of the SSO hospitals) is low or very low (Table 5.10). This figure can be compared with some provinces falling into this Quadrant (for example Gilan) with a high proportion of major surgical interventions providing similar inpatient services, and at a comparable stage of HDI values. This suggests that emphasising one dimension of hospital performance while ignoring other important features such as the complexity of interventions may lead to a different (and sometimes misleading) performance assessment. This argument reveals that inattention to the different dimensions of hospital activities, measured efficiency and performance runs the risk of being misleading, which might be against the real needs of the population for hospitalization. This can be regarded as a limitation of simple ratio analysis which is commonly used in the SSO to monitor hospital performance. This thesis underlines the necessity for reforms in SSO hospital performance criteria.

- ✓ Another important issue is about the use of variables which reflect the procedural complexity. Currently, the only variable reported by the SSO hospital database which implies an idea about casemix is the number of major surgical interventions. Using this (relative value-based) variable to reflect the procedural complexity, however, is subject to a number of shortcomings. It has been argued that price is not a reliable index for classifying surgical procedures by complexity.[232] Furthermore, using major surgeries means that medical (non-surgical) interventions are not captured. There are, however, certain medical cases that are quite resource-intense, such as dialysis or chemotherapy. Hence, a further development of the SSO database is required to capture the intensity of all procedures provided by SSO hospitals. This will help in providing a useful - indeed necessary - adjustment for the interpretation of ratio analysis in monitoring SSO hospital efficiency. Given the multiproduct nature of hospitals, considering casemix is the best way to account for this heterogeneity in efficiency measurement studies. To reflect differences in procedural complexity, several casemix indexes have been defined in the literature.[233] Classification by DRGs is one customary example.

This is a frequently used casemix adjusted tool to categorize separations. The DRG-based system was initially developed in the late 1960s by a group of researchers at Yale University as an instrument to classify inpatients according to their diagnosis and treatment resource intensity into nearly homogeneous groups in order to facilitate utilization review activities.[86] By covering all separations, DRGs reflect the diversity of hospitals' outputs more properly than do major surgical interventions. It has also been argued that DRG- based payment can affect technological change in hospitals, i.e. the adoption of new technologies and discarding of old ones.[332] Considering these advantages, and by analysing the current method and variables used to assess hospital performance in the SSO, this thesis strongly calls for reforms in SSO hospital database in order to capture more appropriate casemix adjusted separations such as DRGs.

- ✓ Considering geographical variations of HDI values (Figure 5.9) amongst those provinces found in the north-east Quadrant, it does not seem that variation in underlying needs for hospitalization is a prominent factor influencing the separation rates and the proportion of major surgical interventions provided. As has been pointed out, institutional factors and especially admission policies (in terms of admitting predominantly minor cases) could be regarded as a most likely reason to explain these variations.

- ✓ About 35% of all hospitals and provinces lie in the north-west and south-west Quadrants (1 and 2), with a sizeable number of them in the south-west quadrant. An examination of the provinces falling into these quadrants by the intensity of the intervention provided reveals no systematic pattern. For example, both Kermanshah and Markazi, with a remarkable difference in the proportion of major surgeries, lie in the north-west Quadrant. However, all provinces in these two quadrants have a similar feature - an excess of available beds.

- ✓ Except for Semnan, all provinces in the south-west Quadrant with the capacity to admit more cases have low or medium HDI values. This may reflect the unnecessary overemphasis on providing, under political pressure, more facilities for these provinces - and possibly unmatched with population needs.

- ✓ Combined service utilization ratios shown in Figures 5.11 can provide a simple picture to identify outliers which need further detailed examination. To determine outliers, some studies have suggested one standard deviation from the mean as a margin of variation.[234] Based on this arbitrary criterion, Figure 5.11 identifies groups of outliers which all have either a very low BTR and BOR indicating a low level of activity, or a very high BOR and BTR implying overcrowding in relation to capacity. However, without consideration of the service mix and the intensity of interventions provided by the SSO hospitals, the Lasso diagram alone cannot provide sufficient evidence to assess the hospital performance. It is likely that a hospital with a very high BOR and BTR admits minor cases. This argument might be strengthened by analysis of the proportion of same day separations reflecting minor cases. However, the data were not available. Figure 5.11 and Table 5.10 show that all four outlying hospitals (very high BOR and BTR outliers) have lower than average major surgical interventions. Further investigations are required to explore the role of factors influencing the variation in separation rates and the intensity of interventions in the SSO hospitals (see section 5.5.3.1). This is a critical issue because policy makers assume these outliers to have an urgent requirement for additional resources to expand capacity to meet high demand and reduce overcrowding.

- ✓ Beheshti Kashan and Hashtgerd Karaj are two hospitals which can be regarded as outliers falling in the very low BTR and BOR quadrant. While Beheshti has above-average major surgical interventions with 44%, Hashtgerd has an intermediate proportion of surgical procedures (21%) (Table 5.10). Evidently, in both hospitals, there is an excess bed availability. Both Kashan and Karaj (as the regions where the two hospitals are located) have a high number of beds per 1,000 insured persons (Table 5.3). The issue is more prominent for Kashan, which has the highest number of SSO beds per insured person across all provinces and areas (1.81 beds per 1,000 insured persons).

5.6 Key findings

- ✓ Over the past few decades, the improvement of Iran's health indicators has been particularly impressive. Much progress has been made in life expectancy, maternal mortality rate and population control. This is largely attributable to the overall improvement of the health status of the population by a strong focus on social development programs, primary health care network, public health activities, and secondary and tertiary level curative care.

- ✓ The growing trend of the SSO hospitals' costs and possible reasons for inefficiency is one of the major concerns to the SSO officials. For this reason, the assessment of performance and efficiency of the SSO hospitals by employing available data and simple ratio analysis has been considered to be an important issue.

- ✓ The ratio of available beds per thousand insured persons has a wide variation, ranging from 0.12 in Fars to 1.81 in Kashan. This suggests that there is not an exact geographical fit between the insured population and the distribution of available SSO hospital beds. This issue might be in part due to the existence of political pressure, often by local politicians, to build new hospitals or expand existing ones. It may also be due to referral of patients across provincial boundaries.

- ✓ The ratio of the number of beds to the number of medical doctors varies considerably across the SSO hospitals. While there are some hospitals, such as Gonbad and Shafa with 7.37 and 7.29 beds per doctor respectively, in Amirkabir Hospital there is one doctor per 1.13 beds.
- ✓ There is a wide variation between hospitals in terms of number of hospital separation per doctor While Hashtgerd Karaj has the lowest number of separations per doctor with 95, Golestan with 974 separations per doctor lies at the top of the list.

- ✓ As expected, the Proportion of Major Surgical Procedures (PMSP) increases as the hospital level becomes more sophisticated. However, there are noteworthy disparities in the SSO hospitals' PMSP, ranging from 90% in Labaffi to 4% in Valiasr hospital. The variation in this ratio is also observed at a provincial level. For example, in Lorestan and Gilan, the PMSP is roughly six times higher than in Golestan.

- ✓ Several factors appear to be implicated in the wide variation in separation rates and in the PMSP across the SSO hospitals; chief among them variation in underlying needs, admission policies and incentives faced by managers, quality and availability of non-hospital services and the Primary Health Care (PHC) network, and the quality and variation in the types of interventions provided by non-SSO hospitals (particularly MOH hospitals). To identify the share of each factor, more data and analysis are required. However, a comparison of the provinces' rankings on the Human Development Index (HDI) reveals that the variation in underlying needs does not appear to be the main reasons to explain the variation observed in separation rates and the intensity of interventions provided by the SSO hospitals.

- ✓ The Lasso diagram shows that more than 70% of all the SSO hospitals and all outliers fall either in the very low BTR and BOR quadrant or the very high BOR and BTR quadrant. A conventional interpretation for this trend would be under-use of resources or excessive demand related to capacity. However, without consideration of the case mix and the intensity of interventions provided by the SSO hospitals, a Lasso diagram alone cannot provide sufficient evidence to assess hospital performance.

- ✓ A comparison of the SSO hospitals in terms of PMSP reveals that all outliers and the majority of hospitals falling in the relatively good-performing quadrant have a low or very low PMSP. This analysis helps in understanding that although simple ratio analysis is a useful tool to identify outlying hospitals, it takes into account only a single dimension of hospital performance, providing a limited overview of the data structure.
- ✓ It is worth noting that all high BOR and BTR outliers have above-average outpatient visits per doctor, and all low BOR and BTR outliers are below-average in terms of outpatient services. This suggests that outpatient services are regarded as complements of hospitals' inpatient services rather than substituting for them.

5.7 Concluding remarks

This chapter has employed a simple ratio analysis technique to measure the efficiency of hospitals owned by the Iranian SSO, comparing them on different types of ratios: staffing, input to output, and throughput ratios. The results have shown that there are remarkable staffing inequalities, mainly at the expense of remote hospitals due to the difficulties in recruiting staff (particularly doctors) because of the living conditions. Simple ratios have also provided an overview of the SSO hospital data set and helped identify outliers which warrant further investigations. The discussion presented in this chapter, however, has revealed that the simple ratio analysis is subject to a number of drawbacks that limit interpretation.

Simple ratio analysis cannot make use of all the variability in the dataset. The unidimensionality of this method can also lead to perverse incentives. By presenting a constructive critique of the current SSO hospital performance assessment criteria, I argued that because of the unidimensionality of the variables and the method used, the results run the risk of making misleading comparisons. For example, the chapter has used a simultaneous assessment of BOR and BTR (the Lasso diagram). This is important, as the recent SSO policy for assessing SSO hospital performance is mainly based on increasing the BTR and BOR and reducing the ALOS. The policy encourages managers to move their hospitals towards the north-east Quadrant of the Lasso diagram, where Lasso interpreted it as a relatively well-performing quadrant. However, significant differences in the Proportion of Major Surgical Procedures (PMSP; as a variable reflecting the complexity of procedures which gives implicitly an idea about the case mix) among the hospitals providing similar services, and at a comparable stage of HDI values has led to the hypothesis that perverse incentive faced by the SSO managers may be responsible for most of the variations. This issue can be regarded as a limitation of the simple ratio analysis which focuses on a single dimension of hospital performance ignoring its multiproduct nature. This is particularly important for social organizations such as the Iranian SSO which aims at meeting societal needs.

Furthermore, this chapter clarifies that the SSO hospital database needs to be further developed to capture more specific data reflecting the mix of outputs produced by a hospital, and quality of care.

Finally, by presenting the limitations of the simple ratio analysis, this chapter recalls for employing more advanced approaches such as DEA which may help to examine the effects of multiple inputs and outputs on SSO hospital performance. This is the issue that will be examined thoroughly in the next chapter.

CHAPTER 6

APPLICATION OF DATA ENVELOPMENT ANALYSIS IN MEASURING SSO HOSPITAL EFFICIENCY

Chapter overview

This chapter aims to identify the relatively efficient and inefficient SSO hospitals, and the magnitude of inefficiencies, employing a Data Envelopment Analysis (DEA) method. In contrast to simple ratio analysis, frontier-based techniques involve two steps, namely the estimation of a frontier and the measurement of the individual hospital deviations from the frontier. These features enable them to handle multiple inputs and multiple outputs.

Chapter 5 revealed that, simple ratio analysis focuses only on a single type of hospital activity. Hospitals use multiple resources to produce multiple products. Therefore, while simple ratio analysis does have certain relative advantages, including ease of computation and providing a quick picture for identifying outliers [235], frontier-based techniques provide a more comprehensive picture with regard to hospital efficiency. This chapter will present the results of SSO hospital efficiency measurement using DEA with a focus on its strengths and limitations.

This chapter is structured in five sections. Section 6.1 will outline the conceptual framework for frontier-based techniques. Section 6.2 will focus on DEA, discussing the relative theoretical and practical advantages of DEA over parametric methods. Section 6.3 will present the results obtained from the validity and reliability assessment of different sets of variables developed by this thesis. In section 6.4, I will discuss the results. Concluding remarks will be presented in section 6.5.

6.1 Principles of frontier-based techniques

This section provides a conceptual framework for frontier-based techniques including parametric and non-parametric methods.

The past few decades have seen the rapid development of a body of literature where various techniques for benchmarking of Decision Making Units (i.e. hospitals in this thesis) have been discussed. In general, inputs go to Decision Making Units (DMUs) to be processed in order to produce products. The benchmarking techniques examine how well scarce resources are converted to valued products. The core concept for all benchmarking techniques is their ability to calculate the ratio of valued outputs (products) to inputs. However, to calculate this ratio, they adopt different methods.

Simple ratio analysis concerns the relationship between pairs of variables in a data set. Because it uses only a pair of variables, some commentators prefer to call this a "partial productivity" measurement method to distinguish this type of benchmarking method from those which can handle multiple inputs and multiple outputs, namely "total factor productivity" measurement techniques[236]. Moving from partial to total productivity measurement requires more advanced techniques which estimate a frontier.

There are a number of methods which have been used to handle a set of input and output variables involving efficient frontier estimation.[237] The two principal types of frontier-based approaches to measuring hospital efficiency have been parametric methods such as SFA, and non- parametric methods such as DEA which uses mathematical programming. Both methods compare the performance of individual hospitals against an estimated efficient frontier.

The core concept in measuring any DMU efficiency was originally proposed by Farrell in 1957.[238] The concept can be illustrated graphically with an analysis that, for the sake of simplicity, takes only two inputs (L as labour and K as capital) producing a certain level of a product. Let me assume that the efficient production function is known; that is the frontier which represents all the various combination of inputs that an efficient unit should use to produce a given level of output. Figure 6.1 shows the basic concept of frontier-based techniques for measuring efficiency. Under a known frontier function[xxxiv], MM` represents the best practice frontier, the lower bound of the input requirement set which corresponds to the notion of an isoquant in neoclassical production theory.[239] According to this frontier, point Q is regarded as an inefficient unit, because it is producing the same level of output while using more inputs. The ratio of OP/OQ denotes the ratio of the minimal input required to the actual input used, given the input mix used by Q. The ratio can only take a value between zero and one, where one stands for the fully technically efficient firm.

[xxxiv] This is an unreal assumption in practice particularly in hospitals in which there is no known functional from (see section 6.2 for more detail).

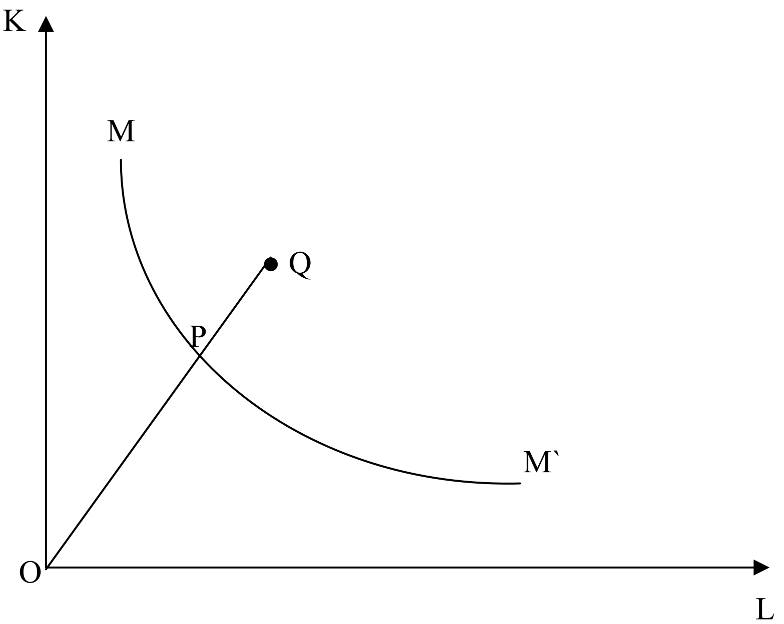

Figure 6.1: The concept of frontier estimation methods in measuring efficiency

6.2 Frontier-based techniques: the concept of DEA

The brief discussion on the principles of frontier-based techniques (section 6.1) has provided a starting point in examining the related methods, SFA and DEA, in more depth. Here, it should be noted that the examination of the econometric or mathematical basis of these methods are beyond the scope of this thesis. Rather, this section aims to provide some basic technical aspects which are necessary to understand the concept of identification of relatively efficient and non-efficient DMUs with a view of determining the target levels for the inefficient units.

The concept of frontier-based techniques illustrated in Figure 6.1 was based on the assumption that the production frontier is known. However, this is not true in practice. When the frontier is unknown, the best way is to use an existing data set to estimate the frontier.[240] There are two major methods for forming a frontier function from a data set broadly known as parametric methods (such as SFA) and non-parametric linear programs (such as DEA).

SFA is an advanced econometric method using statistical methods to estimate a frontier. A production function is defined as the maximum amount of output that can be attained from a given set of inputs. Any deviation from the frontier is assumed to be the results of inefficiency or random error. The ability of this method to estimate random errors is usually regarded as its relative advantage over DEA in which all deviations from the estimated frontier are regarded as the result of inefficiency. However, SFA does assume a particular functional form of the frontier, and a specification of the error distribution. The argument against the application of SFA in the health care industry is well grounded where, as Fried et al.[241] have indicated, there is no known appropriate functional form. This disadvantage has meant that only a small proportion of health care efficiency studies have used parametric methods to estimate production or cost frontiers.[56] Furthermore, a large number of DMUs is usually required "for statistical significance and different parameterisations of the frontier function yield quite different results."[237] For this reason, SFA seems to be better suited to industry-wide studies.

A number of compelling reasons that have convinced me to employ DEA were discussed in chapter 3, section 3.2.2.1. In brief, compared to parametric methods, the appropriateness of DEA for this study is based on its capacity to handle multiple inputs and multiple outputs with different units, its suitability in small scale studies, the ability of DEA to provide additional information in terms of the magnitude of inefficiency, and that DEA does not require specification of a functional form for the production process in the health care industry.

The DEA mathematical framework was established in 1978 in the work of Charnes, Cooper and Rhodes[243] (see Appendix F, for mathematical derivation of DEA formula). This method has been used extensively to estimate measures of technical efficiency in a range of DMUs including universities, hospitals, schools, police stations, and tax offices. DEA estimates the maximum potential outputs for a given set of inputs (output orientation), or the minimum potential resources for a given level of outputs (input orientation). The following hypothetical example can illustrate the core concept of DEA. Let me consider three DMUs that are each using a different amount of a particular input to produce varying levels of one particular valued product. Table 6.1 shows the amount of input used and the product produced. In terms of the fundamental ratio (valued product / input), it is revealed that A is producing the highest amount of valued product per unit of input employed. In fact A can be regarded as a DMU with the "best performance" in this hypothetical data set.

DMU	Input (unit)	Valued product (unit)	Valued product per unit input
A	16	8	0.50
B	15	6	0.40
C	10	2.5	0.25

Table 6.1: Comparisons of technical efficiency scores

If we consider the technical efficiency of A as one (the efficient DMU in this data set), the relative efficiency of the other DMUs can be calculated (Table 6.2). In DEA terminology, unit A is said to be the peer for units B and C.

DMU	Valued product per unit input	Relative efficiency scores
A	0.50	1
B	0.40	0.8
C	0.25	0.5

Table 6.2: Relative efficiency scores

If DMU C wants to achieve a similar ratio to A, it should reduce the use of the input by 50% (input-orientation approach) or increase the production of the valued product by 50% (output-oriented approach) to be regarded as an efficient DMU. By applying the relative efficiency scores to the input of C (10x0.5=5) in the input orientation approach, or to the output of C (2.5 x 1/0.5=5), unit C will have new proposed input and output levels which will make it efficient. In DEA terminology, these new values which convert inefficient units to efficient are regarded as targets for unit C.

Since, health care providers are using multiple inputs to produce multiple valued products, more than one ratio needs to be calculated. One way to deal with the problem is to estimate an efficient frontier which envelopes the available data by calculating a virtual output and a virtual input. In this method, each product or input is given a weight, and efficiency can be defined as the ratio of virtual output to virtual input where virtual output is the weighted sum of the outputs, and virtual input is the weighted sum of the inputs.

Evidently, the challenging point at this stage is to identify the weights. There are two ways to assign weights to inputs and outputs. First, we can assign fixed weights that reflect the values of these variables. However, this is not a straightforward task. There is no agreed standard to assign weights to variables. It is difficult to compare the values of inputs such as the number of staff and the number of high technology services in a hospital to assign different weights. There is a similar problem in the output side of the equation, where a hospital with a lower readmission rate may tend to assign more weight to this variable while another hospital with a lower mortality rate may wish to attach a higher weight to this product. The issue can adversely affect the validity of any findings because it is not clear to what extent inefficiency scores are related to the existence of inefficiency *per se* and how much these scores are what they are because of the weights that are assigned to each variable.

In DEA, the weights are drawn from the dataset, and are chosen in a way that "will maximize its efficiency subject to the condition that the efficiencies of other DMUs are restricted to a value between 0 and 1."[244] From this standpoint, DEA may be regarded as an appropriate benchmarking method for the assessment of DMUs such as hospitals for which there is an uncertainty in valuing their variables. There is one major drawback to DEA, which is its inability to capture random error. However, as Ferrier et al.[245] have shown, because there is no a priori specification of the functional form, specification of error is most unlikely.

6.2.1 Non-computational features of DEA

Before measuring efficiency using DEA, there are certain non-computational features which must be taken into account. Golany et al[246] and Dyson et al[247] have discussed the importance of these features in DEA studies and their impact on the final results obtained. These features can be divided into five categories, namely the specification of variables, the issue of homogeneity, types of returns to scale (constant vs. variables returns to scale), the number of variables, and whether the orientation of the model is input or output. The specification of variables is understood to be a crucial step for any efficiency measurement. This issue was extensively discussed in chapter 4 where I proposed a health-oriented framework. In the following sections (6.2.1.1- 6.2.1.4) the other non-computational features of the DEA measurement procedure are discussed.

6.2.1.1 The issue of homogeneity

Homogeneity of DMUs in terms of their performance characteristics is an important assumption for any DEA study. There are different factors related to the intrinsic characteristics of hospitals or their surrounding environment that can affect their performance.

It is expected that differing missions of the hospitals examined and the complexity of services provided influence their performance. For example, some studies have shown that teaching hospitals are more costly than non-teaching hospitals due to a number of reasons, including their teaching function, a difference in the casemix, and inexperienced residents who tend to order more unnecessary medical testing.[248] Thus, efficiency assessment for teaching and non-teaching hospitals combined into one group would be likely to suggest that the teaching hospitals are less efficient. Other examples of intrinsic factors influential on hospital performance include hospital size, payment system, and hospital financing, as discussed in chapter two, section 2.4.1.

The existence of a non-homogenous environment is a related issue. Environmental determinants have already been discussed as influential factors on organisational performance.[249] For example, chapter five section 5.5.3.3 considered how variations in socio-economic status of the population in the target area may affect the outcomes secured and hence the hospital performance. Inattention to these factors may result in misleading findings.

A customary approach to deal with these pitfalls is to stratify hospitals in order to provide more homogenous subgroups (ibid.). Using this approach, only these similar subgroups are compared with each other, leading to more robust results. In my study, all SSO hospitals except for two are non-teaching hospitals. These two hospitals will be excluded from the analysis in this chapter. All SSO hospitals are acute-care hospitals and homogenous with respect to their ownership, service orientation, profit status, hospital financing, payment system, and other legal and regulatory frameworks that are most often considered to be influential factors on hospital efficiency. For example, all SSO hospitals are non-profit hospitals providing acute surgical and non-surgical services to legislatively mandated insured people. Additionally, all SSO hospitals are accredited by the Iranian Ministry of Health Commission on the Accreditation of Hospitals. This again suggests further homogeneity, because all these hospitals are obliged to follow similar approved standards in delivering health care services. There are, however, two potential confounding factors, namely the variations in the socioeconomic status and population needs (proxied by HDI values) and in hospital size (proxied by the number of beds). The results adjusted for these two factors are discussed in section 6.4.4.

6.2.1.2 Constant returns to scale vs. variable returns to scale

The shape of the frontier (and thereby efficiency results) will differ depending on the scale assumptions. Generally, there are two scale assumptions; Constant Returns to Scale (CRS), and Variable Returns to Scale (VRS). Under CRS, output will change by the same proportion as inputs are changed, e.g. a doubling of all inputs will double output. VRS reflects that production technology may exhibit increasing, constant or decreasing returns to scale.

Figure 6.2 shows that, the effect of the scale-based shape of the frontier on the measure of efficiency. Four data points (A, B, C, and D) are used to estimate the efficient frontier, each with one input and one output and the level of capacity utilization under both scale assumptions (CRS and VRS). With CRS, the frontier is defined by point C for all points along the frontier, with all other points falling below the frontier (hence indicating inefficient units). With VRS, the frontier is ACD, and its vertical and horizontal extensions. Under a VRS assumption, only point B lies below the frontier. By definition, A and C are regarded as peers for B. Under CRS and VRS assumptions, the efficiency of B is measured by the ratio OH/OB and OR/OB respectively. Points R (in the VRS model) and H (in the CRS model) are hypothetical units (reference points) representing the best possible performance for B.

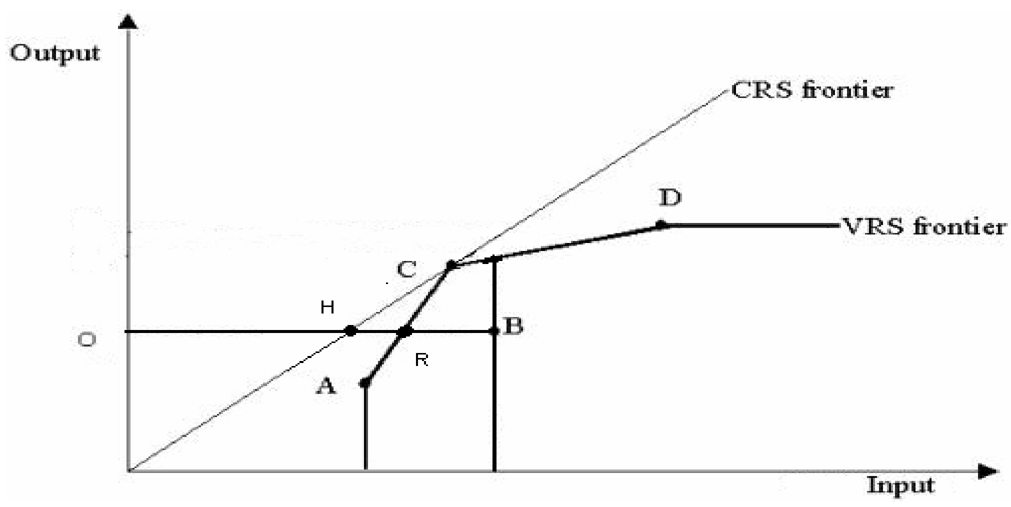

Figure 6.2: CRS vs. VRS model

Figure 6.2 illustrates that, with the exception of point C which is efficient under both assumptions, the measure of capacity utilization is lower (i.e. there is more underutilization) for each point when assuming CRS than when assuming VRS. For example, the CRS efficiency of B is OH/OB, while its VRS efficiency (input orientation) is OR/OB which is greater than the CRS efficiency score. This is consistent with the number of efficient units under the VRS assumption being more than under the CRS model. It has been widely agreed that CRS efficiency scores are equal to or less than the efficiency scores calculated under a VRS assumption.[250] Clearly, this issue can affect the findings of the study.

VRS can be further divided into Increasing Returns to Scale (IRS) and Decreasing Returns to Scale (DRS). Along the segment AC there is IRS in which a given percentage increase in inputs can lead to a larger percentage increase in output. Under similar reasoning, along the segment CD there is DRS (for more detail, see Thanassoulis [240]). The separation of units operating at IRS or DRS segments can aid policy makers in allocating resources for possible expansion in the future.

The choice of CRS or VRS in efficiency measurement studies has been widely argued in the literature.[313] In general, the CRS assumption is only appropriate if all hospitals are operating at an optimal scale. When we expect that the efficiency scores and performance of DMUs will be dependent on their scale of operation, it is preferable to use a VRS model. From this standpoint, in hospital efficiency studies, VRS seems to be more appropriate as it is expected that the scale of operation can influence performance. Furthermore, Galagedera et al.[251] have argued that if there is uncertainty in the selection of the most appropriate variables, VRS appears to be a safer option in terms of providing more robust results. From the preceding overview, the relative advantage of VRS over CRS in hospital efficiency studies should be apparent.

Having said that, the present study aims to compute efficiency scores under both CRS and VRS assumptions in order to determine the effects of scale on hospital efficiency (see section 6.4.2). The deviation of the CRS-based frontier from the VRS-based frontier for each hospital is regarded as its scale efficiency (the smaller the scale efficiency the larger the adverse impact of size on productivity).[252] Scale efficiency will be calculated by the ratio of the CRS efficiency score to the VRS efficiency score for a given hospital.[253]

6.2.1.3 Number of variables

Efficiency scores derived from any DEA analysis depend on the number of variables included in the model.[254] As a general rule, the number of variables employed should be less than the number of DMUs under assessment. This is mainly due to the need to provide an effective discrimination between efficient and non-efficient DMUs.[255] Using a high number of variables relative to the number of DMUs can result in high number of efficient units, thereby leading to low discrimination. Incorporating a small number of inputs and outputs, however, leads to a further set of problems, because there will be a danger of a very low number of efficient units, thereby a low number of peers. It has been argued that the product of the number of input and output variables can be regarded as an indicator of the minimum number of efficient DMUs.[256] To provide an effective discrimination, Bowlin [257] has suggested at least three DMUs for each variable. Based on the above argument and on consultations with other DEA researchers[xxxv], and considering the total sample size for the present study (53 hospitals), it is expected that the use of 7 to 10 variables could provide a reasonable discrimination.

6.2.1.4 Input orientation vs. output orientation

A range of DEA models has been developed for measuring efficiency. These largely fall into the categories of being either input-oriented or output-oriented models. With input-oriented DEA, the linear programming model is configured so as to determine how much a firm's use of inputs could contract if used efficiently while still achieving the same output level. In contrast, with output-oriented DEA, the linear programme is configured to determine a firm's potential output given its inputs if it operated as efficiently as firms along the best practice frontier. The choice of input or output oriented model depends upon the extent to which DMUs have control on their input or output side. It is generally assumed that hospitals have more control over their inputs such as the number of staff, with little control over such outputs as the number of patients.[258,259] Thus, it is more appropriate to adopt an input-oriented DEA model for hospital efficiency measurement studies.

[xxxv] I presented my paper at the IFORS (2005) Conference held in Hawaii, July 11-15. I also took the opportunity to discuss some common pitfalls in efficiency measurement studies using DEA with some DEA professionals including Dr Ronald (University of Maine, USA), Dr Sexton (Stony Brook University, USA), Dr Emrouznejad (Aston University, UK), and Dr Sowlati (University of British Columbia, Canada).

In summary, considering the above discussion, the present study will use an input-oriented approach and a VRS model for measuring SSO hospital efficiency. CRS-based results will also be computed to estimate the scale efficiency scores. Given the acceptable level of homogeneity, all SSO hospitals (except two teaching hospitals) will be included in the analysis as a single group. However, to deal with the two mentioned potential confounding factors (hospital volume and population needs) the results will be adjusted accordingly.

The next section discusses sensitivity analysis in DEA studies.

6.3 Sensitivity analysis

6.3.1 Background and strategies

DEA does not offer any guidance or template to help its user to assess the quality and appropriateness of a set of variables to be chosen from amongst the large number of different sets that could conceivably be developed.[260] The potential problem of model misspecification (i.e. an inappropriate set of variables), however, lies at the centre of any DEA study because of its great impact on efficiency scores and possible subsequent resource re-allocation decisions. To deal with this problem, the development of a workable strategy is required. Without such a strategy, as Epstein et al [261] have pointed out, the user is likely to be left to struggle in a mess of many alternative specifications.

As pointed out earlier in chapter 2, there is an absence of a well-defined framework for selecting the most appropriate set of variables relevant to the comprehensive set of hospital functions. This thesis proposed a health-oriented framework which helps DEA users select a broader set of variables for measuring hospital efficiency with a focus on the Iranian hospitals (see chapter 4, for more detail). However, the majority of those variables cannot be employed in this study for several reasons, including DEA limitations, the small sample size, and the lack of data on some of the variables.

Firstly, it is possible that, for some hospitals, a number of variables such as the mortality rate after low frequency but high-risk procedures (such as aortic aneurism repair) may take a zero value. Because of the limits posed by the mathematics, DEA cannot handle a zero value for any variable.[326] This limitation requires some modification to the original mathematical model. A similar argument can be applied to the use of binary variables, for example, the lack or existence of a properly managed hospital waste disposal function. Such variables may take a zero value where the service is not available and a value of 1 if the service is available. The above argument underlines the necessity of the change in basic DEA models to incorporate quality variables.

Furthermore, the relatively small sample size in this study constrains the use of a broader set of variables. This is because the larger the number of variables used, the larger the number of hospitals that appear to be efficient, thereby leading to a low discrimination.

Finally, data on the majority of non-conventional (development-oriented) variables discussed in chapter 4 are not collected in the current SSO hospital database. One of the objectives of the present study is to determine deficiencies in the current SSO hospital database and to identify new data that are required to enhance efficiency measurement in the SSO hospitals.

Faced with similar limitations to the above, and given the importance of sensitivity analysis in DEA studies, a customary strategy is to develop a variety of model specifications (set of variables). However, as pointed out earlier, there is little practical or theoretical guidance on how to choose between these competing sets of variables. To deal with this, I have used a number of strategies. I have divided these strategies into two main groups, namely pragmatic and statistical criteria, and validity and reliability issues.

6.3.1.1 Pragmatic and statistical criteria

In selecting a set of variables, a majority of studies rely on pragmatic criteria; a phenomenon described by Parkin et al.[262] as 'common-sense rules'. Such 'common-sense rules' lay emphasis on covering the full range of resources used and capturing all relevant activity levels. However, what is meant by 'full range of resources' and 'relevant activities' awaits clarification. This is evident from the fact that, when using 'common sense rules', different studies have selected different sets of variables (see chapter 2, section 2.3 for a full discussion).

To provide specific pragmatic criteria, some studies have proposed to select the model that generates a specific percentage of efficient units, i.e. 40% to 45% of sample size, and the least number of outliers.[324,326,339] The former suggestion (number of efficient units) is because of the better discrimination power of the results obtained, and the latter (number of outliers) is because DEA is sensitive to outliers and possible measurement errors. The presence of outliers can affect the robustness of the results.

To further evaluate the validity of DEA results, some studies have used statistical tests to show the difference in results derived from different models.[263] If there is no statistically significant difference between two models, then one model can be eliminated. This strategy, however, suffers from two drawbacks. First, if two models differ from each other, a statistical test cannot provide enough evidence to select the more appropriate set of variables. Second, only those models which include the same number of variables can be compared with each other. This is because of the effect of dimensionality.[264] Dimensionality refers to the situation in which two models include different types as well as different numbers of variables. In this circumstance, any difference in the results might be due to the impact of both factors, i.e. the type and the number of variables.

In general, although pragmatic criteria can shed light on how to select a model from amongst a list of different sets of variables, they lack any clear decision rules.[339] For example, there is no evidence to indicate the optimal number of efficient units in DEA analysis. Therefore, the use of these criteria as the first step in assessing the appropriateness of the variables selected is subject to debate. To compensate for this, another strategy based on validity and reliability issues needs to be discussed.

6.3.1.2 Validity, responsiveness to change, and reliability

This section presents an assessment of the appropriateness (how well it reflects reality) of a DEA model using validity and reliability examination.

According to Abramson et al,[265] validity refers to how well an assessing procedure measures the characteristics that the researcher actually wants to measure. In other words, validity estimates the accuracy of the method and variables used in measuring what we want to measure in reality. The limits and strengths of the method employed in the present study (DEA) have been previously discussed. Here, the main focus is on the assessment of the validity of different sets of variables. To assess the validity of model specifications, there are different criteria which need to be considered. Some criteria such as face and content validity are based on judgement. Others such as criterion validity and responsiveness to change in the underlying characteristics are based on checks against a set of criteria or data. These criteria will be discussed in the following paragraphs with a focus on their application in efficiency measurement.

Face validity refers to how a variable or procedure appears.[266] Face validity seeks to find whether or not the variable employed seems like a reasonable variable to capture the information that investigators are attempting to obtain. It mainly follows a common sense rule. For example, just looking at the list of different sets of variables for hospital efficiency measurement reveals that, in comparison to the total number of separations, the disaggregation of separations into medical and surgical separations seems to be more valid, if the intention of the researcher is to capture the complexity of the procedures. The concept of face validity implies that there is no need to be involved in the technical aspects of the models developed. This superficial view has led the development of other criteria which are more related to the content of the variables used.

Content validity describes the extent to which a variable covers the specifically intended domain(s) of content under investigation.[267] If the concept that the investigator wants to measure includes different domains, it is crucial to see that all components are being covered by the variables used. For example, if the researcher wants to measure patient satisfaction, various aspects of satisfaction including the relationship between health worker and patient, the quality of care provided, cost, and the physical environment should be considered. Similarly, if the intention is to measure the complexity as well as the quality of care provided by hospitals, we should seek variables which cover both domains.

Face and content validity are based on judgment. However, there are other types of validity which are based on checks against a reference set or data. Criterion validity refers to the comparison of variables or methods with a gold standard or a reference standard which has been demonstrated to be close to the truth.[342] However, a major drawback is to determine a gold standard, which is not usually a simple task particularly in the social sciences. In chapter 4, I proposed a health-oriented framework to select the most appropriate variables. According to the underlying concepts in developing the framework, it can be regarded as a reference standard to compare different set of variables.

Responsiveness to change is another issue which is used in appraising validity. This criterion describes the responsiveness of measurement instruments to change in the underlying characteristic.[268] For example, if there is change in some underlying characteristic of the hospitals under assessment (such as their payment system, which is thought to influence efficiency), a valid set of variables should respond to these changes by constructing a different frontier. It should be noted that to assess the robustness of different models in this thesis, responsiveness to change is not applicable, because there was no change apparent in the underlying characteristics of the hospitals under assessment during the period of the study.

Another concept to test the accuracy of any measurement is the repeatability or a more commonly used word ‘reliability’. Reliability refers to the consistency of information over time, and is about the ability of a measure, a set of variables or a method to reproduce the same findings under the same conditions.[265] Although it might be expected that there would be some changes in hospital efficiency over time, it is unlikely that the results for two or more consecutive years will be dramatically different from each other (see section 6.3.5 for more detail).

The application of the above strategies to examine the appropriateness of the different models developed by this thesis will be discussed in section 6.3.3. The next section (6.3.2) will introduce different model specifications.

6.3.2 Model specifications

6.3.2.1 Data source

Data for the present study were obtained from the Annual Statistical Report (2004)[11] published by the SSO for the year April 2002 to March 2003. This report contains administrative and operational information on all SSO hospitals, and was the most recent available at the time of the present study. The report provides data for all 59 SSO hospitals. Of these 59 hospitals, 57 are non-teaching hospitals. As teaching hospitals have a different mission, requiring a different mix of resources, the two are excluded from the analysis (see section 6.2.1.1).

6.3.2.2 Variables

To capture essential components of hospital resources and products within the data available, four input variables and nine output variables were specified.

The four input variables are: the total number of Full Time Equivalent (FTE) medical doctors; the total number of FTE nurses; the total number of other personnel in FTE; and the average number of staffed beds. The disaggregation of staff to medical doctors, nurses, and others is due to the leading role of staff (particularly physicians and nurses) in treatment, resource use for patients, quality of care, and patient satisfaction.[269] In the existing SSO database, there is no appropriate variable reflecting capital inputs. The number of beds is commonly used as a proxy for capital inputs in hospital efficiency studies[270] (see also chapter 2, section 2.3.4.2.1 for more information about capital inputs).

The selection and definition of hospital outputs were largely discussed in chapter 2, section 2.3. In summary, several hospital-related DEA studies have considered hospital activities in three categories, namely outpatient services, emergency care, and inpatient care services.[271,272] To cover the first two, I used both the number of outpatient visits and the number of emergency visits. For inpatient activities, unweighted units of measurement such as ‘number of discharged patients’, ‘number of patient days’, ‘number of surgical operations’, and ‘number of non-surgical interventions’ were identified. The use of these output variables is consistent with prior published hospital efficiency studies.[273,274] However, measuring hospital outputs by such variables does not capture how procedural complexity may influence utilization, leading to higher efficiency scores for hospitals which admit and treat non-complicated cases. As pointed out earlier, the SSO hospitals do not classify inpatient services based on DRGs. However, the degree of procedural complexity of surgeries is reported by the SSO database, namely the number of major surgical interventions (see chapter 5, section 5.5.3 for more information on this variable). I used the ratio of the number of major surgeries to total surgeries to capture the complexity of surgical operations. It should be stressed that using this ratio means that the complexity of non-surgical interventions is not being captured. There are certain medical interventions such as dialysis that are quite resource intense. Information reflecting the complexity of non-surgical interventions, however, is not available, implying a pressing need for a further development of the SSO database.

In addition to quantity-oriented variables such as the number of procedures, it is important to employ variables reflecting the quality of care. Some examples of quality-oriented variables include re-admissions and post-operative infections (for the full list of quality variables, see chapter 4, section 4.3). However, the SSO hospitals do not generally report information on such variables. I have used the number of unnecessary caesarean section operations (based on WHO recommendation) as a proxy for a quality-oriented output variable. The validity of this variable as a quality variable was discussed in chapter 4, section 4.3.3. Considering World Health Organization recommendation[275], a general hospital that performs more than 15 caesarean sections for every hundred births might be suspected of performing unnecessary procedures. For example, if a hospital performs 200 births of which 80 (40%) are caesarean sections, I included 50 caesarean sections [80- (15% x 200)] as a (negative) output. Regarding the use of this variable, there are two points that need to be addressed.

Firstly, it should be noted that in the conventional efficiency measurement framework, higher values of output variables lead to higher efficiency scores. However, in the case of the caesarean section rate, any rate higher than the 'appropriate' rate could be considered as a negative output which should lead to lower efficiency scores. Unfortunately, existing DEA softwares are not designed to consider such reverse outputs. Nevertheless, the problem can be solved by treating the variable as an input rather than as an output (see Jacobs et al.[249] for more information on dealing with reverse outputs).). It might be argued that the caesarean section rate could be converted to a vaginal delivery rate (by subtraction) thereby avoiding a negative output. However, as pointed out earlier, in the analysis I included the number of unnecessary caesarean sections based on the WHO recommendation. The use of the number of vaginal delivery (for instance, 150 in the above example) is not appropriate, because this is not the actual number of an output produced by the hospital. Furthermore, although not a compelling reason, the caesarean section rate is regarded as a big concern to the SSO policy makers and hospital managers. Using this variable in the analysis and providing more information in terms of the magnitude of inefficiency due to the high caesarean section rate can provide a more understandable and acceptable picture for policy makers and senior managers.

Secondly, a high number of unskilled birth attendants can affect the number of caesarean deliveries performed in a hospital, because either more simple cases (requiring vaginal deliveries) do not get to the hospital or more complicated cases (requiring caesarean deliveries) are admitted in hospitals due to the problems caused by unskilled birth attendants. However, according to the report of Demographic and Health Survey (DHS) in Iran[276], the percent of births with skilled attendants is 90% (95% in urban areas) indicating little adverse effect on the variable.[xxxvi]

6.3.2.3 Proposing different models (set of variables)

Using the variables discussed in section 6.3.2.2, this study has proposed six models for analysis (Table 6.3). All six models include three human inputs (the total number of FTE medical doctors, nurses and other personnel), and the number of beds. All models also include 'the number of outpatient visits' and 'the number of emergency visits.'

Model I includes the total number of discharges, whilst model II uses the total number of patient days. It can be postulated that, because aggregate patient days are computed by multiplying average length of stay and the number of separations, it might be preferable to select aggregate patient days (rather than the number of separations) as an output variable in hospital efficiency studies, as it can reflect the length of stay. However, some studies have shown that efficiency distribution is not sensitive to the change of unit measurement for separations.[351] Nevertheless, both models use unweighted separations or patient days, and cannot reflect appropriately the complexity of the procedures. In response to this deficiency, model III by disaggregation of separations into medical and surgical, and model IV by using the major surgery ratio reflect the complexity of interventions more appropriately than models I and II.

However, still the models do not represent the actual complexity of the interventions.
This is rooted in the limit posed by DEA on the calculation of efficiency scores. In general, DEA measures efficiency scores by dividing the weighted sum of the outputs into the weighted sum of the inputs. DEA derives the weights from the data in a way that maximises the ratio mentioned above. DEA assigns maximum weight to the output that is unique to a DMU. From this standpoint, a DMU with an exceptional performance on only a single output will automatically be assigned a full efficiency score.[249] For the sake of the clarity, let me consider that a hospital has achieved a maximum value on the total number of medical

[xxxvi] A skilled attendant is a professionally trained health worker—usually a doctor, midwife or nurse—with the skills to manage a normal labour and delivery, recognize complications early on and perform any essential interventions, start treatment and supervise the referral of mother and baby to the next level of care if necessary.

interventions per medical doctor. If these two variables (as the output and input respectively) are used in the set of variables, DEA places the maximum weight on this particular ratio even though it may be less valuable (in terms of reflecting the procedural complexity) than other variables such as major surgeries. Unfortunately, the SSO database does not report any variable reflecting the degree of procedural complexity of medical (non-surgical) interventions. Hence, if the reflection of the complexity of inpatient services is central to the model development, the consideration of medical interventions may violate this purpose, because a hospital admitting a very high number of minor medical cases might be regarded as an efficient unit relative to other hospitals. By using weight restrictions, this drawback can be managed. However, in the absence of the information on the relative importance of different aspects of hospital performance, substantial additional studies are required to identify appropriate weights.

In view of the above limitation, model V is proposed to account for hospitals that are performing more complicated procedures. In this model, only the major surgery ratio was used to capture the complexity of procedures.

If quality variables are ignored in efficiency studies, the hospital which uses more inputs to provide more quality might be unfairly classified as an inefficient unit. Model VI is proposed to allow for incorporating quality of care provided by hospitals. This model includes caesarean section operations.

Variables	Models					
<u>Inputs</u>	**I**	**II**	**III**	**IV**	**V**	**VI**
Beds	x	x	x	x	x	x
Doctors	x	x	x	x	x	x
Nurses	x	x	x	x	x	x
Other staff	x	x	x	x	x	x
<u>Outputs</u>						
Outpatient visits	x	x	x	x	x	x
Accident and emergency attendances	x	x	x	x	x	x
Total number of discharges	x					
Total number of patient days		x				
Total number of surgical interventions			x			
Total number of non- surgical interventions			x	x		
Ratio of major surgeries				x	x	x
Caesarean section operations						x
Number of variables	7	7	8	8	7	8

Table 6.3: Specifications of various models ("x" indicates that the variable is included in the model)

6.3.3 Applying the strategies adopted for sensitivity analysis to select the final model

This section examines the appropriateness of the different sets of variables. First, the application of different components of validity (face, content, and criterion validity) is discussed. Then, the use of pragmatic criteria is presented.

Models I and II only include unadjusted activity levels. They do not capture the complexity of the procedures nor the quality of care. Regarding the face validity of the various models, models III to VI have a sound technical and empirical rationale for their use, because to some extent they can capture the aspects of complexity and quality that are regarded as important issues in hospital efficiency studies. A similar argument can be applied in assessing the content validity of the various models. Model VI provides a more accurate measurement set, because it reflects both contents, namely the procedural complexity and the quality of care.

To assess the criterion validity of the models, we need a reference set. As discussed earlier, the health-oriented framework proposed in this thesis can be considered as a standard. Thus, the models which include more non-conventional variables that capture the health orientation of the hospitals can presumably be regarded as more appropriate. From this point of view, model VI is the only model that uses a non-conventional output variable.

The above assessment criteria are based on judgment (face and content validity) or check against a set of standards (criterion validity). To examine pragmatic criteria, the efficiency scores generated from the data under different models are required.

Using an input-oriented approach and a VRS model, technical efficiency scores for the SSO hospitals were computed using the six different sets of variables. The Performance Improvement Management (DEASOFT-V1) software package was used to perform the calculations.[277]

Table 6.4 shows the efficiency scores derived from the data using the six different sets of variables. Of the total sample size, 16 hospitals were always on the frontier (under all models) indicating that these model variations cannot affect their position on the frontier. These hospitals were excluded, because they cannot provide useful information in assessing the appropriateness of the models. Before applying the pragmatic criteria, the following point should be addressed.

Table 6.4 shows a large variation in efficiency scores obtained from different DEA models for a particular hospital. In some cases, the difference is considerable. For example, while under models II, III, and IV, the efficiency score for Sharyarkaraj is more than 80%, the score drops to 51.6% under models V and VI. The key change is that in models V and VI weights are now given to the complexity of procedures and the quality variable, so that when more variables reflecting the complexity and the quality of care are being used, the hospital cannot be regarded as a well-performing unit anymore. Alborzkaraj has a similar situation. Its efficiency score for all models except V and VI is 60% or more (88% for model II). However, the score falls to 35% using models V and VI. A similar argument can be applied to Emamuremeyeh.

Hospital	Model I	Model II	Model III	Model IV	Model V	Model VI
ValiasrMazandran	83.9	100	99.3	93.2	81.2	88.3
Fayazbakhsh	89.2	93.2	89.3	100	92.3	100
Lavasani[1]	63.0	100	84.0	84.6	42.5	
Zarand	100	85.3	100	98.1	75.5	75.5
ChamranSaveh	87.4	81.6	91.9	91.9	73.7	73.7
Thaydarieh	100	100	100	100	98	98
Takestan	80.9	86.5	81.7	77.2	74.7	85.6
GharaziMalayer	72.0	88.4	72.7	67.2	79.9	79.9
AtyehHamedan	100	100	100	100	99.3	99.3
Khalij	61.6	63.8	63.5	63.2	56.2	56.9
EmamArak	100	100	100	98.9	98.9	98.9
ShariatTehran[2]	60.3	97.3				
Khordad15	86.3	86.3	97.9	95.2	84.3	86.3
AlinasabTabriz	79.4	80.7	75.2	73.2	82.5	79.4
SabalanArdabil	65.1	83.5	67.3	42.4	49.4	49.4
Najafabad	74.6	84.1	77.3	77.3	70.4	70.4
SalmanBousher	73.0	72.6	91.3	91.3	69.2	69.2
Sanandaj	75.9	91.5	85.5	100	93.9	100
GharaziSirjan	60.7	83.2	60.7	52.3	49.8	58.1
ShKermanshah	84.0	81.7	95.9	100	100	100
RasoulRasht	89.2	89.7	92.2	100	100	100
ShahryarKaraj	76.8	95.3	95.3	81.2	51.6	51.6
AlborzKaraj	60.9	88.0	63.1	63.5	33.7	35.1
ShahrKord	75.4	80.1	99.5	99.5	72.3	72.3
ShafaSemnan	100	100	100	100	99.3	99.3
Zahedan	78.4	83.1	78.5	78.6	98.3	98.6
RaziGhazvin	100	100	100	100	98.3	98.8
EmamUremeyeh	75.8	88.3	79.7	77.1	62.9	66.6
FarabiMashad[1]	70.5	100	77.6	75.6	48.6	
BeheshtiKashan	49.9	82.4	59.5	58.1	39.0	58.4
Khoramabad	73.4	97.4	93.7	92.3	82.7	84.3
KargarYazd	66.3	98.4	67.0	67.1	64.6	64.9
ArasArdabil	91.0	100	94.5	91.4	88.5	88.5
Abadan	80.7	85.7	82.8	100	100	100
Behbahan	93.4	90.2	94.0	94.4	86.4	89.9
EmamZanjan	100	97.6	100	92.8	87.6	87.6
ShazandArak	98.8	97.1	100	100	100	100
Moayari[1]	56.4	80.5	80.2	89.2	68.5	
Hedayat	73.3	64.1	100	89.1	65.6	65.6
ErshadKaraj	94.0	98.0	100	96.2	96.1	96.2
HashtgerdK	97.3	92.4	98.5	98.5	95.6	98.6

Table 6.4: Efficiency scores using different sets of variables

[1] No obstetric and gynaecology ward in these hospitals (Blank cells for model VI).
[2] No surgical ward in this hospital (Blank cells for models III to VI).

A number of pragmatic criteria were discussed in section 6.3.1.1. These include the number of efficient units and outliers. Table 6.5 summarises the number of efficient units and outliers for all six models.

	Model I	Model II	Model III	Model IV	Model V	Model VI
Sample size	57	57	56	56	56	53
No of efficient units	23	25	26	26	20	22
No of outliers	6	7	12	11	6	5

Table 6.5: Summary of efficiency scores

Table 6.5 shows that more than 45% of hospitals were deemed to be efficient under models II, III, and IV indicating a low degree of discrimination. From this point of view, models I, V, and VI provide a reasonable number of efficient hospitals.

Another pragmatic criterion is the number of outliers. Since no measurement errors are allowed in DEA, this makes it sensitive to extreme observations contaminated by data errors. Based on this concept, the fewer the outliers that the analysis includes, the fewer extreme observations exist, and the greater will be the validity of the findings. Super efficiency scores help in identifying outliers (more than three standard deviations away from the mean efficiency score) which, in turn, can provide an opportunity to assess the validity of the set of variables used.[278] Using the model developed by Anderson et al.[279], the super efficiency score of an efficient hospital was computed and the outliers were identified (for more information on super efficiency scores, see section 6.4.3.1). Table 6.5 shows that model VI includes the least outliers.

6.3.4 Final model; a further assessment of validity

In this section, I argue that amongst the six different sets of variables investigated, model VI is the most appropriate for measuring SSO hospital efficiency. I also provide a further discussion regarding the examination of the validity of the model selected (model VI) using qualitative methods.

Using validity and pragmatic criteria, a general agreement on the relative appropriateness of models VI and V was shown. This does not mean that the two models include the most appropriate variables. It should be acknowledged that there are other variables which can reflect more appropriately the complexity of procedures and the quality of care provided by hospitals. For example, it could be argued that DRGs are a better tool for capturing the casemix and the complexity of services than major surgical procedures which are based on relative values. Nevertheless, among different models, and based on the sensitivity analysis and data availability, the two models include the more appropriate variables.

Table 6.4 shows that efficiency scores obtained from models V and VI are more or less identical. This can be confirmed using the Spearman's Rank Correlation Coefficient (Table 6.5.1). This Correlation Coefficient was extremely high (0.96) and different from zero at the 1% level of significance, suggesting a significant agreement between two models.

It is worth noting that in comparing the agreement of model VI with the other models, the Spearman's Rank Correlation Coefficients seem generally low, suggesting little agreement between model VI and the other models (models I to IV). The Correlation Coefficients between each pair for model I, II, III, and IV with model VI were 0.68, 0.66, 0.65, and 0.73 respectively.

	Model I	**Model II**	**Model III**	**Model IV**	**Model V**
Model VI	0.68	0.66	0.65	0.73	0.96

Table 6.5.1: Spearman Correlation Coefficients between each pairs for model VI and other models

The strong agreement between models V and VI means that the inclusion of an additional variable in model VI (caesarean section operations) could not affect the findings significantly. The interpretation might be at least two-fold. Firstly, those hospitals that are doing more complicated procedures (proxied by the major surgery ratio), in general, may provide better quality services. If so, using caesarean section operations as a quality variable may not lead to a significant difference in the findings. Secondly, it can be proposed that 'caesarean section operations' only assesses 'quality' in one aspect of hospital outputs. It does not reflect the quality of a hospital overall. This means that, in order to assess the quality of care, more variables covering the different dimensions of quality, such as outcome and structural variables need to be employed in efficiency studies.

The above analysis might suggest that it is unnecessary to include caesarean section operations in the final model. However, retention of this variable may make the model more acceptable to the SSO managers and policy makers. This is because the high rate of caesarean section operations is one of the major concerns of the managers, and model VI by using this variable can provide more information in terms of the magnitude of inefficiency. Considering the above argument, I finally decided to select model VI as the basis for the further analysis undertaken below. Given the impact of the variables used on the DEA results, I decided to carry out a further assessment of the validity of the model selected using qualitative methods. Only a few researchers used qualitative methods in the assessment of the validity of the DEA findings. For example, after measuring the efficiency of general hospitals in Greece, Athanassopolous et al,[280] selected a panel of ten experts to discuss the summary of the method used and results obtained. Then, the panel was provided with a questionnaire concerning the validation of hospital efficiency, asking questions about the appropriateness of the variables used and the efficiency ratings of the hospitals. Another example is the study undertaken by Hollingsworth et al. [337] In this study, in order to select the most appropriate variables for hospital efficiency measurement in England, a survey was undertaken involving all providers (trusts) and purchasers (health authorities). The authors asked the participants to rank the usefulness of the available variables on a scale from 1 (very useful) to 5 (not useful). Most participants selected those variables which accounted for case mix, allowed for valid comparisons over time, and appeared easy to use.

As pointed out earlier, one of the objectives of this thesis is to analyse the factors affecting SSO hospital efficiency and remedial actions using in-depth interviews (see chapter 2, section 2.7). One chapter (chapter 7) is devoted to that. In interviews with SSO health professionals, I took the opportunity to obtain insights from the participants regarding the choice of the variables and the results obtained. I felt that it was necessary to understand how SSO health professionals who are involved in the SSO health system perceive the DEA findings. A full description of the method used, including sampling strategies, sample size, data collection, and data analysis is provided in chapter 7, section 7.2. Here, only a brief description of certain results is presented.

For my thesis, two aspects were explored. On the aspect of input and output selection, participants discussed the appropriateness of the set of variables selected (model VI) given the constraints of the available data in the SSO database. A typical comment made by a SSO senior expert included:

> *Considering the limits posed by data availability, the set of variables used looks good to me. The number of major surgical interventions is the only variable that we have to examine the complexity of procedures. I also agree with the use of caesarean section rates. It is very high in our hospitals.*

The general agreement concerning the appropriateness of the set of variables used, however, did not deter the participants from urging the need to enhance the SSO database in order to capture more detailed information. This discussion was mainly focused on the need to capture more appropriate variables reflecting the procedural complexity such as DRG- based separations, and the quality of care provided such as the readmission rate, and the postoperative infection rate.

Regarding additional variables that might be used, a few participants suggested that patient satisfaction and/or the level of staff knowledge should be in the set of variables.

> *I agree with the inputs and outputs used in this study. I only give one further comment, that is the use of variables reflecting patient satisfaction and the level of knowledge of staff particularly nurses. For example, you might use the number of training hours for staff.*

The second aspect was about the ranking of the SSO hospitals, examining the extent of agreement between the participants' views and the results obtained from the DEA analysis. The participants were asked to rank a sample of 12 SSO hospitals[xxxvii] based on their view about hospital efficiency and performance. They considered a range of factors to rank these hospitals, including hospital age, the number of complaints received, patient and staff satisfaction during inspections, patient turnover, and the knowledge and experience of their managers. General agreement was found as to which were the good-performing hospitals, and on a number of mid-performing hospitals including Shariati Esfahan, Amirkabir Ahvaz, Gonbad Golestan, Ershad Karaj, and Hedayat. Their view on Sabalan Ardabil and Beheshti Kashan as poor-performing hospitals was also consistent with the results of the DEA analysis

[xxxvii] A list of 12 hospitals was provided based on three levels of efficiency scores; low, medium, and high (For definition of these categories, see section 6.4).

(49% and 58% respectively). However, participants (particularly policy makers) considered Alborz Karaj as a mid to good-performing hospital. This hospital has a high caesarean section rate (48%) and a very low proportion of major surgical interventions (4%) leading to a very low efficiency score (35%) in my analysis. A number of reasons may explain this disagreement.

Alborz Karaj has one of the highest BOR among SSO hospitals (80%; national average: 68%), and a low ALOS. Moreover, the ratio of the total number of separations to doctors is very high (nearly 1.5 times the national average). These good throughput ratios and variables reflecting workloads could affect the view of experts and policy makers on the hospital's performance, as current SSO policy considers these variables to be the most important in assessing hospital performance. Furthermore, hospital age, as pointed earlier, was one of the factors on which the participants assessed performance. This hospital is very new (3.5 years). To what extent newness is appropriate for performance assessment is unclear. Finally, producing a very low proportion of major surgical interventions (the least across all the SSO hospitals) might indicate that this hospital admits only non-complicated cases. This might have lead to an acceptable level of patient satisfaction when policy makers inspected the hospital. They may have ignored referral to other hospitals.

The above findings reveal that the key informants involved in the SSO health system recognised the appropriateness of the set of variables used, and the validity of the results obtained.

In conclusion, on the basis of pragmatic criteria and validity, I selected the set of variables included in model VI as the final model for measuring SSO hospital efficiency. This model and the results obtained from the DEA analysis was then recognised to be appropriate and valid using in-depth interviews with some SSO key informants. For a further assessment, I examined the reliability of the same set of variables (model VI). This issue is discussed in the next section (6.3.5).

6.3.5 Reliability of the set of variables selected for this study

In survey research, reliability is an attribute of the measurement of a set of variables, and it helps verify the consistency of the findings when they are being reproduced over time under the same conditions. One would not normally expect to obtain very different results using the same set of variables over a short period. Finding a large degree of variation in results should motivate researchers to seek the possible sources of that variation, which may arise from at least the two following sources.

First, variations in results over time might be due to the existence of inconsistency in definition and calculation of the variables being used. For example, whether the SSO database uses a similar definition and process to calculate the variables (such as the number of major surgical interventions) used in the present study needs to be examined. This sort of variation in defining variables might be partly due to the relative skill of the persons who collect the data, and their propensity to make mistakes (observer error). However, the certain steps taken by the SSO health system decrease the possibility of the observer errors (see chapter 5, section 5.4 for more information).

The second possible source of variation might be related to the measurement tool used in the measurement process. This, however, cannot be applied to the present study, because the study uses the same method and software to measure efficiency across all the hospitals.

To test for reliability, some studies have compared the efficiency scores for two consecutive years using the same variables and methods.[262] As pointed out earlier**,** it is unlikely that the efficiency scores for two or more consecutive years will be significantly different from each other. In hospital efficiency studies, the use of panel data would help in clarifying a number of issues such as whether the outlying hospitals are only one-off data abnormalities, and whether efficiency scores change significantly from year to year and display inconsistency.[82] These issues do affect the efficiency scores, and hence can be regarded as an indication of the reliability of the set of variables used.

Efficiency scores were computed for the two consecutive years, 2001-02 and 2002-03, using the variables included in model VI. In 2001/02, 23 out of 53 of hospitals were deemed to be efficient. In 2002/03, 22 hospitals were deemed to be efficient. Outlying hospitals were the same. As a test of the difference in efficiency scores between these two years, the Spearman's Rank Correlation Coefficient was 0.89 and different from zero at the 1% level of significance, indicating that the results were positively and strongly related and stable across the two years. This provides evidence of the reliability of the set of variables used.

The next section (6.4) provides a full discussion of the results obtained, including technical and scale efficiency, with a view of determining the target levels for inefficient hospitals which would render them efficient. Furthermore, given that in any DEA analysis, some hospitals are always classified as efficient units relative to others, a full ranking of efficient hospitals is provided.

6.4 Discussion of the results obtained

6.4.1 Technical efficiency scores

Using a VRS model and an input oriented approach, technical efficiency scores for SSO hospitals were computed (Table 6.6) (Means and standard deviations for input and output variables are provided in Appendix E.).

As pointed out earlier, two teaching hospitals were excluded. Furthermore, because model VI includes variables such as the major surgery ratio and the number of caesarean section operations, four more hospitals were excluded as they did not have surgical and/or gynaecology and obstetrics wards. Consequently, 53 hospitals were retained for this analysis.

Technical efficiency scores for individual hospitals are shown in Table 6.6. Out of 53 hospitals, 22 (41%) were deemed to be operating efficiently relative to other hospitals. This suggests that the set of variables selected has a good discriminatory power, i.e. small enough to provide discrimination, and large enough to provide a sensible number of peers.

Table 6.6 also shows that the average score for inefficient hospitals (n=31) was 78% with a standard deviation of 17.5. This illustrates that, for these inefficient hospitals, the overall inputs could be reduced by 22% without reducing the collective outputs. As can be seen from Table 6.6, Alborz Karaj was the most inefficient hospital relative to other SSO hospitals (35.1%).

Hospital	Efficiency scores (%)	Hospital	Efficiency scores (%)
Valiasr Mazandran	88.3	Alborz Karaj	35.1
Fayazbakhsh	100	ShahrKord	72.3
Shariati Esfahan	100	Amiral Ahvaz	100
Zarand	75.5	Shafa Semnan	99.3
Razi Chalus	100	Zahedan	98.6
Chamran Saveh	73.7	Razi Ghazvin	98.8
T.Haydarieh	98	Emam Uremeyeh	66.6
Bojnoord	100	17Sh. Mashad	100
Amirkabir Ahvaz	100	Beheshti Fars	100
Takestan	85.6	Beheshti Kashan	58.1
Gharazi Malayer	79.9	Khoramabad	84.3
Atyeh Hamedan	99.3	Kargar Yazd	64.9
Khalij	56.9	Aras Ardabil	88.5
Emam Arak	98.9	Birjand	100
Eslamshar	100	Abadan	100
15 Khordad	86.3	Behbahan	89.9
Alinasab Tabriz	79.4	Emam Zanjan	87.6
Sabalan Ardabil	49.4	Shazand Arak	100
Gharazi Esfahan	100	Saghez	100
Najafabad	70.4	Kosar Broujerd	100
Salman Bousher	69.2	Neka	100
Sanandaj	100	Hedayat	65.6
Kashani Kerman	100	Mehr Borazjan	100
Gharazi Sirjan	58.4	Ershad Karaj	96.2
Sh. Kermanshah	100	Hashtgerd K	98.6
Gonbad Golestan	100	**Min**	**35.1**
Rasoul Rasht	100	**Mean of inefficient hospitals**	**78**
Shahryar Karaj	51.6	**Standard Deviation**	**17.5**

Table 6.6: Technical efficiency scores for the SSO hospitals

According to the efficiency scores derived, inefficient hospitals can be grouped into low, medium, and high levels of inefficiency (Figure 6.3). 18 of the inefficient hospitals that achieved scores between 75% to 99.9% can be classified as low-grade inefficient units. Eleven hospitals with efficiency scores between 50% to 74.9% were classified as medium-grade inefficient units. There were also two hospitals grouped as high-grade inefficient units with the efficiency scores less than 50%. These results were examined for factors leading to the various levels of inefficiency. For instance, it appears that the hospitals Alborz Karaj and Sabalan Ardabil, which performed fewer major surgical interventions and which had a high number of caesarean section operations, were operating at a high-grade of inefficiency.

Shahryar Karaj (efficiency score: 51%), and Khalij (efficiency score: 56%) were not much better.

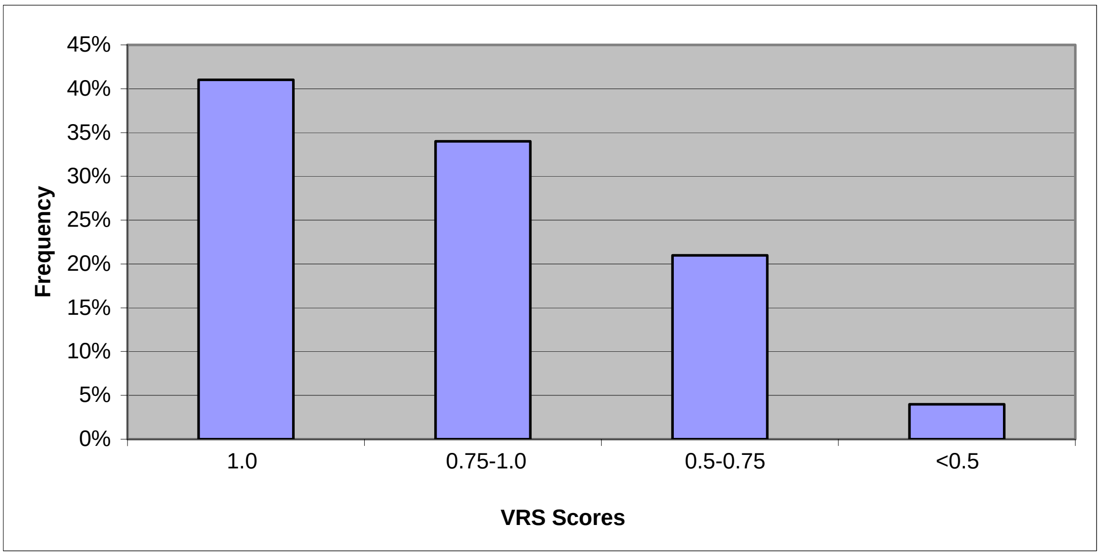

Figure 6.3: Distribution of efficiency scores under VRS model

In 2002-2003 in 31 inefficient hospitals, there were 1,187 medical doctors, 3,574 nurses, and 2,779 other staff. In that year, these hospitals were running 3,925 staffed beds. This analysis suggests that these hospitals need to reduce their excess inputs to become efficient. This can be achieved by reducing the number of medical, nursing, and other staff and/or by reducing the number of staffed beds within the context of population health and health care needs of the community in the target area.

The calculation of the magnitude of inefficiencies at the individual hospital level provided an insight into their weakest areas of performance. Table 6.7 illustrates this point by providing an example from Chamran Saveh. The table (6.7) shows the actual inputs and the target inputs to achieve the current levels of output. From this analysis, it appears that for this hospital, the number of doctors and the number of caesarean sections are two areas that require the highest percentage changes. The result is in line with the simple ratio analysis. This hospital has one of the highest rates of caesarean section (50% of total deliveries), and a very low number of separations per medical doctor when compared to the other SSO hospitals.

Variable	Actual	Target	Difference between actual and target level (%)
Caesarean section operations*	563	353	37.1
Beds	73	52	28.1
MDs	42	14	66.4
Nurses	64	47	26.2
Other staff	50	36	26.2

Table 6.7: Actual and target inputs (Chamran Saveh Hospital)

* I have treated caesarean section operations as an input

Looking at the actual and target inputs for other hospitals may reveal different aspects of performance that require high percentage changes. Taking Valiasr Mazandaran as another example, the number of other staff is the aspect that needs a high percentage change (Table 6.8). Again, this is in line with the results obtained from simple ratio analysis where this hospital has one of the highest ratios for the number of other staff (non-medical and non-nursing staff) to the number of separations.

Variable	Actual	Target	Difference between actual and target level (%)
Caesarean section operations	653	577	11.6
Beds	201	177	11.6
MDs	51	45	11.6
Nurses	197	165	16.2
Other staff	166	103	37.7

Table 6.8: Actual and target inputs (Valiasr Mazandaran Hospital)

The comparison of target inputs for the above-mentioned hospital (Valiasr Mazandaran with an efficiency score of 88%) with Sabalan Ardabil (one of the least efficient hospitals with an efficiency score of 49%) reveals some interesting points. Table 6.9 shows the actual and target inputs for Sabalan Ardabil. Relative to other SSO hospitals, as can be seen from Table 6.9, Sabalan Ardabil uses very high input levels to produce a given output, requiring high percentage changes in all areas.

Variable	Actual	Target	Difference between actual and target level (%)
Caesarean section operations	1112	401	63.8
BEDS	135	43	67.7
MDs	53	19	63.9
Nurses	106	52	50.5
Other staff	84	41	50.5

Table 6.9: Actual and target inputs (Sabalan Ardabil hospital)

Both hospitals (Valiasr Mazandaran and Sabalan Ardabil) have a very low proportion of major surgical interventions (4% for Valiasr Mazandaran and 5% for Sabalan Ardabil). However, their efficiency scores are considerably different. Sabalan Ardabil uses a large amount of extra inputs in all categories of resources (all staff inputs and the number of beds) to produce a given amount of output, leading to a very low efficiency score. According to DEA analysis, Valiasr Mazandaran was found to be a low-grade inefficient unit. Looking at simple ratio analysis in more depth reveals that this hospital (Valiasr Mazandaran) produces a large amount of other outputs (relative to the resources used), i.e. a very high rate of outpatient visits per doctor (7,653) leading to a high efficiency score. This can be regarded as a weakness of DEA in which a unit showing a very good performance on a single output-input ratio, even though relatively less valuable, can achieve a high efficiency score.

A similar argument can be applied to hospitals including, among others, Neka that achieved a full efficiency score (100%). This hospital has a very low proportion of major surgical interventions (7%), and the highest rate of caesarean section operations across the SSO hospitals (67% of all deliveries). However, an exceptional performance on other areas such as outpatient visits resulted in a full efficiency score. Neka with 10,343 has the highest rate of outpatient visits per doctor across all SSO hospitals.

Before leaving this discussion, two points should be noted. First, it should be emphasized that in DEA analysis, the target inputs for individual hospitals are identified relative to the performance of other hospitals. This implies that the results could be influenced by different factors, including population needs. Accordingly, as was pointed out earlier, to make a comment on input reductions for each hospital we should take into account influential factors such as the level of population need and the burden of disease. Second, being relative, efficiency scores and the analysis of target levels might vary, depending on the selection of hospitals.

6.4.2 Scale efficiency

To provide further insight into the impact of hospital size on efficiency, Table 6.10 shows the scale efficiency and types of returns to scale. Those hospitals with higher scale efficiency scores have less input wastes attributable to their size.

The comparison of scale efficiency scores revealed that out of 53 hospitals, fourteen have no scale inefficiency. The average score for scale-inefficient hospitals was 0.87, indicating that 13% of the input wastes could be attributable to operating at a non-optimal size.

Scale inefficiency can be further explored by analysing the type of returns to scale. A given percentage increase in inputs can lead to: (i) a higher percentage increase in output (Increasing Returns to Scale or IRS); (ii) a lower percentage increase in outputs (Decreasing Returns to Scale or DRS); or (iii) the same percentage increase in output levels (Constant Returns to Scale or CRS). As shown in Table 6.10, 40% of hospitals are operating with IRS, 26% with CRS, and 34% with DRS. This indicates that 74% of hospitals are not operating under the most productive scale size. They need to adjust their capacity in order to improve their efficiency.

This analysis could help reallocate resources from those hospitals which are operating under DRS to those operating under IRS. For example, Ershad Karaj and Mehr Borazjan with high technical efficiency scores (see Table 6.6) have the lowest scale efficiency scores across the SSO hospitals. Simple ratio analysis revealed that both hospitals have a very low number of beds (33 and 16 respectively, possibly inconsistent with the relative needs of the population in the target areas), very high separations per bed, and good values of major surgery rates, suggesting their potential capacity to increase their scale size. This is consistent with the scale efficiency analysis where both hospitals are operating with IRS. This implies that an increase in the resources for these hospitals might lead to a net gain in output levels.

Table 6.10 also shows that efficiency scores derived from CRS and VRS are relatively well matched as about 70% of hospitals have the scale efficiency scores 0.90 or more.

Hospital	Scale efficiency	Type of returns to scale	Hospital	Scale efficiency	Type of returns to scale
Valiasr Mazandran	0.93	DRS	Alborz Karaj	0.97	IRS
Fayazbakhsh	1	CRS	ShahrKord	0.8	IRS
Shariati Esfahan	1	CRS	Amiral Ahvaz	1	CRS
Zarand	0.83	IRS	Shafa Semnan	0.98	IRS
Razi Chalus	0.91	IRS	Zahedan	0.99	DRS
Chamran Saveh	0.9	IRS	Razi Ghazvin	0.9	DRS
T.Haydarieh	0.85	IRS	Emam Uremeyeh	0.98	DRS
Bojnoord	1	CRS	17Sh. Mashad	1	CRS
Amirkabir Ahvaz	1	CRS	Beheshti Fars	1	CRS
Takestan	0.99	IRS	Beheshti Kashan	0.98	DRS
Gharazi Malayer	0.88	IRS	Khoramabad	0.97	DRS
Atyeh Hamedan	0.83	DRS	Kargar Yazd	0.96	DRS
Khalij	0.89	IRS	Aras Ardabil	0.59	IRS
Emam Arak	0.8	DRS	Birjand	0.95	IRS
Eslamshar	0.85	DRS	Abadan	1	CRS
15 Khordad	0.66	DRS	Behbahan	0.97	IRS
Alinasab Tabriz	0.74	DRS	Emam Zanjan	0.95	DRS
Sabalan Ardabil	0.92	IRS	Shazand Arak	0.95	IRS
Gharazi Esfahan	1	CRS	Saghez	1	CRS
Najafabad	0.95	IRS	Kosar Broujerd	1	CRS
Salman Bousher	0.98	DRS	Neka	1	CRS
Sanandaj	1	CRS	Hedayat	0.69	IRS
Kashani Kerman	0.96	DRS	Mehr Borazjan	0.52	IRS
Gharazi Sirjan	0.95	IRS	Ershad Karaj	0.45	IRS
Sh. Kermanshah	0.99	DRS	Hashtgerd K	0.82	IRS
Gonbad Golestan	0.99	DRS	**Min**	**0.45**	
Rasoul Rasht	1	CRS	**Mean**	**0.87**	
Shahryar Karaj	0.97	DRS	**Standard Deviation**	**0.12**	

Table 6.10: Scale efficiency scores and types of returns to scale for the SSO hospitals
IRS: Increasing Returns to Scale, DRS: Decreasing Returns to scale, CRS: Constant Returns to scale

6.4.3 Assessment of efficient hospitals

During recent years, in DEA efficiency studies, an increasing emphasis has been placed on the assessment of efficient units. This is because the standard approach to DEA involves relative measurement in which the efficiency score of each hospital is computed relative to the best performing hospitals in the sample. Thus, there must always be at least one hospital for which the efficiency score is one (100% efficient). In DEA, if more variables are used to calculate the relative efficiency of a given set of hospitals, the number of efficient hospitals increases.[240] This is problematic because it leads to a low ability to discriminate between better performing and poorly performing hospitals.

In this thesis, only 22 out of 53 hospitals were classified as efficient units, reflecting a reasonable level of discrimination. However, in order to obtain the full ranking of the entire set of hospitals and/or to achieve discrimination within the 22 efficient hospitals, alternative approaches need to be adopted. This, in turn can provide a more elaborate picture for policy makers who seek a comprehensive performance framework which includes all the hospitals under scrutiny. In order to achieve such a comprehensive understanding, I have used the concepts of super efficiency, slack positive efficient units, and the frequency of peers. Furthermore, using different approaches in ranking efficient hospitals, this thesis is an attempt to add to the existing DEA literature to examine the general agreement between those approaches.

6.4.3.1 Super efficiency scores

Using the model developed by Anderson et al.,[279] the radial super efficiency score of an efficient hospital (hospital X) can be computed by assessing it relative to the frontier constructed by assessing the efficiency of all other hospitals excluding the hospital in question. This means that hospital X can have an efficiency score above 100%, hence the term super efficiency score. It should be noted that some studies have shown that non-radial super efficiency provides a more robust performance measure.[281] However, the software used was unable to measure non-radial super efficiency scores. Thus, the results of radial super efficiency should be interpreted cautiously. To compensate for this, I used other approaches (slack positive efficient units, and frequency of peers discussed in following sections) to achieve more robust results.

Table 6.11 shows super efficiency scores for all 22 SSO efficient hospitals.

Hospital	Super efficiency score
Gonbad Golestan	100.3
Neka	101.6
Kashani Kerman	103.3
Sh. Kermanshah	104.3
Rasoul Rasht	113.0
Amiral Ahvaz	113.1
Shariati Esfahan	114.1
Beheshti Fars	115.5
17 Sh. Mashad	115.8
Birjand	117.7
Shazand Arak	118.8
Bojnoord	118.9
Sanandaj	119.1
Mehr Borazjan	119.5
Saghez	120.9
Abadan	122.4
Razi Chalus	126.6
Fayazbakhsh	137.0
Gharazi Esfahan	142.1
Eslamshar	143.3
Kosar Broujerd	164.2
Amirkabir Ahvaz	166.2

Table 6.11: Super efficiency scores

As can be seen from Table 6.11, Amirkabir Ahvaz is the most efficient hospital on this analysis. This is consistent with the results of simple ratio analysis where this hospital has the highest proportion of major surgical interventions across all SSO hospitals (82%), and a low (relative to other SSO hospitals) caesarean section rate (25%). Good performance in different areas has also been noted for Kosar Broujerd and Eslamshahr that achieved the next highest super efficiency scores. Table 6.11 also shows that Gonbad Golestan and Neka have the lowest super efficiency scores. Again, this is consistent with the results of the simple ratio analysis, where both hospitals have a very low proportion of major surgical interventions, and a high caesarean section rate.

As discussed earlier (see section 6.3.3), another advantage of the analysis of super efficiency scores is in identifying outliers. This in turn provides another opportunity for assessing the validity of the model selected for efficiency measurement. Using input and output variables included in model VI (Table 6.3), five hospitals were specified as outliers. To compensate for the effects of outliers, the hospital efficiency scores were computed before and after excluding these five outliers. To demonstrate an overall relationship between rankings of hospitals based on their efficiency scores, Spearman's Rank Correlation Coefficient was computed. This was extremely high (0.91) showing a strong positive agreement between the two models (with and without the outliers), and also differed from zero at the 1% level of significance. This indicates that the scores obtained are due to operational factors rather than to the effect of outliers and possible measurement errors, hence supporting the validity of the set of variables used.

6.4.3.2 Slack positive efficient hospitals

An alternative way to discriminate efficient hospitals is to classify them into fully efficient and weakly efficient hospitals by identifying slacks. It should be noted that in order to construct the efficient frontier in DEA, some assumptions need to be made. One of these assumptions is the feasibility of the vertical drop and horizontal extension parallel to the input and output axes respectively (Figure 6.4, and for more details see Coelli et al.[282]). These sections of the frontier, however, can cause some conceptual difficulties. To illustrate the problem, refer to Figure 6.4 where hospitals A, B, C, and D are the efficient hospitals which construct the frontier.

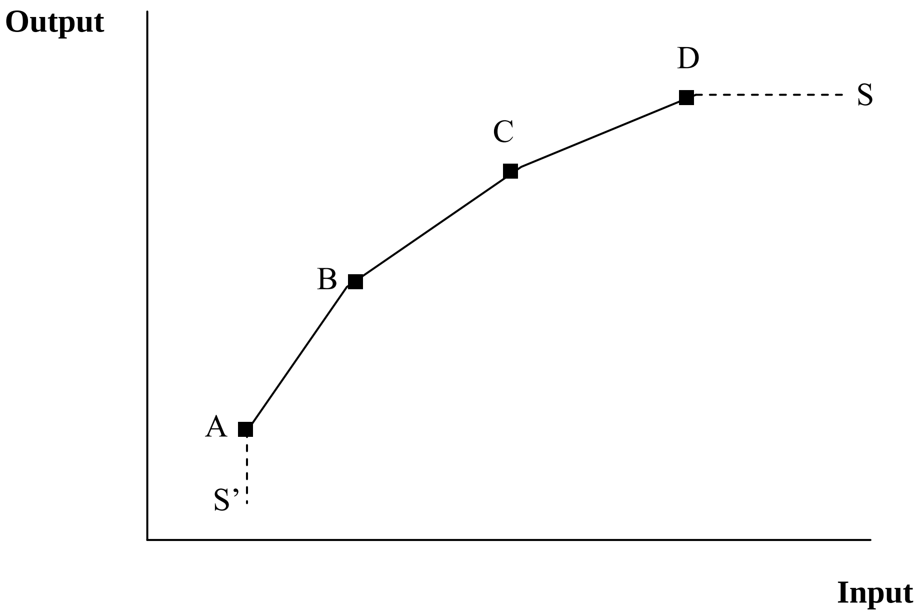

Figure 6.4: A conceptualization of weak efficiency

All hospitals resting on the frontier, including the vertical drop (AS' in Figure 6.4) and the horizontal extension (DS in Figure 6.4) are deemed to be efficient, with each having the same efficiency score (100%). However, those efficient units resting on the vertical drop or the horizontal extension of the frontier are still able to increase their output levels or to reduce their input levels without changing their efficiency scores – hence the term slacks. The existence of these non-zero input (or output) slacks helps distinguish between efficient hospitals in that hospitals with a positive slack are generally regarded as weak efficient units.

The identification of slacks for SSO efficient hospitals shows that there is a general agreement between this method and super efficiency scores in differentiating efficient units, particularly for those with very low or very high super efficiency scores. The DEA analysis has revealed that, for instance, Gonbad Golestan, Neka, and Kashani Kerman have positive slacks, and hence are weak efficient units. These hospitals have the least super efficiency scores as well (Table 6.11). On the other hand, for Amirkabir Ahvaz, Kosar Broujerd, Eslamshahr, and Gharazi Esfahan, which have the highest efficiency scores (Table 6.11), the slacks are negative. These hospitals can be considered to be fully efficient hospitals.

6.4.3.3 Frequency of peers

To discriminate efficient hospitals in more depth, some studies have suggested that it is worth identifying the number of times that an efficient hospital acts as a peer[283] (see section 6.2 for the definition of peer). This can classify efficient hospitals as self-evaluators and active comparators. Self-evaluator hospitals are not peer to any inefficient units. These units are referred to as self-evaluators because excluding them does not impact on the efficiency scores of other units. Compared with self-evaluators, active comparators can be regarded as better performing units. Excluding them does have an impact on the efficiency scores of other units. This is due to their outstanding operating environment which has led them to be a role model for more inefficient units by providing information about their targets. It is thought that the efficiency scores of those units which are mentioned as peers more often should not rely on only a few performance ratios. Figure 6.5 shows the number of times that an efficient hospital acted as a peer. Two hospitals with zero values (Gonbad Golestan and Kashani Kerman) are excluded.

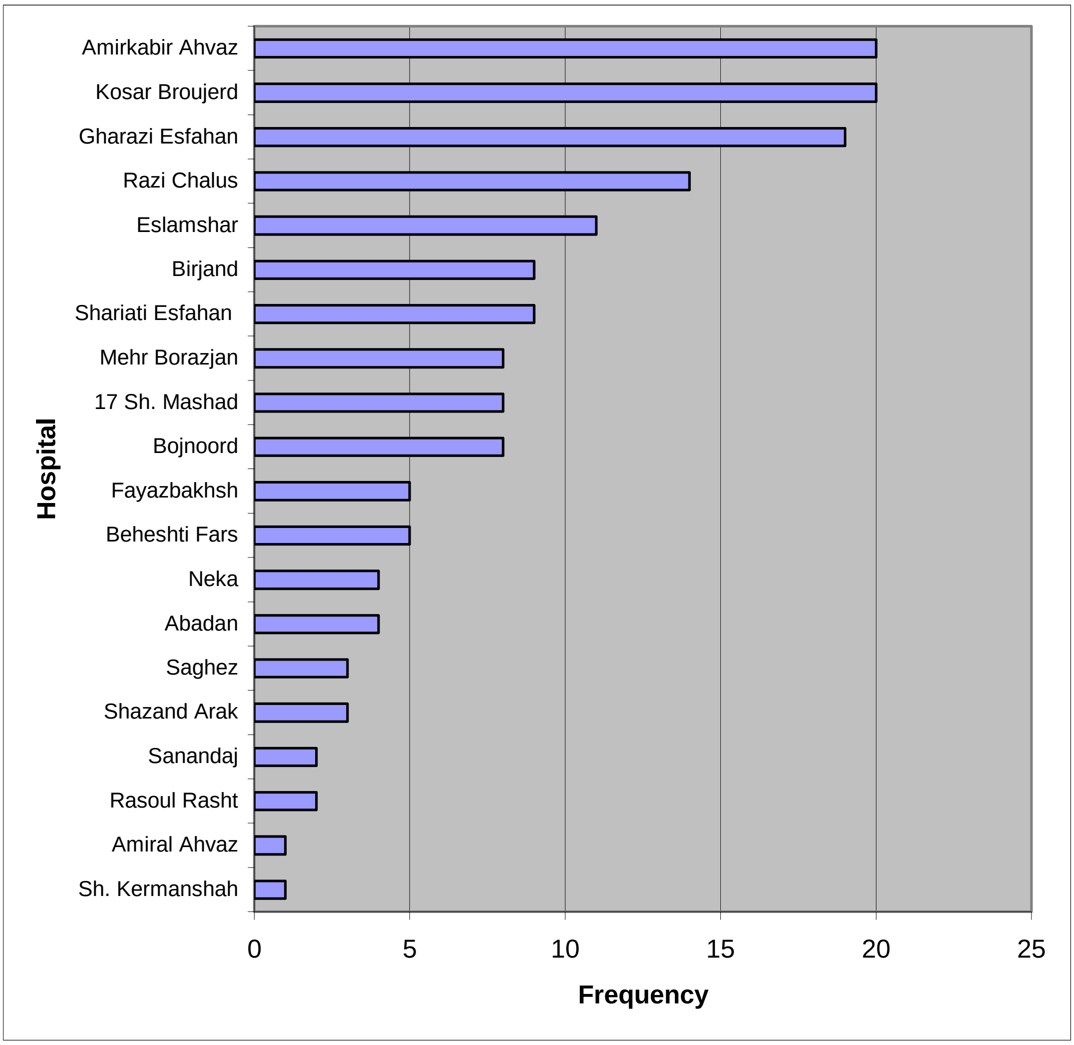

Figure 6.5: Frequency with which the SSO hospitals appear as peers

The identification of the frequency of peers for the SSO hospitals is in line with the results derived from the two previously mentioned approaches in the assessment of efficient hospitals.

Gonbad Golestan and Kashani Kerman are not peers for any other inefficient hospitals. This is consistent with these two hospitals being weak efficient hospitals (slack positive) with very low super efficiency scores (Table 6.11). Examination of performance ratios has shown that, for both these hospitals, the number of outpatient visits per doctor is very high while the proportion of major surgical interventions is very low and they have a low number of emergency visits per doctor, indicating an exceptional performance on only one aspect. By omitting the number of outpatient visits from the set of variables for all hospitals running DEA, the efficiency scores for Gonbad Golestan and Kashani Kerman would drop substantially to 61.8 and 57.8 respectively. This critical analysis underlines the importance of interpreting DEA results cautiously. Similar results were obtained for some other hospitals with low super efficiency scores and positive slacks. For example, Sh. Kermanshah can be regarded as a peer only for one hospital.

On the other hand, AmirKabir Ahvaz, and Kosar Broujerd have acted as peers most often. These hospitals are well performing units in several areas, including the major surgery ratio, outpatient visits, caesarean section operations, and emergency visits per doctor. For example, AmirKabir Ahvaz has a very high rate of outpatient visits per doctor, and the highest proportion of major surgical interventions to all surgical procedures across all SSO hospitals. Emergency visits per doctor for this hospital are at an average level, and the caesarean section rate is less than average. Similar figures can be shown for Kosar Broujerd (Table 6.12).

	Proportion of major surgical interventions to all surgeries	Outpatient visits per doctor	Emergency visits per doctor	Proportion of caesarean section to all deliveries
AmirKabir Ahvaz	82%	8,380	952	25%
Kosar Broujerd	53%	4,152	1,397	22%
Average (across all SSO hospitals)	**34%**	**4,247**	**972**	**44%**

Table 6.12: Comparison of different areas of performance for two high-ranked efficient hospitals

To sum up, the analysis of efficient hospitals using alternative approaches provided in this section (section 6.4.3) has demonstrated that the results do not vary when a range of different methods is used.

6.4.4 Sample classification; adjusting for HDI values and size

As discussed earlier in this chapter, homogeneity is a crucial issue in any hospital efficiency measurement using DEA. This is because of the nature of this method in which efficiency is measured based only upon the value of inputs and outputs, ignoring a set of factors including ownership, size, market structure, mission, payment system, burden of diseases, and population needs which can affect efficiency scores. Because of their impacts on hospital efficiency, these factors need to be recognized and controlled to the extent possible.

In section 6.2.1.1, I reported that SSO hospitals are homogenous with respect to a number of factors, including ownership, service orientation, profit status, hospital financing, payment system, and other legal and regulatory frameworks. There are, however, two major sources of potential confounding environmental and institutional factors, namely socioeconomic status and the relative needs of different populations (proxied by Human Development Index values), and hospital size (proxied by the number of beds). These factors are discussed in sections 6.4.4.1 and 6.4.4.2 respectively.

Before analysing these factors in more detail, it should be noted that pooled data were used to control differences in population needs and hospital size. Using pooled data can provide a common scale for measuring efficiency which is useful for examining whether or not the efficiency scores of various groups are different. Using this approach assumes that all hospitals are being compared with the same production technology and as a result with the same frontier.[284] For the purpose of this study, the approach seems fairly reasonable, because all SSO hospitals, as pointed out earlier, are similar in terms of organisational factors which could affect hospital production frontiers. Furthermore, due to the relatively small sample size in relation to the number of variables, the classification of hospitals to different subsets may result in a high proportion of efficient hospitals. This low degree of discriminating power of the analysis can adversely affect the comparison of different subgroups.

6.4.4.1 Impact of Human Development Index (HDI) values on efficiency

Dividing the SSO hospitals into two groups, located in the high and low HDI value regions (more and less than average), Table 6.13 thus compares the technical efficiency scores of hospitals performing in different operating environments.

	Hospitals in high HDI value regions (n=29)	**Hospitals in low HDI value regions (n=24)**
Mean efficiency scores	91.94%	81.67
Standard Deviation	13.2	19.79
Min	58.15%	35.17%
Max	100%	100%
Hospitals on frontier (%)	54%	25%

Table 6.13: Comparison of efficiency scores for hospitals located in high and low HDI value regions

As shown in Table 6.13, compared to the low HDI value group, the high HDI value group was found to have higher efficiency scores. The Mann Whitney test has shown that the difference between these two samples is significant at the 5% level. Of 29 hospitals in the high HDI value group, 54% were found to be operating on the frontier, compared to 25% of hospitals in low HDI value regions. In high HDI value provinces, approximately 60% of all SSO hospitals are performing at 95% of the full efficiency or better, whereas in low HDI value provinces around 50% of hospitals are performing at 80% or less. In the following, I attempt to identify the main underlying factors contributing to this result.

Firstly, The HDI values, to some extent, can reflect underlying needs for hospitalization, influencing separation rates and the complexity of services provided by hospitals. This requires different mixes of health services which may influence hospital performance.

Secondly, provinces with high HDI values generally include larger cities (Tehran, Khuzestan, Fars, Esfahan, Mazandaran, etc). As a result, the SSO hospitals in these areas are located in larger cities compared to the hospitals located in low HDI value regions. This may affect hospital performance by providing a higher level of competition, as larger cities have many more hospitals including hospitals owned by the Iranian Ministry of Health and the private sector.

Thirdly, provinces with high HDI values are generally more attractive for experienced staff including managers and technical staff. For example, doctors or nurses prefer to work in hospitals located in Tehran, Fars, Esfahan, etc. This can lead to the more efficient use of existing resources – but perhaps at the expense of equity. A similar argument can be applied to hospital managers, where generally young and inexperienced managers are appointed to run the hospitals located in the low HDI value provinces.

Finally, during the past few years, although efforts have been placed on providing the various types of inputs required for undertaking complicated procedures in low HDI value regions, people still wish to be referred to larger provinces and regions. This can affect the number of major surgical interventions (which is included in the set of variables for the present study) leading to the lower efficiency scores.

Substantial investigations are needed to analyse the role of the above factors that are beyond the scope of this thesis.

Due to the significant difference between the efficiency scores, the above results lay more emphasise on the excess inputs reduction for the hospitals located in the low HDI value regions to make them efficient. However, it should be stressed that in the resource allocation processes, efficiency is usually not the only criterion favoured by society and policy makers and the other important objective is equity.[285] It has been argued that both objectives (equity and efficiency) should be met concurrently in the allocation of health care resources in order to improve population health status and reduce inequitable access to health care services.[286] However, this is not always a straightforward task. The trade-off between efficiency and equity has been well documented in the literature.[287] For example, providing the same access to the high technology equipment for people living in remote areas as in big cities may be equitable but is unlikely efficient. Another example which would be contradicting the equity is to reduce the number of medical staff (for example specialists), or the number of beds in hospitals located in the low HDI value regions to make them efficient, despite the results presented in this section pointing in this direction. Hence, hospital efficiency improvements should be attempted with consideration of equity and health care needs of the community in the target area.

6.4.4.2 Impact of hospital size on efficiency

In addition to the impact of environmental factors, there are institutional factors such as hospital size which can affect hospital performance[288,289] (see also chapter 5, section 5.4.1 for more detail). To compensate for this effect, I divided the SSO hospitals into three groups, namely small with fewer than 100 beds, medium with between 100 and 200 beds (inclusive), and large with 200 or more beds.

Table 6.14 shows the association of efficiency scores and hospital size. As can be seen in table 6.14, hospital size does not seem to be an influential factor on the efficiency scores of large and medium sized hospitals. However, the average efficiency score across the small hospitals is different from that of the medium and large sized hospitals, being highest among the three subsets. Although the Mann-Whitney test has shown no significant differences between small hospitals and other groups at the 5% level, the small-sized hospitals do have an apparent 8% to 9% net efficiency gain over large and medium sized hospitals respectively. Furthermore, hospitals in the small group had the highest percentage of hospitals on the efficiency frontier, followed by the large group (44%) and then the medium-sized group (33%).

	Small hospitals (n=20)	**Medium hospitals (n=24)**	**Large hospitals (n=9)**
Mean efficiency scores	92.98%	83.51%	84.73%
Standard Deviation	10.49	20.61	17.17
Min	65.64%	35.17%	58.4%
Max	100%	100%	100%
Hospitals on frontier (%)	50%	33%	44%

Table 6.14: Comparison of hospitals' size with their efficiency scores and returns to scale status

It is worth noting that this finding is consistent with the findings of two other studies using pooled data in which the small hospitals had the highest average efficiency score.[290,291] However, in both those studies average efficiency increased with decreasing size. In other words, both studies have found a higher average efficiency for medium sized hospitals compared with large sized hospitals. Table 6.14, however, suggests a higher mean efficiency score for large hospitals, though not statistically significant.

The plot chart can provide a better view of the relationship between bed size and efficiency scores (Figure 6.6). The plot chart indicates that efficiency scores in small sized hospitals are very high, but they become lower as hospital size increases to around 100 to 200. Thereafter, efficiency scores trend higher when hospital size goes up so that the two largest hospitals are deemed to be efficient. This implies a partial U-shaped relationship between hospital size and efficiency scores.

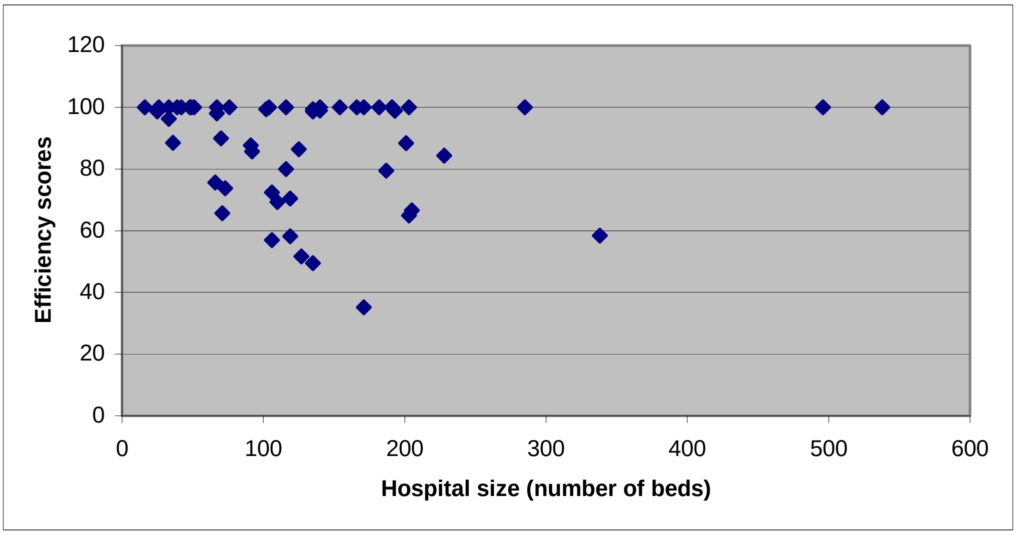

Figure 6.6: Hospital size and efficiency scores

The findings of this study have revealed that, except for one hospital (Beheshti Kashan), all SSO hospitals with more than 250 beds lie on the frontier. Analysing the data in more depth in the subset of large hospitals reveals that in this group, Beheshti Kashan with 338 beds has the lowest efficiency score (58.4%). In almost all aspects of performance analysed in this study, Beheshti Kashan can be considered as a low performing hospital. More interestingly, this hospital has the highest proportion of beds per 1,000 insured persons among all the SSO hospitals (see chapter 5, Table 5.3). The observed inefficiency score may possibly be due to resource mismanagement, excess (and perhaps unnecessary) resources in relation to the population needs in target area (needs and resource mismatched), the location of hospital which is very close to hospitals located in Esfahan, or the combined effects of factors aforementioned. This is only speculation and should be investigated further. It should be stressed that it is possible that hospitals use extra resources in providing higher quality services. Although, the present study has tried to include variables reflecting quality, due to constraints in the available data, still more quality variables need to be used in the analysis to investigate the above issue thoroughly.

6.5 Concluding remarks

In this chapter, an efficiency assessment of the SSO hospitals in Iran was carried out using DEA. This is the first systematic attempt to examine the efficiency status of the health sector in this country using DEA. The analysis has provided SSO hospitals' relative technical and scale efficiency scores, the aspect(s) in which the hospital is weak, target setting (i.e. the amount of input and output levels which would render a hospital relatively efficient), and a ranking of efficient units. Given the impact of the variables used on the results, this chapter has also contributed to the existing DEA literature by providing a full discussion on sensitivity analysis in order to select the appropriate set of variables for measuring SSO hospital efficiency.

Rather than providing only an interpretation of the DEA results, this chapter compared the results obtained from simple ratio analysis (chapter 5) and DEA findings. This analysis has provided insight into strengths and limitations associated with DEA as well as into the practical usefulness of the information obtained from DEA analysis. In this regard, the following points should be noted.

Firstly, it was revealed that DEA is a useful tool in assessing hospital performance, particularly when the results obtained from simple ratios are inconsistent. For example, looking at different ratios such as outpatient visits per doctor, the Lasso diagram, and the proportion of major surgical interventions for some hospitals (such as Khalij) suggests different perceptions of performance assessment (a good performing hospital on some ratios but a poorly performing hospital according to others). In these circumstances, simple ratio analysis fails to give an overall performance characteristic of the hospital. DEA, however, takes into account all inputs and output levels, simultaneously providing an overall indication of the efficiency.

Secondly, hospitals with a fairly evenly good performance in different aspects (such as AmirKabir Ahvaz and Kosar Broujerd) were rated as efficient units, or achieved very high efficiency scores. This can be regarded as a relative advantage of DEA over simple ratio analysis in which the multi-product nature of hospitals is not adequately taken into account.

It is important to make clear that, in addition to the above-mentioned advantages, my analysis, like any empirical study, is subject to the following limitations. These limitations emphasize that the DEA results should be interpreted with care. The DEA results should be regarded as a starting point for measuring SSO hospital efficiency, and can lead to further investigation to identify why there are differences in performance.

First, in respect of relatively efficient hospitals, the comparison of the two techniques (DEA and simple ratio analysis) revealed that hospitals with an exceptional performance on a single output-input ratio (such as the number of outpatient visits per doctor for Gonbad Golestan and Kashani Kerman), achieved very high efficiency scores. This analysis indicates a major DEA drawback in which all weights are placed on only one subset of variables. This can be regarded as one of the limitations of my study posed by the method used (DEA). This can be solved by applying appropriate weights to the inputs and outputs. However, in the absence of the information on the relative importance of different aspects of hospital performance, the specification of weights is not a straightforward task.

Given that DEA has a drawback in terms of placing all weights on an individual ratio with an exceptional value, and considering the weaknesses of ratio analysis such as its inability to summarise the overall performance characteristics of a DMU (hospital in my thesis), simple ratio analysis and DEA should be regarded as complementary tools in assessing hospital performance and not as methods that can be replaced by each other.

Second, DEA is not a statistical technique, which means there is no way to take account measurement errors. This makes it sensitive to measurement errors, i.e. overestimation or underestimation of inputs or outputs. Outlying hospitals can distort the shape of the frontier influencing the efficiency scores of all hospitals under assessment. I presented a number of actions taken by the SSO to improve the reliability of the data used (see chapter 5, section 5.4). I have also used another approach to estimate the possible effects of measurement errors on the results obtained. I measured efficiency scores before and after excluding the outliers. I found a strong positive agreement between the two, suggesting little impact of possible measurement errors on my findings.

Third, DEA only measures hospital efficiency relative to the performance of the hospitals that construct the frontier. This suggests that, any changes in hospitals in the sample can affect the efficiency scores and ranking of other hospitals. Thereby, it is not legitimate to compare the efficiency scores derived from this study with other studies using a different sample.

Fourth, the DEA results are very sensitive to the input and output variables used. I provided an extensive sensitivity analysis (using validity and pragmatic criteria, and qualitative methods) to select the most appropriate set of variables amongst the various sets proposed.

However, due to data constraints, the results should be interpreted cautiously. Hospital efficiency analysis using variables reflecting different aspects of hospital performance, more accurate procedural complexity, the complexity of non-surgical interventions, and the quality of care, could yield more valid results. As an ongoing research project a reworking of the analysis to take account of these complexities would be the next step. However, as is the case in most situations, the data were not available for the SSO hospitals. I was also unable to employ a full range of input variables including capital. I used the number of beds as a proxy for capital input variables as has been done in a number of studies. However, it should be acknowledged that this variable cannot fully reflect capital input.

Finally, hospital managers usually make allocative decisions on the basis of the cost and not the quantity of inputs. An example for this would be the substitution of doctors with less expensive trained nurses. From this point of view, the inclusion of the cost of inputs to measure efficiency is logical. However, data on the cost of inputs were not fully available.

These limitations recall for a strong revision and enhancement of the SSO hospital database to generate information for monitoring a fuller range of hospital functions such as preventive care and health promotion programs, quality of care, and input variables, including cost of inputs and capital inputs. The above limitations also underline the necessity for reforms in the DEA framework.

Despite these limitations, DEA results provided insight into SSO hospital performance by increasing understanding of SSO hospital efficiency. However, the results fail to provide a comprehensive picture about factors affecting SSO hospital efficiency and options for actions to improve this efficiency. This is the issue that will be examined in more depth in the next chapter.

CHAPTER 7

FACTORS AFFECTING SSO HOSPITAL EFFICIENCY AND REMEDIAL ACTIONS TO IMPROVE THIS EFFICIENCY

Chapter overview

The purpose of this chapter is to analyse the different factors affecting SSO hospital efficiency, and to identify remedial actions to improve this efficiency.

In chapters five and six, the relative efficiency of the SSO hospitals was examined using both simple ratio analysis and DEA respectively. Although the information derived from those chapters is useful in terms of providing an insightful view regarding "how big is the difference in efficiency amongst the SSO hospitals", it does not provide a complete picture about factors responsible for differences in efficiency measurement. This recalls a number of other objectives proposed for the present study (see chapter 2, section 2.7). These objectives are health professional perspectives "in analysing the factors affecting SSO hospital efficiency", and "in identifying options for actions that would make an inefficient hospital more efficient". To achieve this, qualitative methods are required to answer questions such as "what are the possible influential factors on SSO hospital efficiency? how do these factors affect hospital efficiency? and what are useful remedial actions to improve efficiency?". The objectives mentioned provide a basis for exploration of a number of issues surrounding hospital efficiency which will be discussed in this chapter. The intention is not to verify or test any prior hypothesis, but instead to explore and develop an in- depth understanding of a particular concept within a particular context.

I used in-depth interviews with key informants to explore how the concept of efficiency is understood by SSO and MOH health professionals, and their views on factors affecting SSO hospital efficiency, and remedial actions to improve hospital efficiency. As well, I took this opportunity to examine the validity of my DEA findings, exploring key informants' views on the variables used in estimating efficiency scores, and the extent to which they agreed with my estimated efficiency scores and with my identification of the benchmark hospitals. The validity of DEA findings was covered in chapter 6, section 6.3. In this chapter (chapter 7), the focus is on the concept of efficiency, factors affecting efficiency, and remedial actions. In meeting the above objectives, the understanding of health professionals involved in the SSO health system about the national and local health services situation in order to identify the factors affecting SSO hospital efficiency and different options to improve hospital efficiency will be presented. To provide a comprehensive picture, managers at hospital and provincial levels were asked for their insights into the local health systems, and SSO health professionals and policy makers were asked about factors affecting efficiency and options for actions at the national level. This knowledge is potentially useful for other agencies and organisations providing hospital care for the Iranian people (such as the Iranian MOH), and possibly for other countries at a comparable stage of socioeconomic development such as Jordan, Saudi Arabia, Syria, Morocco, Bahrain, and Qatar.

This chapter is organised as follows. Section 7.1 will discuss the appropriateness of qualitative methods in meeting objectives determined by my present study. Section 7.2 will describe the method used in more detail, including the sampling strategy, data collection, data analysis, and validity of the results. Section 7.3 will present the findings. Concluding remarks will be presented in section 7.4.

7.1 Selection of qualitative method

In general, data can be collected employing quantitative and/or qualitative methods. This does not imply that these methods should be considered as opposites. In many cases quantitative and qualitative approaches play complementary roles.[292] Qualitative methods can play an important role to assess the validity of findings derived from the quantitative studies, and to pose questions for which a fundamental understanding of nature of efficiency, and local factors influencing hospital efficiency is needed. By using qualitative methods, the present study aims to provide a meaningful interpretation of findings from the quantitative work.

The results obtained from simple ratio analysis and DEA (presented in chapters 5 and 6) are valuable in identifying hospitals which are deemed to be technically efficient or inefficient, and the magnitude of the inefficiency, from which should flow insight into how to improve hospital management, and mobilize additional resources. Yet, there are numerous areas of hospital efficiency measurement where providing meaningful interpretation of findings is essential. For instance, the quantitative component of this thesis did not include individual or social factors possibly influential in hospital efficiency, as they are difficult to measure or scale by numerical values. The issue, however, is critical, because without knowledge of factors affecting hospital efficiency, the possible options to improve efficiency cannot be explored in any depth. I argue that qualitative methods are appropriate to examine the above issues.

Many of the merits of qualitative methods are now well recognised by health professionals.[293,294] These methods describe and explain data in an identifiable local context. They are useful for exploratory research when relevant information is unknown or cannot be easily collected through quantitative surveys, or when researchers want to reveal the importance of context, culture, and local factors. One of the main focuses of the present study is to analyse the factors affecting SSO hospital efficiency. Literature review has revealed the impact of different social, political and individual factors, local market structure, and organizational factors on hospital efficiency (see chapter 2, section 2.4 for more detail). A qualitative interview approach is appropriate, as, in achieving the above objective, considerable knowledge of local factors is required. Insight into the factors influencing hospital efficiency could be obtained by asking key informants involved in the local context to provide information on issues which could not be covered by the quantitative methods used in this study.

7.2 Methods

7.2.1 Sampling techniques and sample size

Samples in qualitative methods are usually purposive to allow a realistic pursuit of information.[295] Information-rich participants (key informants) are selected to provide relevant information about an area of research. There are several different techniques for purposefully selecting information-rich participants.[296] The present study uses two main techniques, namely a direct selection technique, and snowballing. Both techniques serve the purpose of identifying participants who have rich information about hospital management in general and SSO hospitals in particular.

The first technique is about a deliberate and direct choice of participants. It means that the researcher selects those participants who s/he thinks will provide the best and most relevant information. Using this method the researcher aims to get high quality descriptions of each issue under study.[297] For the present study, the criteria for inclusion included the extent of knowledge and experience with SSO hospitals (or at the national level), and the level of involvement in related departments in the SSO health system and the Iranian MOH (i.e. in departments related to hospital performance assessment). Before starting the present study, I was heavily involved in the SSO health system, and so knew most of the key informants. Hence, purposive sampling was employed in this study as it increased the range of data that could be discovered.[298] To cover the full range of health professionals, I decided to select some knowledgeable professionals at various levels of the SSO health system. These levels were policy makers, senior experts, mid-level managers, physicians, and hospital administrative staff.

Amongst the policy makers, key informants who are involved in the SSO health system at national level were selected. They were selected because they constitute the key decision makers for the SSO health system, and their perspectives can heavily affect the possible future policies related to remedial actions for efficiency improvement. At the expert level, a number of senior personnel involved in Direct Service Provision (SSO Hospital Performance Assessment Department including clinical and paraclinical affairs) were identified. This group is important because they are aware of different factors affecting SSO health care and hospital performance. Furthermore, such experts play a key role in helping policy makers to develop possible future polices. It was expected that these two first-mentioned groups would be able to provide information at a national and (to a lesser extent) local level. These policy makers and experts based in Tehran can be regarded as important participants, because of the great deal of centralized decision making regarding hospital performance in the SSO health system. However, due to the importance of the local factors leading to inefficiency and local options for actions for improving efficiency, these local factors were also explored in more detail. This was achieved by involving mid-level managers. Thus, SSO hospital managers, physicians, and hospital administrative staff were identified based on the location of hospitals and efficiency scores obtained from the DEA analysis (chapter 6). According to HDI values related to each province (high, medium, and low) and different levels of efficiency scores (low: <50%, Medium: 50%-75%, and high: 75%-100%) six hospitals in different provinces were selected and their SSO hospital managers, physicians, and hospital administrative staff were identified (Table 7.1). This sampling strategy increased the opportunity of collecting a full range of information about factors affecting efficiency and remedial actions to improve efficiency.

After identification of the initial group of respondents, and in order to provide a more comprehensive picture, the present study adopted another sampling technique, namely snowball sampling whereby the key interviewees were asked to provide names of other key informants.

Hospital	Level of efficeincy score	Level of HDI value
Gonbad Golestan	High	Medium
Rasoul Rasht	High	High
Hedayat	Medium	High
Sahrkord	Medium	Low
Sabalan Ardabil	Low	Medium
Alborz Karaj	Low	Medium

Table 7.1: Hospitals selected for the qualitative phase

Using the above-mentioned sampling techniques and adopting the concept of theoretical saturation, 11 in-depth interviews and one focus group discussion were conducted. It has been argued that the usefulness of qualitative research is based more on the information richness of the cases selected and the capacity of the researcher to observe and analyse them than on sample size.[298] The total number of participants is mainly based on an important methodological issue in qualitative methods, namely theoretical saturation. Theoretical saturation is a concept that considers the collected data as sufficient when further interviewing ceases to provide new information and repeats what has been reported by one or more previous key informants.[299] Using different methods of data collection (in-depth interviews and focus group discussion (see section 7.2.2), a degree of data saturation was achieved through the 11 in-depth interviews and one focus group discussion. The focus group consisted of eight key informants including two participants (one senior expert and one hospital manager) who were interviewed separately. Data saturation was reached where no new data was being identified from the last three interviews, and nothing substantially new was added to what had already been collected.[300] For this reason, I was satisfied to work with the data from the in-depth interviews and focus group discussion with those 17 key informants who had firsthand experience with the phenomenon under study.

All participants were full-time members of either the Iranian SSO or the MOH. Because of their extensive involvement in the SSO and the Iranian health system, and also their valuable experience in monitoring hospital performance, they could be expected to be able to provide information on the current state of SSO hospital efficiency.

7.2.2 Methods of data collection

To gather qualitative information on factors affecting SSO hospital efficiency and remedial actions to improve hospital efficiency, two data collection methods were selected. Adopting two (or sometimes more than two) methods in data collection is in accord with the methodological strategy of triangulation, in which the use of multiple methods, multiple data sources, and multiple perspectives for data collection can overcome the partiality of relying on data from one source and method.[301,302] The rationale behind it is that, if one collects data through individual interviews, as well as observation, then one can present a more comprehensive perspective on the research questions. Triangulation is a way of validating the findings. Adopting this concept, the present study used a methodological triangulation by undertaking semi-structured interviews as well as focus group discussion.

7.2.2.1 Semi-structured interviews

Qualitative individual interviews are well suited to exploring questions in the human services which relate to the meaning of experiences.[303] Interviews are deemed appropriate for this component of the study, as they allow rich descriptive data to be collected.[304] A semi-structured interview technique tends to minimise the formulation of specific questions. This allows the investigation to proceed in an open-ended manner, drawing upon in-depth individual perspectives on factors affecting hospital efficiency and remedial actions. By following a semi-structured interview format, the researcher has flexibility to probe particular issues recognised as being crucial to the study, ultimately providing a holistic understanding of the interviewee's point of view.[305] Through the use of semi-structured interviews and open-ended questions it becomes possible to deepen the participants' self-exploration in an effort to limit interviewer bias.

7.2.2.2 Focus group discussion

A focus group interview was conducted with eight key informants (including an MOH expert, SSO experts, SSO hospital managers, and hospital administrative staff), to obtain their assessment of the issues. The focus group technique is a semi-structured, person to group interview, which aims to explore a specific set of issues and themes.[306] It is a tool for collecting qualitative data from a group's perceptions, attitudes, and experiences on a defined topic. Focus group discussions can reveal the consensus and diversity of participants' experiences, preferences, and assumptions. They also allow group interaction so that participants are able to build on each other's ideas and comments to provide an in-depth view that is not attainable from individual questioning. In focus group discussions, all interviewees have an opportunity to hear each others' responses modifying their own opinions, and making additional comments which are not possible through individual interviews. These interactions between participants can enhance data quality.[307] Although focus group discussions can provide some new information, for the purpose of this study, the comparison of the individual and focus group interviews is used as the basis of triangulation. This means that the main aim of the focus group interview is not to gather new information. Rather, the focus group interview is used to clarify themes that have already emerged and to check with participants that these issues are representative of them as a group. This increases the validity of the findings.

7.2.2.3 Interviews and group discussion procedure

At least three days before the interview and group discussion, each interviewee was given an information package. This package contained an introductory letter (including the main themes of the interview), information on the study (a brief review of the study including the background, the method used, the general description of different sets of variables proposed for the analysis, and a brief presentation of the DEA results), an information sheet for participants (Appendix B), and the standard consent form (Appendix C).

All interviews and focus group discussion were conducted by myself. They were conducted after obtaining written consent from each interviewee. A copy of the information sheet was left with each participant. All interviews were conducted in the SSO headquarters building or in an SSO hospital. All interviewees appeared to be relaxed, and willing to share their perspectives. All participants also consented to the use of a tape recorder. I did not gain an impression that any interviewee was unwilling to share his or her ideas because of the recording. For individual interviews, each participant was interviewed once for approximately 50 to 90 minutes. The focus group discussion took an hour and half which is deemed appropriate.[5] All interviews were completed in about two months which was consistent with my original timeframe.

To ensure that all relevant topics were covered and that similar information was obtained from a number of people by covering the same material, an interview guide was developed prior to my fieldtrip (Appendix D). Questions in this guide were open-ended. The guided interview method was chosen because its semi-structured nature allows for common themes to be addressed with each participant whilst simultaneously allowing freedom to follow up issues of interest arising in a particular interview situation. Such a method facilitates deep investigation of issues and offers individuals an opportunity to express perspectives on issues of personal priority. According to the interview guide, four main themes were covered, namely the interviewees' understanding of the concept of efficiency, the validity of findings obtained from DEA analysis (discussed in chapter 6, section 6.3.4), key factors affecting SSO hospital efficiency, and remedial actions to improve hospital efficiency.

In this chapter, three themes, namely SSO health professional's perception of efficiency, factors affecting SSO hospital efficiency, and remedial actions to improve SSO hospital efficiency are explored. The participants were asked broad questions and encouraged to respond in a narrative form. Each interview began by exploring how the concept of efficiency was understood by the participant (When you think of efficiency, what comes to mind?). This was because my study is the first systematic attempt in health care efficiency assessment using DEA in Iran, and thus the participants are unlikely to have been exposed to the use of frontier-based techniques for the assessment of efficiency and productivity. After exploring the validity of the DEA findings (discussed in chapter 6), the interview then continued by analysing two other themes; the main factors affecting hospital efficiency, and remedial actions that would make an inefficient hospital more efficient.

With each participant I referred to the interview guide that I had developed. Subsequent questions were derived from the participants' responses. However, the aim was to allow participants to express their perspectives in their own words. Participants were told that the list of question was a guide and that they were free to discuss the aspects of the research questions that they found interesting or relevant.

7.2.3 Data analysis

Preliminary analysis began concurrently with the data collection on the night immediately following each interview. This was done by reading the notes that I had written during the interview. These notes pointed to the main issues and concerns raised by interviewees about the questions. This provided me with a better view to address any misinterpretation of questions asked and interviewees' concerns about particular questions. After initial data analysis, all responses were transcribed by myself in the original language; Persian. Due to the cross language nature of the present study, the initial transcription to the original language can improve the accuracy of transcribed materials.[308] The accuracy improved by returning all transcriptions including some unclear points (from my point of view) to the interviewees, asking for their final commentary on the data collected, and thereby confirming that I was actually presenting their real ideas. After this phase, I then translated all these materials into English. With a clear identification of the objectives of the qualitative component of my research, pre-existing categories and units of analysis had been identified in order to develop an analytic framework.[309] Using this framework, the research is able, as Streubert et al[310] have pointed out, to recognise patterns and relations in data.

The process of data analysis for the present study included the following steps. Firstly, all interviews were transcribed and identified by a code number only. References to the names of other persons were omitted from transcripts, with only initials appearing in the transcripts.

Secondly, according to the research objectives, four main categories were identified, namely how the concept of efficiency is understood, the examination of the validity of findings obtained from the DEA analysis, factors affecting SSO hospital efficiency, and remedial actions that would render an inefficient hospital efficient. Then, the complete collection of transcripts was first read in its entirety to gain an overall impression with respect to the research objectives.

Thirdly, transcripts were re-read and areas of texts were identified as relating to each of the main categories. Using Microsoft Word, this part of the text was then "cut and pasted" under the title of that category (for example, factors affecting SSO hospital efficiency) in separate sheets. To facilitate the data analysis, I decided to classify the data in another fashion as well. At this stage, the relevant text in each of the main categories was classified according to the different level of the participants; i.e. policy makers, senior experts, mid-level managers, and hospital administrative staff. This was useful as I found variations in responses from participants at different levels. For instance, experts differed from mid-level managers in how the concept of efficiency was understood.

The final step of the data analysis was to code the text. In this step, I applied short descriptions to each relevant part of the text in each main category. For example, under the title of factors affecting hospital efficiency, several participants referred to the current payment system (PAY) as a factor which negatively impacts SSO hospital efficiency. Similarly I applied the code HOS.B to current hospital budgeting as another factor influencing hospital efficiency which was pointed out by some participants.
It is worth noting that because of the clear definition of the different categories, the clear questions asked, and the level of knowledge of the participants (all highly educated persons), I did not have any serious problem in identification of texts related to each category nor in coding the text. For example, almost all participants were familiar with conceptual issues with respect to factors affecting hospital performance, and some of them classified very clearly the factors, which was very helpful in coding at this stage.

7.2.4 Validity

This qualitative study used different approaches to improve the validity of the results. While the research methods and findings have been explored, it is also crucial to evaluate the quality of the qualitative research, reflecting the extent which the results obtained are trustworthy. To assess the validity of the findings from a qualitative study, various suggestions have been discussed in the literature.[311,312] The following methods for enhancing the research validity or trustworthiness of the findings were built into the present study:

- ✓ Triangulation: this is an approach that contributes to the validity of qualitative research using multiple methods, sources of information, and/or researchers.[313] There are different types of triangulation.[314] In the present study, I employed two types of triangulation:

    - o Methodological triangulation: the data were collected using different methods, namely individual interviews and focus group discussions.

- Data triangulation: A range of perspectives was gathered from multiple information sources (policy makers, senior experts, hospital managers, and hospital administrative staff) so as to gain a more comprehensive picture of the issues under scrutiny.

- ✓ Member checking or respondent validation: during the interview, at the end of each section, I restated and summarised what I had heard. This method can help researchers ensure that what they are hearing is correct. I also used another strategy to enhance the validity of the findings. Following data collection and transcription, I reported back the manuscript and related categories to the participants, asking for their final confirmation. I also asked for their final comments clarifying some points that, from my point of view, were unclear. The participants verified the manuscript and the categories matched their answers. Both methods can improve the accuracy of the data obtained.

- ✓ Using disconfirming evidence: this method consists of searching for conflicting data, including them in final report. The inclusion of conflicting data that run contrary to most findings may enhance the validity of the data collected. Although not much conflicting data were found in my study, there were a few examples, including participants' conflicting views on the relationship between cost sharing and hospital efficiency, and on the understanding of the concept of efficiency.

7.3 Results

The results of the analysis of the data have been separated into two parts. The first part (section 7.3.1) documents participants' experiences and knowledge of different themes and related questions, often in their own words. This stage mainly concerns the description of the data. The second part (section 7.3.2) consists of synthetizing the findings, and develops some ideas arising out of the data looking for similarities and differences in the responses in more depth.

7.3.1 First part: Description of the results

7.3.1.1 Concept of efficiency

According to the research objectives, I was interested to know how the concept of efficiency is understood by health professionals and policy makers in the SSO and MOH. Participants defined efficiency from several perspectives. Policy makers defined efficiency as the ratio of products to resources. Efficiency could be measured based on the levels of products produced and resources used, as attested by the following SSO policy maker:

> *In my opinion, efficiency is about the comparison of products gained and inputs used. To me efficiency is the art of use of the least resources to get maximum products.*

Experts analysed the concept of efficiency in similar ways but in more depth using more technical language. For instance, one of the SSO experts stated:

> *When I think about efficiency, the first thing that crosses my mind is isoquant and isocost curves. I consider a hospital efficient when it has the best mix of inputs leading to the lowest possible cost to produce a given output. Of course I assume that all other things including the quality of care provided is equal.*

The above quotes illustrate that the relationship between resources and products lies in the heart of the policy makers and experts' understanding of efficiency.

Both policy makers and experts defined the main hospital outputs as the number and quality of services provided by hospitals and patient satisfaction:

> *I consider the quality of care as a main product in hospitals. If we provide high quality care, it can eventually lead to the higher level of patient satisfaction. Furthermore, some hospital workloads such as the number of surgeries should also be considered as hospital products.*

Mid-level managers and physicians, on the other hand, defined the concept of efficiency differently. Several mid-level managers argued that to define efficiency we need to identify the organisation's objectives. Then the capacity of any organisation in achieving these predetermined objectives could be considered as efficiency:

To me, efficiency is the achievement of predetermined objectives. In hospitals as main health care providers, the main objective is to provide high quality care. So, efficiency assesses our ability to provide better health care in order to increase the level of patient satisfaction.

Quality features of efficiency was again highlighted by another mid-level manager describing efficiency as follows:

Efficiency can be achieved when we meet hospital objectives which to me are patient satisfaction and very low number of complaints.

In contrast, hospital administrative staff mainly understood hospital efficiency in monetary terms.

I think that efficiency is a subtraction of expenditures and income. If this is positive, efficiency exists. Otherwise we are running our hospital inefficiently. In my opinion, expenditures could be reduced by decreasing the average length of stay, and increasing the bed occupancy rate. …The income can be increased by admitting more patients.

This view has been supported by other hospital administrative staff stressing the role of process and output quantity variables in improving hospital efficiency.

The above descriptive findings have revealed that participants defined efficiency from different perspectives. This issue is discussed in more depth in section 7.3.2.1.

7.3.1.2 Factors affecting efficiency

From amongst the factors affecting SSO hospital efficiency, one of the most strongly articulated (particularly by experts and mid-level managers) was inappropriate medical tariffs and the payment system for physicians. They argued that the current payment system (fee-for service) along with inappropriate medical tariffs can lead to unnecessary referrals. A typical comment provided by an expert in the interview included:

The payment system used to fund physicians is very important because the level of the physician's financial incentive depends largely on the method by which he or she is being paid. The current payment system associated with inappropriate medical tariffs encourages some physicians to *induce patients for more unnecessary referrals leading to the use of unnecessary resources which could have been used for quality improvement.*

This quote refers to the relationship between the payment system and medical tariffs in hospital efficiency. The issue was explored in more detail by another expert:

> *The tariffs that are applied to the SSO hospitals are determined by the government. These tariffs are not appropriate. By inappropriate I mean they are much lower than tariffs adopted by private hospitals. The tariffs are also improperly determined because the difference in values of doing complicated procedures such as hip replacement and minor surgeries is not appropriate. So, these inappropriate tariffs along with the method of payment encourage physicians to do as many simple interventions as possible to earn more. This may not be consistent with the population needs.*

In accord with the above factors, there was an increasing concern among participants regarding the current employment situation in which physicians are allowed to practice in both SSO and private hospitals simultaneously. For example, one of the senior experts described his concern as follows:

> *Several SSO specialists are working in private hospitals as well. Given the existence of the huge gap between public and private tariffs, sometimes 8 times, physicians tend to undertake complicated procedures in private hospitals. Although not all people, many patients accept this offer, because they think that they are provided a higher quality of care in private hospitals.*

Hospital budgeting was another factor discussed by participants. They believed that the current method of SSO hospital budgeting could lead to hospital inefficiency. This issue, however, was explored from different perspectives. For example, policy makers and experts spoke of the role of the current budgeting method in encouraging hospital managers to spend more. The following quote illustrates a typical comment made by one policy maker:

> *Currently we use line item budgets based on past expenditure as the main mechanism for hospital financing. This method encourages managers to spend more, because when they spend more, they can get more. For example, I inspected a hospital three months ago. Based on the statistics provided, I realized that as time goes on the number of day care interventions*

is declining. The main reason for that was the method of hospital budgeting. When patients are admitted, the total expenditure is more than day care, because the hospital can consider the accommodation fee as well. This can finally lead to a request for a larger budget for next year.

The issue was further explored and confirmed by experts:

According to the current SSO hospital budgeting, hospitals are seeking to do the interventions that have a higher value. For example, they tend to do more minor surgeries. They can do a large number of them, because the difference between the relative values of minor surgeries and major surgeries has not been properly determined.

A typical response from a mid-level manager was that:

The administrative staff who are responsible for budgeting only want to cut the budget as much as they can. They only consider a small proportionate increase in the last year's budget which captures the inflation rate with little attention to in-year changes in input prices. They also do not consider the population needs. This insufficient budget affects the quality of care. Furthermore, hospital or provincial managers do not have enough authority to transfer funds between budget headings.

In an attempt to explore the above issue in more detail, I asked hospital administrative staff to comment on the above issue. Participants stated that the main problem with the current hospital budgeting system is the lack of valid and reliable data reflecting population needs.

The SSO Health Department should provide us valid and reliable data to assess the population needs in different areas. When we do not have any data on it, we will allocate the budget only based on the hospital's previous budget adjusted by the inflation rate.

The above quote illustrates that the lack of data reflecting population needs is one of the challenging issues in hospital budgeting, a problem which should be resolved by health professionals.

Experts reflected upon the lack of data on monitoring of physicians' performance as one of the factors influencing hospital efficiency. This was, they said, because the available data only captured physicians' activities at an aggregated level (for example the total number of visits, total number of prescriptions etc.) The data do not reflect the quality of care nor how the pattern of practice can affect the efficient use of resources. For instance, one stated:

> *There is no data showing the extent to which our physicians follow evidence-based guidelines. In fact, based on my experience, variations in physician practice style can be regarded as main causes of the variation in the use of resources leading to inefficiency…. Another factor which can affect hospital efficiency is the method that we use to evaluate physicians' performance. Physicians are currently being assessed only on the basis of the number of services provided, with a little attention to the quality of care, because we do not have any data on that aspect of the performance.*

The above comments on data availability point to a number of areas in the current SSO hospital database which need a thorough review and changes. These areas include the data capturing the quality of care, population needs, physicians' performance measurement at patient levels, and the extent to which evidence-based practice is being followed.

So far, the participants explored various factors (such as the payment system, inappropriate medical tariffs, hospital budgeting, and a lack of data required for planning and performance monitoring) which could lead to hospital inefficiency by influencing those who are involved in managing and in providing health care services such as hospital managers, physicians, and hospital administrative staff. There was, however, another perspective among participants in terms of factors that could increase the number of unnecessary referrals leading to an inefficient use of hospital resources. The prevalent feeling, particularly amongst physicians and mid-level managers, was that the lack of cost sharing is an important factor.

> *Unnecessary referrals to hospitals are another source of hospital inefficiency. Although some managers may stress the important role of physician-induced demand in increasing the number of unnecessary referrals, I think physicians are not always guilty. I think there are other factors which are being missed by policy makers. I think the lack of co-payment is one of the most important factors. All services provided by SSO hospitals are free. For some people going to clinics or hospitals is a kind of hobby. They come to hospitals and clinics for very minor issues.*

From the above quote, it can be argued that some participants particularly those who are directly involved with patients are aware that demand-related factors can play as important a role in causing hospital inefficiency as do supply-related factors.

In contrast to this, one participant had a negative attitude towards the relationship between cost sharing and hospital efficiency:

> *I do not think that the lack of cost sharing is an important factor for unnecessary demands. I think our people care about their health status. So, if we set a small co-payment, the current pattern of referrals will change slightly. But if the level of cost sharing is set high, some genuine patients will not go to hospitals and clinics. This can delay the diagnosis, because it is highly possible that they will not go to clinics or hospitals. Clearly, this is not consistent with the objectives of welfare organisations such as SSO. Furthermore, late diagnoses cost more.*

In lieu of the role of cost sharing, this participant considered another factor affecting patients as follows:

> *I think the lack of a referral system is a factor which needs urgent attention. Patients are free to choose their physicians in the SSO outpatient clinics and hospitals. Most of them prefer to select specialists and sometimes subspecialists for their minor problems. For example, as a specialist I spend 50% of my time seeing patients who could be effectively treated by general practitioners. To me this exactly means the inefficient use of time and resources.*

The above findings represent different participants' views in addressing various factors which can initially affect health care providers (such as the payment system), or patients (such as lack of a co-payment system or the referral system) leading to hospital inefficiency. These organisational factors were most frequently discussed by different participants. There were, however, some perspectives reported by a number of policy makers and experts indicating the impact of characteristics of managers on hospital efficiency:

> *I think hospital efficiency is being deeply affected by the shortage of educated and experienced hospital managers. This is particularly important for hospitals located in small cities or small provinces where only a few experienced managers are willing to work. All hospital and provincial managers are physicians, but the medical curriculum in Iran does not provide any information on health care management issues, principles of health economics, and health*

resource allocation. So how could we expect an efficient use of hospital resources from those who are not familiar with that at all?

In addition to inadequate management qualifications and experience, experts considered poor interpersonal communication skills to be a managerial characteristic influencing hospital efficiency.

The above factor was an interesting point to me, because those who are in charge of appointing managers are pointing to it. So, I asked them why they do not take any action to replace underperformers. The answer to this question revealed another category affecting hospital efficiency, the category that only a few participants were willing to explore, political interferences. These participants have expressed some concern regarding the role of political issues in appointing provincial and hospital managers. For example:

There are many power centres such as local officials and MPs, Ministry of Health, National and Local Councils of Workers that directly or indirectly influence decisions regarding the appointment of managers. Sometimes, we have to consider their choices, because we need their support in the Parliament or other power centres.

In addition to the role of political issues in appointing inexperienced managers, both experts and mid-level managers reflected that overstaffing and location of some hospitals should be regarded as other political-related factors leading to hospital inefficiency.

In our country, the SSO is generally considered to be an affluent organisation. Given the high rate of unemployment in the health sector, the hospitals and clinics owned by the SSO are potentially regarded as good resorts to soothe this issue. So, the SSO is always under pressure by government to employ more health workers including physicians, nurses, and administrative staff. Unfortunately, due to the governmental structure of the SSO, in many cases the government is successful.

Consistent with the above quote, another expert stated:

During elections, one of the most appealing promises made by MPs or local officials is to build a hospital in their region or to expand existing hospital wards. To me it is clear that the development of the SSO health network is not based on population needs. For example, I *remember that when I was inspecting [hospital name], there were only two patients in a paediatric ward with 8 staff.*

In summary, in-depth interviews with SSO health professionals revealed a number of factors affecting SSO hospital efficiency. Some factors influence hospital efficiency by affecting health providers such as the hospital budgeting or payment system. Other factors such as the lack of cost sharing may initially affect patients, increasing unnecessary demands. Apart from these factors, some participants reflected upon managerial characteristics and political interference as factors leading to the mismanagement of existing hospital resources and overstaffing. Development of the SSO health network without much attention to population needs was another area of concern. These factors are classified and discussed in more depth in section 7.3.2.2.

7.3.1.3 Remedial actions

Most participants believed that the rules and regulatory framework and incentives facing health care providers are possibly the most important factors influencing SSO hospital efficiency. This suggests that remedial actions for improving efficiency should focus mainly on the policies influencing these factors. This assumption is in line with the findings where several participants strongly expressed the need for supply-side and regulatory framework reforms. Most often, the participants talked about the necessity of changes in the factors influencing efficiency that they had pointed out earlier in the interview. For example, one participant commented on the necessity for reform of hospital funding and the payment system used to fund physicians as follows:

In order to improve hospital efficiency, we need reforms in different areas. For example, we should change the current hospital financing to prospective financing which is primarily based on diagnosis… The payment system is also another area requiring an infrastructure change. For the payment system, I propose a fixed salary plus bonus instead of fee-for-service. The bonus can be rewarded to those physicians who are doing more complicated interventions.

Another participant commented on the advantages and disadvantages of different payment systems stating that the method of funding physicians needs to be selected very carefully:

Reforms in the current payment system should definitely happen. I am thinking of a capitation system. But I do believe that no payment system is perfect. Each payment system has its own weakness. For example, fixed salaries may encourage low productivity. Or fee-for service may encourage supplier-induced demand. The incentives created under each system should be investigated thoroughly considering the current socio-political environment.

Another factor that was frequently mentioned by participants as a target for a substantial change was medical tariffs. One participant illustrated the point by emphasizing the impact of inappropriate medical tariffs on population health:

We should change the current medical tariffs in order to increase appropriately the gap between minor and major interventions. When physicians compare the risks, time, and resources used for the majority of major medical procedures with their tariffs, they find them unfair. Accordingly, they tend to do minor interventions. This, of course, might not be in line with population needs.

Reform in policies related to the cost sharing and referral system was another area which participants (particularly senior experts and hospital managers) showed a growing concern about it. A typical comment in an interview with a hospital manager included:

I think we definitely need to change our policy in terms of the cost sharing and referral system. I think we should still provide services free of charge for patients who are admitted. But for outpatient visits, I think we should consider a small co-payment. This is mainly based on my personal experience. People think that there is no harm if a doctor visits them for very minor things. I believe that a considerable amount of unnecessary outpatient visits will decrease if we change our policy.

In line with the above quote, another hospital manager made an interesting point:

Last year, we planned to make appointments by telephone for our outpatient visits in our hospital. It is interesting to know that nearly 50% of appointments were cancelled daily. This shows that most people were not in real need to see a doctor. I think a small amount of cost sharing can lead to a decrease in unnecessary visits leading to more efficient use if resources. Furthermore, we need to assign a GP or a skilled nurse in outpatient departments to visit *patients in order to distribute them properly between GPs or different specialities. At present, even with minor abdominal pain, patients want to see a gastroenterologist.*

In addition to the above reforms regarding the funding system, payment arrangements, and cost sharing affecting incentives faced by health care providers and patients, participants also expressed the need for reforms in the current performance measurement criteria and the variables that are collected. As noted by one participant:

> *We are just collecting variables reflecting activity levels in aggregated forms. Having obtained these types of variables, we have little information on quality variables, and the extent to which our physicians follow evidence-based medicine. From this standpoint, our hospital database needs infrastructure changes.*

Another participant, however, had a negative attitude towards changing the hospital database without consideration of the organisational capacity and development as a prerequisite for technological reforms.

> *Such changes in the hospital database will not work. I think for any reform to achieve its objectives, we should consider the capacity of the organisation and their policy makers' views. If we think of changes in the database to capture a broader set of variables, do we have trained experts to know how we can use the variables? What do exactly want from the quality of care? Is the concept of quality the same as thought of by hospital managers, experts, and policy makers? To what extent are our policy makers happy to capture quality of care, when they can show their accomplishments by growing numbers of activity levels? Until we have answered these sorts of questions, we should not think of technological reforms.*

A number of participants (mostly experts) reflected upon managerial issues. Some participants stressed the importance of the reforms in criteria used to appoint hospital and provincial managers. They believed that because of the current SSO organisational structure, the SSO is sometimes forced to accept the recommendations made by political lobbies.

> *From my experience, many managers recommended by MPs or other local officials were not successful in running hospitals. This is because they were only selected on criteria such as being a relative or friend of an official. Most often, they have no experience and knowledge in health resource management. SSO should be run as a real NGO.*

From this quote, it can be argued that the political environment has a great effect on SSO hospital efficiency so that a reform in organisational structure is required.

Some participants stated that the current medical curriculum needs some changes to be more public health oriented.

> *The current medical education system simply ignores all issues related to population health, heath resource allocation, and principles of health economics. The only thing that we never talk about in our curriculum is to increase the value of resources, the concept of opportunity costs, and managerial issues.*

Reforms recommended by participants focused mainly on payment arrangements, the cost sharing and referral system, the hospital database, and managerial issues. These reforms mainly affect the incentives faced by health care providers and patients. There has been, however, another approach to improve hospital efficiency discussed by two senior experts.

The key idea of this approach is to split funder and provider in order to increase the accountability of health care providers. Participants proposing this approach believed that the current socio-political environment does not allow for reforms in different areas (such as regulatory framework and managerial issues) to be carried out separately. They stated that the SSO needs a holistic approach which includes all areas. In this context, one reflected:

> *In my opinion, the only way to improve SSO hospital efficiency is to mimic the structure of private corporations while emphasising the social objectives through SSO ownership. Under this reform, a contractual relationship with hospitals should be set. The hospital, through its managerial board, is given an overall prospective budget cap with autonomy in financial management, personnel delegation, and service planning. The SSO role would be to monitor quantity and quality of care provided by hospitals, patient satisfaction, and the extent to which the hospital will meet social objectives determined by the SSO… This approach may also lead to reduced political interference.*

As this quote illustrates, the participant believes that by providing more competition, giving more authority, and decreasing the role of the political environment, the hospitals will be encouraged to use resources more efficiently. In this case the SSO will be a funder with a great role in monitoring and assessing hospital activities. The issue will be discussed in section 7.3.2.3.

7.3.2 Second part: synthesis and discussion of the qualitative results

This section is an attempt to understand the meaning of the findings described in section 7.3.1. In this section, after reviewing the main viewpoints of the key informants, I present my own deductions from their remarks.

7.3.2.1 Concept of efficiency

The findings of this study revealed that the concept of efficiency was understood differently by participants at different levels. With regard to their understanding on the concept of efficiency, the participants can be divided into three groups: policy makers and experts who described efficiency as “the relationship between products produced and resources used”, mid-level managers and physicians who identified efficiency as “the capacity of the organisation to meet predetermined objectives”, and hospital administrative staff who considered efficiency as “the subtraction of expenditures from incomes.”

Firstly, according to the above findings, the concept of efficiency for mid-level managers and physicians is to meet the objectives without consideration of the resources used. This idea is closer to the concept of effectiveness. This might be in accordance with the criteria by which their hospital performance is currently evaluated by SSO officials. These criteria are rarely based on exploring the extent to which hospitals improve the value of resources, i.e. how well resources are used to produce valued products. If there is any shortage in the hospital budget which might be due to the inefficient use of resources, the gap is covered by SSO officials at the end of the financial year. The managers’ performance is mainly assessed by the level of satisfaction of local MPs and other powerful local managers such as provincial governors and to the lesser extent patient satisfaction assessed by regular inspections and the number of complaints. It appears that this sort of assessment had a substantial impact on the managers’ understanding (and/or expression) of the concept of efficiency.

The above issue is important, because this understanding of efficiency can eventually affect mid-level managers’ approach towards the identification of factors influencing efficiency in their own hospital and the remedial actions they will actually take. The challenging question here which needs to be explored in more depth is why SSO policy makers and experts adopt policies and assessment criteria which encourage SSO mid-level managers to obtain approval from MPs and other provincial managers with little attention to the resources used. This might be due to the influential role of MPs and provincial officials in appointment processes, and to the governance structure of the SSO in which the members of the Board of Directors and the Managing Director of the SSO are appointed by the Minster of Health with approval from the Council of Ministries.

Secondly, from the findings, it could be suggested that the policy makers and experts are generally familiar with a layperson's definition of efficiency, i.e. how well (scarce) resources are converted into products. However, the concept of efficiency defined by them seems to be more about technical or operational efficiency where they defined hospital products as the number of services and/or the quality of services provided by hospitals. Considering their definition of hospital products, it appears that they do not take into account whether or not the outputs produced best accord with the greatest possible amount of health benefits to the population (with the minimum use of scarce resources); the definition of allocative efficiency provided in section 2.2.. Rather, their focus is more on the number of services provided and some individual-based quality variables such as patient satisfaction.

Thirdly, administrative staff defined efficiency as a difference between expenditures and income. This is not surprising as it is consistent with their accounting view background.

The different perspectives of different participants (policy makers, hospital managers, and administrative staff) on efficiency can influence the way that they manage health resources in the hospital setting. These various perspectives can also provide different views on the way that they identify factors affecting efficiency and thus take remedial actions to improve this efficiency.

The results of this study have also revealed participants' various perspectives in defining hospital products. Policy makers and experts believed that the products can have both quality and quantity features. Most mid-level managers agreed that the "quality of care", and "patient satisfaction" should be regarded as main hospital products. Hospital administrative staff, on the other hand, considered hospital outputs in monetary terms. These findings illustrate that, although in assessing efficiency, product from a hospital administrative perspective is represented by the output in monetary terms, other participants highlighted the importance of the quality features of hospital products.

The above findings of my present study have implications for hospital efficiency. The majority of SSO health managers, including policy makers and mid-level managers, have a demand-oriented perspective. This exclusively demand-oriented view can sometimes lead to the inefficient use of resources. The prescription of Vitamin B_{12} injection is an example. This drug is fully covered by the SSO and lots of people ask their physicians to prescribe it, as it makes them feel better and more energetic. The high number of prescriptions along with its relatively high price result in a serious financial burden for the SSO. Six years ago, as the former Head of the Department of Statistics in the SSO Health Affairs Department, I was involved in a project studying the clinical benefits of Vitamin B_{12} injection for people who do not suffer from the specific anaemia due to deficiency of this substance. The study concluded that there is little clinical evidence of any benefit from this drug for the general population. Irrespective of the findings, we were unsuccessful in excluding the drug for non-specific use from the SSO pharmaceutical benefit scheme, because of pressure from MPs, and from insured people, and because of the SSO officials' exclusively demand-oriented perspective.

Another challenging issue here is that, although several health professionals emphasized the crucial role of qualitative aspects of efficiency, little effort has been made to enhance the SSO hospital database to capture quality variables. This again might be due to the differences in understanding of the concept of efficiency between administrative staff (who do not tend to spend money on those issues that they do not believe in) and other health professionals. The inadequate attention to enhancing the SSO hospital database might also stem from the socio-political environment, which tends to support those managers whose performance can lead to some changes (though minor) in the *short run*. Infrastructure changes in hospitals leading to the improvement of the quality need time. For this reason, SSO policy makers and hospital managers are not generally willing to be involved in such time-consuming processes.

7.3.2.2 Factors affecting hospital efficiency

The participants provided an insight into factors influencing SSO hospital efficiency. According to the findings, I classified their comments into three main categories. These categories, which are presented in Table 7.2, include organisational factors, the characteristics of managers, and the political environment.

Organisational factors are related to the regulatory interventions and to factors that are intrinsic to the SSO hospital organisation. Examples of this category include the hospital funding system and the SSO payment system for physicians. The category entitled characteristics of managers is about those factors that are directly related to the qualification and experience of hospital or provincial managers and their managerial skills. Political factors are viewed as those that are external to the hospital organisation and arise from political issues. The pressure from MPs and/or other local authorities to build new hospitals or the uneven spread of existing facilities relative to population needs can be regarded as examples of this category.

Before discussing these factors in more depth, it should be noted that, as several participants pointed out, many factors have a close relationship with each other. For instance, we cannot ignore the role of political interference in appointing health care managers which can in turn affect the characteristics of those managers. This underlines the importance of having a holistic approach to deal with hospital inefficiency.

From the data emerged 11 sub-categories were grouped into three main categories (Table 7.2). In the following sections, these three groups are discussed.

<table>
<tr><th colspan="3">Factors Affecting SSO Hospital Efficiency</th></tr>
<tr><th>Organisational Factors</th><th>Characteristics of Managers</th><th>Political Determinants</th></tr>
<tr><td rowspan="2">Hospital budget
- no valid data on population needs
- no appropriate response to society needs
- line item financing
- encouraging a service-oriented approach
- inflexible
- inadequate
- affecting the level of activities, patient satisfaction, and quality of care</td><td rowspan="2">Inexperienced, and unqualified managers
- inefficient use of resources</td><td>Governance structure of the SSO
- overstaffing</td></tr>
<tr><td rowspan="8">Pressure from politicians
- overstaffing
- inefficient use of human resources
- inappropriate hospital location and development of existing facilities</td></tr>
<tr><td>Payment system for physicians
- encouraging service-oriented approach
- supplier induced demand; unnecessary referrals</td><td rowspan="7">Poor communication skills
- unable to establish a good rapport</td></tr>
<tr><td>Inappropriate medical tariffs
- low compared with private sector
- unable to reflect the difference between major and minor interventions</td></tr>
<tr><td>Data constraints to
- reflect the quality of care
- capture evidence-based practice
- reflect population needs
- monitor performance</td></tr>
<tr><td>Working in the private sector
- doing more complicated interventions in the private sectors</td></tr>
<tr><td>Lack of a cost sharing system
- unnecessary referrals</td></tr>
<tr><td>Lack of a referral system
- unnecessary referrals particularity to specialists</td></tr>
<tr><td>Lack of autonomy (at provincial and hospital level) in
- financial delegation
- personnel
- service planning</td></tr>
</table>

Table 7.2: Factors affecting SSO hospital efficiency

7.3.2.2.1 Organisational factors

The findings of this study revealed the following sub-categories related to the organisational factors.

- *Hospital funding system*

Participants agreed that the current centrally directed line item budget is an important factor leading to hospital inefficiency. This is consistent with the findings of several studies undertaken in different countries, showing the impact of hospital financing methods on hospital efficiency, particularly line item budgeting.[315,316] To reflect how this factor influences SSO hospital efficiency, first, I present the process of budgeting in more detail. Then, I discuss the limits of the current method of SSO hospital budgeting.

The line item budget was adopted as the method of SSO hospital financing in 1991. Until then, SSO hospitals were paid for whatever expenditures they incurred in the provision of health care services. In 1991 (when the line item budget was adopted), the number of beds, the number of specialization departments, and workloads such as the number of admissions (1990 level of workloads) were used to determine individual hospital budgets. In this method, the budget is series of lines that each represents one item of resource input, for example, salary, food, drugs etc. This means that centrally the SSO determines not only the total budget but also how exactly the budget should be spent in different lines. Then, the budget for next year will be based on past expenditure plus 15-20% to capture the inflation rate and wage increases. The current process of hospital budgeting suffers from a number of limits.

Firstly, there are no valid and reliable data to determine the real budget required to respond efficiently to the needs of the population served. For example, the burden of disease and hence population need in the southern part of Iran is different from that in the central part (in the south, the main issue is infectious disease whereas life-style disease is more important in the centre) requiring a different amount and mix of resources. Yet the hospital budgets do not allow for this, the ability of a hospital to use resources in order to produce the products that meet the needs of their local society can be adversely affected.

Secondly, because the initial estimates of individual hospital budgets were based on the 1990 workload levels, some efficient hospitals were probably punished, while inefficient hospitals were rewarded. This claim was frequently repeated by some hospital managers during my interviews. Considering this issue, and in the absence of data reflecting the population needs, some hospitals spend the whole amount of their annual budget in 8-9 months. Thus, although the current hospital financing reflects a budgetary cap, there are other mechanisms such as retrospective budget adjustments to respond to financial problems. These hospitals set a complementary budget and the SSO finally approves this budget. This is because, as some participants stated, there is always money for these hospitals with little attention to investigating the reasons for possible budget shortages. The process of approval, however, is time-consuming. During the period required to approve the complementary budget, hospitals have to pay only a proportion of staff wages. This can adversely affect the level of services provided by hospitals, the quality of care, and patient satisfaction.

Additionally, this sort of hospital budgeting does not take into account in-year changes in input prices. This issue was pointed out by mid-level managers and experts, particularly in terms of drug prices which may even double over a financial year.

Finally, as pointed out by some participants, the current hospital budgeting encourages managers to spend more. Perverse incentives may arise because any operating budget remaining at the end of the financial year should be sent back to the SSO, so that hospital managers tend to use up all their budget allocation. Furthermore, if hospital managers are unable to use up the whole amount of their budget by the end of the financial year, the budget for next year will be decreased. Thus, they try to increase the number of separations, even for unnecessary situations, and to do more minor interventions since their total value (the number of interventions multiplied by their relative values) is more than the total value of the major interventions foregone. This last point again underlines the interrelated features of factors affecting hospital efficiency, being in this case related to the inappropriate medical tariffs.

- Inappropriate medical tariffs

At present, the Iranian MOH is main organisation responsible for determining the values of medical interventions and diagnostic procedures. The values of medical interventions are determined on the basis of a relative value scale.[xxxviii] The results of this qualitative research suggest that the amount of "K", determined by the MOH are very low compared with private tariffs (usually 8-10 times less than the value set by the private sector). Thus, physicians generally tend to do the more risky and complicated procedures in private hospitals. This can be implicated in the high level of underuse of the theatres and equipment that are available in the SSO hospitals.

As pointed out earlier, doing more minor interventions that have overall a higher total value is also supported by hospital managers because of the structure of the hospital financing. Hence, generally SSO physicians tend to do the complicated interventions in private hospitals, and under the current rules and regulations there is no limit on their work in private hospitals.

- Practicing in the private sector

At present there is no national policy to address the question of whether or not physicians working in SSO hospitals should be allowed to work without restriction in private hospitals. Many SSO physicians particularly well-known specialists work in both SSO and private hospitals. Combined with other factors such as inappropriate medical tariffs, a considerable proportion of patients requiring complicated procedures would be directed to private hospitals. This can lead to the inefficient use of the existing facilities in the SSO hospitals. Here, it should be noted that introducing a non-private practice allowance may cause other problems such as recutting and retaining only young and probably inexperienced physicians whose private practice has not yet matured.[317] This may lead to the inefficient use of resources. This argument shows that regulation on dual practice is a challenging issue, requiring thorough investigation.

- Payment system for physicians

One of the features of the SSO hospital system is that all physicians are paid on a fee-for service basis. This means that their services are not included in the hospital budget. The impact of different payment systems used to fund doctors on hospital efficiency, and some of

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[xxxviii] In this system, the price value of each intervention is determined by two components; its weight and an index which is called "K". The index is a fixed amount which is identified and changed annually by the Iranian MOH. For example, National Medical Tariffs shows that the price value for tonsillectomy is 4K. If for a hypothetical year, K for surgical interventions is 1000 Rials (Iranian currency), the value of this intervention will be 4000 Rials.

their advantages and disadvantages have been investigated in other countries.[318,319] In general, these studies found that switch from a payment system which provides less incentive to increase services to one with a stronger incentive can increase the number of unnecessary care and marginal admissions. The findings of this thesis illustrate that the current SSO payment system pushes physicians to be more service-oriented. This is because the more interventions and consultations that physicians perform, more income they will have. Physicians are encouraged to admit or visit more marginal cases. Hence, the matter of supplier-induced demand can arise, and is exacerbated by a growing number of physicians particularly over the recent years. Over the past decade, the ratio of doctor to patients has risen due to a progressive expansion of medical schools intakes. This excess supply of doctors has been reflected in the form of low incomes. In my study, the interviewees believed that physicians try to reach a target income. This issue may increase the number of unnecessary referrals leading to the inefficient use of resources. This factor has a close relationship with other factors, for example the structure of hospital financing that supports a service-oriented approach.

Unnecessary patients referrals induced by physicians can be at least in part monitored by an effective performance measurement. However, there has been little attention to this issue, another organisational factor mentioned by several participants; lack of data required for an effective monitoring of hospital performance.

- Data constraints

Data availability is regarded as a long-standing challenge in the SSO hospital system. Over the past decade, a particular emphasis has been placed on enhancing the database. For example, in 1998 the SSO officials decided to change the organisational structure of the Heath Affairs Deputy[xxxix] in order to establish a new department to study different ways to improve the database and the methods the data are being collected. In line with this change, a substantial number of qualified people were recruited. Although, it is thought that these changes have improved the validity and reliability of the methods of data collection, little attention has been paid to collecting that data reflecting the quality of care, and performance measurement at the physician and patient levels.

[xxxix] This Deputy is responsible for all SSO health services

At present, hospital performance is assessed on the basis of simple ratio analysis and conventional throughput ratios such as the average length of stay, and bed occupancy rate. Performance measurement only based on these types of variables reflects the extent to which the service-oriented approach is prominent in the SSO health system. As pointed out by participants, there are also no data reflecting the compliance of physicians with evidence-based practice. For example, one of the participants reflected upon this issue indicating its important role on hospital efficiency.

> *…this is really important, because we can improve hospital efficiency by implementing cost-effective practice. There is no effective monitoring of the extent to which practice is evidence-based. For example, many physicians order lots of unnecessary lab tests or imaging before performing surgery.*

- Autonomy

Autonomy and decentralising management at provincial and hospital levels was another organisational factor which was particularly discussed in the focus group. All group members agreed that SSO hospitals are managed as administrative units of a larger hierarchy. The participants mentioned that, in this system hospital management team is regarded as an administrator who should follow orders from SSO headquarters, i.e. any day-to-day decisions should flow from hierarchy to the management team. The group reached the conclusion that autonomy can affect hospital efficiency, because managers will have more flexibility to make decisions on behalf of their hospitals. At present, mid-level managers have little authority to reallocate resources within their hospital budget in response to population needs. For example, one of group members stated:

> *If a hospital or provincial manager wants to reallocate his hospital resources to expand a particular ward based on the population needs, it requires a very complicated and time-consuming bureaucratic process…. Most often, managers give up…*

The results of this study have also revealed that hospital managers have little autonomy in other aspects of financial management such as transferring money between budget heads. Local managers have also very limited authority in personnel delegation such as changing staffing levels and mix, motivating staff, rewarding good performance and dealing with poor performers. This lack of autonomy can lead to hospital inefficiency. The above results are consistent with the findings of previous studies in other countries showing several advantages in giving more authority to local managers. For example, it is expected that decision-making based on local priorities and interests can be faster and more precise.[320] Although the examination of the role of autonomy in hospital efficiency is not core to this study, suffice it here to say that participants (particularly mid-level managers and experts) believed that the current hospital inefficiency in the SSO health network might be at least in part due to the inability of the health system in shifting the management responsibility to local managers in three areas, namely financial, personnel, and planning. However, they emphasized that the extent of delegation in these areas must be clear, because poor management skills with a greater autonomy could adversely affect hospital efficiency. Nevertheless, they believed that the fear of poor management should not lead us to manage the SSO hospitals as administrative units of a large hierarchy.

So far, I discussed factors that primarily involve health care providers. There are, however, other factors discussed by participants (particularly mid-level managers and physicians) that initially affect patients, namely the lack of a co-payment and referral system.

- Lack of a cost sharing system

In the SSO hospitals, all services including outpatient consultations, admissions, drugs, laboratory tests, and imaging services are offered to patients for free at the point of delivery. In this study, participants believed that a small amount of cost sharing could reduce unnecessary referrals effectively, leaving the resources for improving the quality of care. The role of cost sharing in controlling unnecessary referrals has been discussed in many studies. For example, one study found that "cost sharing markedly decreases the use of all types of services among all types of people."[321] It was also noted that reduced use had "little or no net adverse effect on health for the average person"[321]. However, it has been argued that, before implementing cost sharing policies, the effects on vulnerable people such as sick poor and chronically ill should be explored in more detail.[322] This is because of the possible impact of the cost sharing in placing financial burden on vulnerable people, encouraging them to delay their referrals. The establishment of the amount of cost sharing is a critical issue and should reflect patients' income, economic growth, and health care costs. This argument shows that cost sharing is a complicated process requiring a thorough investigation.

- Lack of a referral system

Lack of a referral system was also discussed as another factor that increased the number of unnecessary visits, particularly for specialists. At present, patients can choose their physicians. Participants believed that most patients prefer to be seen by specialists for those problems that can be dealt with effectively by general practitioners. This has led to a financial burden on hospitals because they have to pay more for consultations made by specialists compared to general practitioners. Furthermore, more visits by specialists result in longer waiting lists, and thus less patient satisfaction. The issue may also affect the quality of care provided by specialists, because they have to spend less time per visit due to a greater number of patients.

In brief, the findings illustrate that organisational factors, rules and regulation are important features influencing SSO hospital efficiency. Another important issue discussed in this section was the interrelated features of different organisational factors. The structure of hospital financing, the payment system used to fund physicians, and inappropriate medical tariffs are key factors that all encourage hospital staff to spend more, and to do interventions with higher total values. These perverse incentives might be aggravated by the lack of a cost sharing and referral system. Furthermore, due to the lack of data reflecting population needs, quality of care and evidence-based practice, and the structure of current performance assessment criteria, little attention has been paid to meet the real needs of the populations in the target areas.

7.3.2.2.2 Characteristics of managers

The findings of this thesis illustrate that the characteristics of managers could influence hospital efficiency in several different ways. This is in line with studies indicating the relationship between relevant qualifications and experience of hospital managers and hospital efficiency.[323] The present findings can be classified into three sub-categories, namely management qualification, management experience, and poor communication skills.

- Health management qualification

Participants indicated that all hospital and provincial managers are physicians, most of them specialists. They generally do not have any formal health management qualifications. Furthermore, they have not attended any courses related to management sciences, health resource allocation, or health economics during their study at medical school. This is because of deficiencies in the current medical curriculum. This problem mainly originates from the fact that, the curriculum has not been revised since 1979.[309] The current Iranian medical curriculum pays little attention to population health issues and management sciences (ibid).

- Health management experience

A group of participants indicated that some hospital managers do have substantial experience even with no academic qualifications. Their experience in managing health resources can help them use resources more efficiently than inexperienced managers. Experienced managers, however, prefer to work in hospitals located in the big cities, or in provinces with high Human Development Index (HDI) values affecting the level of hospital efficiency. Interestingly, these comments are in line with the findings of the quantitative component of the present study. According to those findings, the difference between the efficiency scores of hospitals located in provinces with high HDI values and those hospitals located in low HDI provinces was found to be statistically significant.[xl]

- Poor communication skills

Participants believed that the poor communication skill of some hospital managers is another factor that can influence hospital efficiency. Previous studies have shown that poor interpersonal communication skills and education levels of personnel negatively affect efficiency.[324] One of the key mechanisms to improve efficiency is the ability of managers to establish a good rapport from the early stages with those affected by the changes. Evidently, this ability requires good interpersonal communication skills. Those managers who do not have these skills will eventually fail to implement policies required for achieving higher levels of efficiency.

[xl] See chapter 6 Section 6.4.4.1 for more detail.

7.3.2.2.3 Consequences of political determinants

The impact of environmental factors on efficiency has been discussed in different studies in other countries.[325] In Iran, there has been so far no study exploring the impact of environmental factors on efficiency. The findings of the present thesis have shown that political determinants such as the governance structure of the SSO and pressure from MPs and other politicians can affect hospital efficiency in different ways. These ways might be different in various countries depending on their socio-political structure. The participants in this research mentioned two consequences of political determinants, namely overstaffing, and hospital location and development policies.

- Overstaffing

Participants believed that overstaffing is one of the main consequences of political interference in the SSO hospitals leading to inefficiency. As pointed out earlier, although a non-governmental organisation, the Iranian SSO is under close control of the government. This is because of the organisational structure of the SSO in which the Board of Directors and the Managing Director are appointed by the Minister of Health with the approval of the Council of Ministries. Furthermore, the SSO High Council, whose main duties are to investigate the budget and make decisions regarding social security policies, includes 15 members, amongst whom seven are representatives from different ministries. Thus, it should not be surprising if the Iranian government tries to resolve some socio-economic problems using SSO resources.

One of the major national priorities currently facing Iran is a high level of unemployment. In 2002, the unemployment rate was estimated to be about 14%.[326] Due to the over-production different health workers over the past two decades, the high unemployment rates of medical doctors, nurses, and other health workers have become a matter of national debate.[327] For a long time, the SSO has been under pressure to contribute to the issue by employing doctors, nurses, and other health professionals in its owned and operated hospitals and clinics. This pressure has led to a remarkable variation in staffing ratios in the SSO health network, particularly in hospitals. Some participants mentioned a situation in which considerable pressure was put on the SSO to employ doctors in hospital located in the big cities. Looking at Table 5.7 (chapter 5), it is revealed that staffing and bed to staff ratios vary considerably across SSO hospitals. For example, while Hedayat (located in a big city) has 1.61 beds per doctor, in Shafa Semnan hospital there are 7.29 beds per doctor. This overstaffing can partly explain the difference between the efficiency scores of the two hospitals obtained from the DEA analysis (Hedayat: 65%, Shafa Semnan: 99%; chapter 6, Table 6.6).

- Hospital location and development

Another consequence of the impact of political determinants on hospital efficiency discussed by some participants concerned hospital locations and expanding the existing facilities. During elections, one of the most important promises made by many MPs, provincial governors, workers' unions, and other local officials is to build a new hospital, or to expand the existing wards. After elections, they will try to keep their promises by putting pressure on the MOH and the SSO. In many cases, the SSO is the first target, because of its perceived resources. Therefore, the location or size of some hospitals might not be in line with the extent of demand in its catchment area, because the assessment of population needs was not a main criterion for building or developing hospitals. Furthermore, as pointed out earlier, data constraints are another factor in the assessment of population needs. The impact of the political environment on location and size of SSO hospitals was discussed by participants from several points of view.

Participants pointed out that at least part of the existing inefficiency in some hospitals is due to their location. Esfahan and Markazi are two provinces with very powerful workers' unions, so that the SSO was forced to build hospitals in those two provinces even in their smaller cities, for instance, Chamran Saveh in Markazi province, and Najafabad in Esfahan. These two hospitals are located in cities that are very close to the capital cities of their provinces. In these areas, many patients tend to refer to the SSO hospitals located in the capital cities. This can lead to the inefficient use of resources in hospitals in the small cities. In line with this finding, the DEA analysis in chapter 6 (Table 6.6) has shown low efficiency scores for Chamran Saveh and Najafabad (73% and 70% respectively), while both hospitals located in the capital cities of those two provinces (Emam Arak, and Shariati Esfahan) have efficiency scores of 98% and 100%.

Hospital location was discussed from another standpoint as well. One of the participants stated that there are some hospitals (such as Beheshti Kasahan) that in proportion to number of insured people, experience insufficient demand for the existing facilities. The participant continued that the SSO was under political pressure to increase the number of beds and staff of this hospital. Looking at Table 5.3, chapter 5, reveals that Beheshti Kashan has the highest ratio of beds to 1,000 insured people across all the SSO hospitals. There is an agreement between this statement and the efficiency score obtained from the DEA analysis (chapter 6, Table 6.6) showing a low value for Beheshti Kashan (58%). The analysis of scale efficiency and types of returns to scale derived from the DEA analysis (chapter 6; Table 6.10) has also shown that Beheshti Kashan is scale inefficient, operating with Decreasing Returns to Scale (DRS). The impact of political factors on hospital size was further explored by another participant giving another example; Shahryar Karaj. The DEA analysis has shown that the hospital is scale inefficient operating with DRS (chapter 6, Table 6.10). The efficiency score of this hospital is 51% (chapter 6, Table 6.6) representing the second worst efficiency score across SSO hospitals.

The above findings demonstrate another agreement between the results derived from the DEA analysis and qualitative findings underlining the effect of inappropriate hospital size on hospital efficiency. The investigation of types of returns to scale also revealed that 34% of SSO hospitals are operating with DRS, implying the necessity of the reducing the scale of operations of those hospitals to restrain the unnecessary use of inputs (chapter 6; Table 6.10). As discussed by some participants, this issue might be, at least in part, due to the impact of political factors on the expansion of the SSO hospitals.

7.3.2.3 Remedial actions

Interviews with SSO and MOH health professionals and policy makers suggested a number of remedial actions that could improve hospital efficiency. According to the findings, the prevalent feeling was that the SSO as a health funder needs to strengthen its role in the provider-patient relationship. There were, however, some participants whose key idea was to create a funder-provider split in order to increase the accountability of hospitals for more efficient use of resources.

Participants commented on different actions needing to be taken to clarify and strengthen the role of the SSO. These actions include reforms to the regulatory framework, database improvement, and managerial issues.

Remedial actions affecting the regulatory framework such as reforms in hospital financing, the payment system used to fund physicians, and medical tariffs were those predominantly mentioned by participants. Participants proposed different payment arrangements for SSO hospitals, for example, salary plus bonus, capitation, and DRGs based separations. But, as one of the participants mentioned, more investigation is required to explore which are the more appropriate payment arrangements, as none of them are perfect. Capitation was frequently proposed by participants. The literature on the effect of capitation on hospital efficiency and quality of care, however, is inconclusive. For example, although Chu et al [328] have found that efficient California hospitals are more likely to be in capitated contracts, other studies have indicated that capitation has led to a lower quality and under-provision of medical care.[329] Both studies argued that the selection of payment arrangements may depend on different factors including the socio-political environment, and patients' and health care providers' characteristics.

The necessity of reforms in cost sharing policies and referral system was another area discussed by participants. Over the past few decades, cost shifting to patients and efforts to establish a referral system have been a common feature of the health systems in many OECD[xli] countries.[330] These reforms try to encourage patients to use resources and the physicians network more efficiently. Cost sharing can also affect providers, because as cost sharing increases, patients will push their physicians into making more cost-effective medical decisions. The participants indicated that even a small amount of cost sharing for pharmaceuticals and outpatient visits would reduce the number of unnecessary referrals. It should be, however, noted that the issue of cost sharing needs to be viewed in the context of the socio-economic status of the Iranian people in order to decrease the side effects of this policy on the poor and vulnerable. For example, it might be argued that due to a significant difference in economic status of people living in different regions, the amount of cost sharing

[xli] Organisation for Economic Co-operation and Development

may vary across provinces. More investigations are needed to analyse the factors affecting cost sharing policies.

Using a GP or a skilled nurse at the first contact point was another action discussed by participants. They believed that many patients can be effectively treated by GPs, while according to the current policy, they can select their physicians. This can lead to unnecessary referrals to specialists and even sub-specialists. In this regard, a few participants suggested a higher amount of cost sharing for patients who are not referred from a primary provider, i.e. GP or nurse. This is again underlines the efficient use of resources where patients can be treated effectively by cheaper services.

Improvement of the SSO hospital database was another area that needs to be modified in order to improve hospital efficiency. Some participants believed that the SSO as funder should strengthen its role in providing health care. They reflected upon the importance of having valid and reliable variables to assess physicians' performance and the quality of hospital care. They stressed that the current performance measurement criteria, which are based solely on the number of activities at an aggregate level, can lead to perverse incentives, and thereby the inefficient use of resources.

Reforms in appointing hospital managers in order to recruit and develop more experienced and skilled managers was another concern of participants, particularly the experts. Their comments on managerial issues can be divided into three parts. First, almost all experts indicated that the current appointment criteria should be modified. In doing so, some participants proposed changes in the SSO organisational structure to decrease political pressures in appointing unskilled managers. They also suggested some reforms in the Iranian medical curriculum to capture principles of community medicine, health economics, and health resource management. Finally, they commented on the necessity of providing educational opportunities for current SSO health care managers by offering scholarships or holding training workshops.

In brief, most participants reflected upon reforms that could strengthen the SSO role as a health funder. There was, however, another approach mentioned by a few participants, focusing on a funder-provider split.

This approach relates to the concept of corporatization whose effects on hospital efficiency have been discussed in a number of studies.[331,332] According to this approach, hospitals owned by the SSO should be corporatized and treated as private corporations, though still funded by the SSO. Hospitals should be governed by elected boards from the hospital staff and insured people in their target areas to ensure that the hospital is responding to population needs. The mechanism includes an agreement between the hospital Board of Directors and the SSO, now as a funder and supervisory agency

Participants proposing this approach believed that, for a number of reasons, corporatization could improve SSO hospital efficiency and the quality of care provided by SSO hospitals. Basically, the SSO is an insurer organisation and so its main responsibility is not to provide direct health services to its insured people by building hospitals and clinics. Running and owning hospitals and clinics means that the same organisation plays the role of funder, provider, and inspector. In fact, under the current arrangements the SSO evaluates its own performance. This, as participants emphasized, can adversely affect the quality of care, and actions required to improve population health. As evidence for this claim, participants mentioned inattention in capturing information reflecting quality of care, medical errors, re-admission rates, and community-related health issues such as lifestyle education programs for public. This approach would, they believed, help the SSO strengthen its inspection role to tighten the link between the resources allocated to hospitals and delivery of desired health outputs and outcomes.

Furthermore, under corporatization, the SSO could set a real financial bottom line. This would make hospitals fully accountable for their financial performance. This issue was discussed by participants as a factor affecting hospital efficiency highlighting that our hospital managers are not “cost consciousness.” Furthermore, under a contractual relationship with a corporatized organisation, hospital managers would be given more autonomy in changing staffing levels and mix, in transferring between budget items, and in developing service plans for more efficient use of resources. Increasing hospital autonomy can be regarded as a way of improving efficiency. This issue is well documented by a number of studies in other countries.[323]

Finally, the participants stressed the role of corporatization in reducing government interference. Using this approach may free the SSO from some constraints in appointing unskilled hospital managers, building new hospitals, or expanding hospitals in disproportion to population demand. This should allow the SSO and the hospitals to make more rational decisions and plan future investments with greater certainty.

In brief, the findings of the qualitative component of this thesis have revealed that, a majority of the participants felt a need for reforms in the regulatory framework and managerial domains. The second idea, corporatization, discussed by a few key informants, could improve efficiency by enhancing accountability, autonomy, performance assessment, and participation by other major stakeholders. It could also reduce government interference that was regarded as an important environmental factor leading to hospital inefficiency. Comparing these two approaches, it appears that in order to improve hospital efficiency, both approaches would seek the same objectives, namely to strengthen the SSO role in performance assessment. However, the participants proposing the second approach stressed the importance of having a holistic approach to improving hospital efficiency, claiming that only by corporatization can the SSO hospitals improve their efficiency. Adopting an appropriate strategy to improve hospital efficiency and possible barriers in implementing remedial actions, however, needs to be viewed in the context of the economic, social, and political environment.

7.4 Concluding remarks

Using qualitative methods, this chapter has provided meaningful insight into Iranian health professionals' views of efficiency and factors affecting it, and of possible remedial actions.

The findings revealed that the participants were well aware of the importance of efficiency. However, in defining efficiency and hospital products, they presented different views, ranging from technical efficiency, operational efficiency, and effectiveness.

The findings of the qualitative component also illustrate that a complex mix of organisational factors, characteristics of managers, and political determinants has contributed to SSO hospital inefficiency. The comments of the key informants suggest that, because of the characteristics of the existing hospital financing system, inappropriate medical tariffs, the payment system used to fund physicians, and the unbalanced production of doctors and other health workers, supplier-induced demand and hence hospital inefficiency can arise through several mechanisms. Retrospective hospital financing, and fee-for- service arrangements may lead perverse incentives in terms of more unnecessary induced referrals, and possibly more additional and unnecessary tests and treatments. Moreover, medical tariffs (especially for major medical procedures) which have little relation to the real resources used can lead hospitals and physicians to focus more on interventions where the tariffs offered relative to the resources used are the highest, resulting in a misallocation of resources with an impact on population health.

Furthermore, some of the informants mentioned that, there are considerable deficiencies in the SSO hospital database used to evaluate physicians' performance, monitoring the type and quality of care provided at the patient level. In addition, the current SSO hospital performance measurement is mainly based on throughput ratios such as ALOS, BOR, BTR, and on aggregated data on the number of curative care activities such as the total number of separations and outpatient visits. This monitoring system again supports a service-oriented approach leading to a more inefficient use of resources. These factors should be viewed along with a socio-political environment that exerts pressure on the SSO to build new hospitals, and with an uneven spread of existing facilities relative to demand. This can raise the overall operating costs of the SSO hospitals without noticeably improving population health.

Having discussed all factors affecting SSO hospital efficiency, the interviews with participants provided valuable insight into remedial actions to improve efficiency. In general, two approaches were discussed by the participants. The first approach focused on reforms that would clarify and strengthen the SSO's role as funder. These reforms include modifying the regulatory framework such as hospital financing and payment arrangements, medical tariffs, policies related to cost sharing and referral systems, reforms in the hospital database in order to capture variables reflecting the quality of care and cost-effective practice, and reforms in the criteria for managerial appointments. The key idea of the second approach was a funder-provider split. The concept of corporatization was proposed which includes a contractual relationship between the SSO and each hospital. According to the participants, this approach would allow the SSO to strengthen its role as an inspector by enhancement of the database, and by tightening the link between resource allocation and desired outputs and outcomes.

Finally, it should be noted that any qualitative study such as the present one itself will have strengths and limitations that need to be addressed. The method and sampling strategy adopted for this study allowed me to explore an extensive range of key informants' views and experiences. I have also used a number of approaches to improve the trustworthiness of the findings, namely triangulation, member checking, and using disconfirming evidence (for more information see section 7.3.3).

Nevertheless, the small sample size may limit the generalization of the findings. Having said that, the findings represent the views of 17 SSO and MOH health professionals who have been involved in the SSO and/or the national health system for a long time. Thus, it is likely that much the same information would be obtained while investigating similar issues in other Iranian public hospitals, particularly hospitals owned by the MOH. Another possible limitation of this study is that mid-level managers were not interested in discussing issues related to their own capability. For example, their (mid-level managers) limited knowledge of the health management sciences was pointed out by senior experts or policy makers. On the other hand, policy makers focused more on the role of local factors and factors inside the hospitals instead of possible deficiencies in the process of policy making and implementation. Thus, although approaching different types of interviewees might be useful in covering a broad range of information, they may consider their own position during the discussion. Finally, although the views of a wide range of health professionals have been presented, it was not feasible to recruit patients as another type of stakeholder. Had this been possible, their expressed views may well have been different to those inside the system.

CHAPTER 8

CONCLUSION

Chapter overview

The aim of this thesis has been to enhance hospital performance with a focus on the Iranian SSO hospitals. Related objectives were identified (as outlined in chapter 2, section 2.7), and a range of investigative methods employed in order to achieve these objectives. In this final chapter, I revisit these objectives, discussing an overview of the main findings together with their implications. I also explore the contribution this study makes to the understanding and measurement of hospital efficiency.

✓ Objectives related to the selection of variables

The first two research objectives were related to the review of the literature on hospital functions and performance measurement in order to propose a conceptual framework for selecting the most appropriate variables. This in turn could provide insight into deficiencies in the current SSO hospital database. In chapter 2, I critically appraised the service-oriented approach, as it is used in the literature, for selecting (conventional) variables for measuring hospital efficiency. I found a lack of conceptual clarity for selecting the most appropriate variables. I also found that the variables used in hospital efficiency studies mainly reflect a narrow view of hospital functions, namely curative care, with a little attention to quality variables. In chapter 4, I argued that the critical step in efficiency studies is to provide a clear understanding of all functions of the organisation (hospital in my study) and appropriate variables by which the efficiency of the organisation should be assessed. To discuss a broader set of variables linked to the essential functions of hospitals, my point of departure was the concept of a Health Promoting Hospital which gives rise to a fuller range of hospital functions coupled with the hospital's commitment to improving the quality of services. Undertaking an in-depth investigation regarding the multi-product nature of hospitals, I proposed a conceptual framework with a focus on the SSO hospitals, discussing the necessity of the use of a broader set of variables (development-oriented) in hospital efficiency studies using frontier-based techniques.

Meeting the above objectives revealed a number of practical and theoretical implications which can be used by SSO health administrators and DEA professionals. First, it should be noted that using both conventional and development-oriented variables can enhance the validity of hospital efficiency studies, because together they can capture a fuller range of hospital functions and quality of care. This, in turn can provide a more valid tool for hospital efficiency measurement from both the policy maker’s and the health administrator’s point of view.

Furthermore, it is worth noting that, although the framework proposed has revealed the value of development-oriented variables in hospital efficiency measurement, it has also drawn attention to problems associated with the evaluation of hospital performance. This will help in developing proposals to determine deficiencies in the current SSO hospital database and to identify new data to enhance efficiency measurement. In the current SSO database, there is no variable reflecting a broad range of hospital functions such as preventive care, protective care, health promotion activities, staff development related activities, and interactive functions. There are also few variables reflecting the quality of care. From this standpoint, there is a pressing need for major revisions in the SSO database in order to capture a broader set of variables.

Unfortunately, the use of a broader set of variables in DEA studies can lead to problems. Relative to the number of hospitals (sample size), using a higher number of variables results in more (apparently) efficient units, leading to low discrimination. This issue underlines the need for theoretical developments and possible changes in the capabilities of DEA so that this method can handle a broader set of variables.

✓ Objectives related to SSO hospital efficiency measurement

The next two research objectives were related to the identification of efficient and inefficient SSO hospitals, measuring the magnitude of inefficiency of inefficient hospitals. Bearing the deficiencies in the SSO database in mind, I decided to use the data that are currently available. This was because waiting for perfect data may well have lead to an extensive delay, and also because the use of existing data is often a catalyst for enhancing a database. In this thesis, I used two methods to measure SSO hospital efficiency, namely simple ratio analysis and Data Envelopment Analysis (DEA).

First, simple ratio analysis (chapter 5) was used to provide a general overview of the dataset. It was also useful for identifying the outlying hospitals. Additionally, the comparison of the results obtained from simple ratio analysis and DEA analysis (chapter 6) provided valuable insight into the benefits and shortcomings of each method. In simple ratio analysis, a variety of input, output, and throughput ratios were used to compare the relative efficiency of SSO hospitals. For example, combined service utilization ratios (Lasso diagram) showed that all outlying hospitals were either in the low bed turnover, low bed occupancy group, indicating a low level of activity (calling for discussion on deficiencies in the existing services as well as uneven access to facilities in comparison to population needs in the target area); or in the high turnover, high occupancy group (calling for discussion about overcrowding in relation to capacity, and about expansion of facilities, as well as quality and case-mix control).

Considering major surgery rates, which implicitly provide some information about the case-mix, has revealed that all high-turnover, high-occupancy outlying hospitals as well as the majority of hospitals falling in the relatively well-performing quadrant in the Lasso diagram had a low major surgery rate. This is a reminder that, although ratio analysis has several advantages including conceptual simplicity, ease of computation, and identification of outlying hospitals, it can only measure the performance of hospitals over a single dimension ignoring their multi-input and multi-output nature. From this standpoint, more advanced techniques such as DEA may be more helpful in capturing the multi-product nature of hospitals by handling multiple inputs and outputs.

The DEA results (chapter 6) showed that 22 of the 53 hospitals comprised the efficient frontier i.e. were operating as efficient units relative to other SSO hospitals. The average relative efficiency scores of the thirty-one off-the-frontier (inefficient) hospitals was 78%, implying the potential for a reduction in all inputs on average by about 22% with no impact on output levels. The average scale efficiency of 0.91 indicated that 9% of the input wastes could be attributable to operating at a non-optimal size. The findings also showed that 74% of SSO hospitals were not operating under the most productive scale size; most were operating with Increasing Returns to Scale (IRS). In addition to studying SSO hospitals overall and relative technical and scale efficiency, I analysed the magnitude of the inefficiency for each individual hospital by identifying the areas of weak performance. Taking Chamran Hospital as an example, it appeared that the number of doctors and the number of caesarean sections are two areas that require the highest percentage changes.

In view of the relative nature of DEA analysis in which some hospitals are always classified as efficient units relative to others, this study then proceeded to a full assessment of efficient units by calculating super-efficiency scores, by identifying weak efficient hospitals, and by determining the frequency of peers. Comparison of the results from this full assessment of efficient hospitals and the findings from the simple ratio analysis provided a constructive insight into major shortcomings associated with DEA analysis. Discussion ensured as to how some hospitals with low super efficiency scores and slack positive hospitals were deemed to be efficient only by placing all weight on one subset of variables. This means that hospitals with an exceptional performance on a small subset of variables, even though less valuable compared with other subsets, can gain a full efficiency score.

The findings of efficiency measurement accommodate a number of important methodological issues and implications which need to be addressed in more detail. By providing a full ranking of efficient hospitals and comparing this with simple ratio analysis, this thesis has contributed to the existing literature on hospital efficiency studies using DEA. The analysis has shown that there is a general agreement between three methods used in ranking efficient hospitals. For example, AmirKabir Hospital gained a very high super efficiency score. The hospital was slack negative efficient units, acting most frequently as peers. These findings highlight the priority for further investment that should be given to this hospital. On the other hand, Gonbad Golestan Hospital, which was classified as a weak efficient unit registering the lowest super efficiency score, was not a peer for any other inefficient hospital. Analysing the performance of this hospital (Gonbad Golestan) in more depth revealed that DEA has allowed this hospital to be on the frontier by assigning a very high weight to where its performance is exceptional (i.e. the number of outpatient visits to the number of doctors) and very low weights to the remaining subset of variables. By omitting the number of outpatient visits from the set of variables for all hospitals, the DEA efficiency score of Gonbad Golestan Hospital (which was ranked as an efficient hospital in the original DEA analysis) dropped considerably to 57.8. This critical analysis of the study strongly suggests that the findings obtained from unconstrained DEA in hospital efficiency studies should be interpreted with caution. By using weight restrictions, this deficiency can be appropriately responded to. However, substantial studies are required to identify the appropriate weights for the different areas of hospital performance. The findings also suggest that simple ratio analysis and DEA should be regarded as complementary methods in efficiency measurement rather than as alternative methods.

The second methodological issue concerns the sensitivity analysis. In chapter 6, I argued that, in DEA studies, the set of variables used can heavily influence not only the efficiency score of the related hospitals, but the efficiency scores and rankings of other hospitals. Hence, I used different approaches to examine the robustness of the set of variables selected. First, the robustness of different sets of variables was examined using validity assessment criteria and pragmatic criteria. A further assessment of the validity of the model (set of variables) selected was done using in-depth interviews with SSO health professionals. Second, the reliability of the model selected was examined. The reliability of the set of variables was confirmed by showing a positive and strong relationship between the efficiency scores obtained from two consecutive years. I also employed another method to examine the possible effects of measurement errors on the results obtained, as DEA results are very sensitive to measurement errors. I computed efficiency scores before and after excluding the outliers (as potential sources of measurement errors). Again, a strong positive agreement between the two models showed the small impact of possible measurement errors on my findings.

This thesis also poses a number of implications for SSO hospital managers and SSO policy makers. Currently, simple ratio analysis in general (and throughput ratios such as bed turnover rate, bed occupancy rate, and average length of stay in particular) is the only method actually used to monitor SSO hospital performance. The method, however, suffers from some drawbacks as it reflects only variables in pairs, failing to provide an overall view of hospital performance. These drawbacks can lead to the kinds of misleading results discussed earlier. These findings call for reforms in SSO hospital performance criteria in which more advanced techniques (such as DEA) are used as complementary tools to obtain more robust results.

The findings of DEA analysis provide a number of implications for hospital managers seeking to improve the performance of their hospitals. By identifying the relative efficiency scores, and the magnitude of inefficiency at the individual hospital level, a more informative analysis in terms of their hospital's weak areas of performance would be feasible. This is an important issue for hospital managers because the SSO hospital financing system is planning to move from historical line item budgeting to a prospective case-related financing system. Such a change should lead to a more competitive market in which the SSO hospitals will be required to make more efficient use of their resources.

The DEA results also provide a number of implications for SSO policy makers. If the health care needs of the community in the target area are kept in mind, the estimation of inefficiency in this study indicates that the improvement of SSO hospital performance can help release scarce resources which can be alternatively used to increase the quality of care, to provide more promotive and preventive services (such as staff and patient education) or for other valued purposes. Additionally, the presence of Decreasing Returns to Scale (DRS) in 34% of the SSO hospitals under scrutiny implies that the scale of operations of those hospitals should be reduced to restrain the unnecessary use of inputs. This is an important policy implication because in recent years many SSO hospitals were subject to expansion in capacity with little attention to the real needs of the population in target areas. This issue underlines the necessity to revise the existing criteria which have lead to this increase in the scale of SSO hospitals. Analysis of the returns to scale status can also provide valuable information for SSO policy makers in reallocating resources from hospitals operating with DRS to those operating with IRS.

✓ Objectives related to factors affecting efficiency and remedial actions

In addition to the measurement of SSO hospital efficiency, this thesis has contributed further to the wider discussion of hospital efficiency by raising questions about factors affecting efficiency and remedial actions to improve efficiency. Using in-depth interviews and focus group discussion, this thesis found a number of organisational factors (including hospital budgeting, payment system used to fund physicians, inappropriate medical tariffs, and lack of an effective monitoring of hospitals), political determinants (influencing SSO policies in recruiting new staff, building new hospitals or developing existing facilities), and hospital under-management due to the lack of the managerial skills necessary in complex facilities such as hospitals. To deal with the above factors, the interviewees stressed the necessity for reforms of the regulatory framework, particularly the hospital budgeting and payment system, in order to improve efficiency. A few participants provided a more holistic approach, proposing hospital corporatisation which includes a contractual relationship between the SSO and each hospital.

In the light of the above findings, this thesis recommends that a serious effort should be made to strengthen the managerial skills of provincial and hospital managers. This may also include reforms in the Iranian medical curriculum, as those taking up managerial positions tend to be relatively junior medical doctors with little managerial knowledge or skill. Furthermore, different ways of improving incentives for the efficient use of resources should be considered. These include reforms in the SSO database to enhance hospital performance monitoring, medical tariffs, and hospital budgeting and/or a more comprehensive approach, i.e. corporatization in order to increase hospital autonomy and hence accountability.

Finally

At the end of my PhD, I have gained enough knowledge to realise that my study must be considered as a work in progress. I started my doctoral studies with a desire to measure SSO hospital efficiency using an advanced method, i.e. DEA. However, I realised that hospital efficiency studies are more than the simple measurement of efficiency. A hospital is a dynamic organisation with multiple objectives facing disagreements on its priorities. Policy makers, hospital managers, physicians, and patients will often have different views on the hospital's objectives and functions. This makes hospital efficiency measurement difficult. Nevertheless, I believe that the health-oriented framework that I have proposed fits quite well with the characteristics of social organisations such as SSO that are concerned with meeting social objectives.

Furthermore, I have realised that there are several technical and methodological issues affecting the results of efficiency studies for which there is still little guidance. This has motivated me to think of further research projects in more depth. For example, considering the limitations posed by the data and methods used, there is an urgent need for future research using a broader set of variables together with (DEA) weight restrictions in order to increase the validity of the findings. However, as pointed out earlier, substantial investigations are required to estimate the appropriate weights. The issue also underlines the necessity for theoretical developments in DEA which might be of particular concern to health professionals involved in efficiency studies.

I now do have an empirically based understanding of efficiency measurement. This understanding will allow me to refine my original aim to improve SSO (and Iranian) hospital efficiency. It will also redirect me toward a more holistic approach in this context.

APPENDICES

APPENDIX A	HOSPITAL EFFICIENCY STUDIES
APPENDIX B	INFORMATION SHEET
APPENDIX C	CONSENT FORM
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APPENDIX A: HOSPITAL EFFICIENCY STUDIES

	Method	Output variables	Input variables
Duckett et al (2000)	Simple ratio analysis - Simplicity - Providing an overview of the data set	Casemix adjusted separations	Total hospital costs adjusted for discrepancy elements
Mahapatra et al (1994)	Simple ratio analysis - Simplicity - Low cost	-Number of deliveries -Number of major surgeries -Number of laboratory tests	-Number of separations -Bed occupancy rate (throughput ratio) -Bed turnover rate (throughput ratio)
Al-shammari (1999): Public hospitals in Jordan	DEA -More powerful in the context of hospitals -Not required to the estimation of production function	- Patient days - Minor surgical operations - Major surgical operations	- Number of bed day -Number of physicians - Number of other personnel
Ramanathan (2005)	DEA - Powerful technique for performance measurement	- Patient days - Minor surgical operations - Major surgical operations - Outpatient visits	- Number of bed day -Number of physicians - Number of other personnel
Kwakye (2004)	DEA -Producing more accurate results with small samples	-Patient days -Outpatient visits	-Number of beds -Number of physicians, nurses, administrative, technicians, and others
Zere (2000)	DEA -Its capability to handle multiple variables -No need to specify functional distribution	-Patient days -Outpatient visits	-Number of beds -Aggregate total recurrent expenses

	Method	Output variables	Input variables
Pavananunt (2004)	SFA -Its capability in distinguishing statistical noise and inefficiency	-Patient days -Outpatient visits -Number of emergency visits	-Annual payroll of personnel -Total amount of annual expenditure of capital -Medical and non-medical expenses
Zere et al (2006)	DEA -Easily accommodated multiple inputs and outputs -Providing specific input and output targets	-Outpatient visits -Inpatient days	-Recurrent expenditure -Number of beds -Number of nursing staff
Osei et al (2005)	DEA -Handling multiple inputs and outputs with different units -it dies not require an assumption of functional form	-The number of separations -Maternal and child care (including antenatal care, immunisation and growth monitoring)	-Total number of staff - Number of beds
Baht et al (2001): Public hospitals in Gujarat state of India	DEA -Not required to define production or cost functio -More flexible to handle multi-product firms like hospitals	-Number of inpatient admissions -Number of outpatient visits -Number of cases handled under laboratory services	-Number of doctors, nurses, paramedical, administrative, and non technical staff -Number of beds -Costs of drugs -Equipment index -Maintenance expenditures

	Method	Output variables	Input variables
Kirigia et al (2002): Public hospitals in Kenya	DEA -More flexible to handle multiple inputs and outputs	-General inpatient admissions -Outpatient visits -Dental care services -Paediatric admissions -Maternity admissions	-Number of doctors, nurses, paramedical, administrative, and subordinate staff -Costs of drugs -Costs of other consumables -Number of beds
Owino et al (1997): Public hospitals in Kenya	SFA -Revealing absolute efficiency rather than relative -Not sensitive to mismeasurement	-Inpatient admissions -Outpatient visits -Number of surgical interventions	-Number of beds -Average wage of staff
Chang et al (2004)	DEA -Flexibility in handling multiple inputs and outputs with different units of measurement	-Number of patient days -Number of outpatient visits -Number of surgeries	-Number of beds -Number of medical staff -Number of nurses -Number of supporting medical personnel
Hollingsworth (1995)	DEA	- Number of hospital days for medical and surgical patients - Total accident and emergency visits - Outpatient attendances - Obstetrics and gynaecology inpatient days - Other speciality inpatient days	- Staffed beds - Nurses - Total of professional, administrative staff - Total of non-nursing medical and dental staff - Cost of drug supply - Capital charge

	Method	Output variables	Input variables
Webster et al (1998)	DEA - More appropriate for understanding of the performance of individual units	- Acute care inpatient days - Surgery inpatient days - Non-inpatient occasion of service - Nursing home type inpatient days - Surgical procedures - Acute care inpatient separations - Accident and emergency - Total inpatient revenue	- FTEs of salaried medical staff - FTEs of nursing staff - FTEs of other staff - Beds - Material costs - Admissions
Hofmarcher et al (2002):	DEA -Ability to handle multiple variables	-Number of case mix adjusted discharges -Inpatient days	-Medical staff expenditures -Non-medical staff expenditures -Number of beds
Vitaliano et al (1991)	SFA - Ability to distinguish inefficiency and errors	- Patient days - Emergency room visits - Outpatient clinic visits	- Total cost - Wages of registered nurse - Wages of radiologists
Zuckerman et al (1994)	SFA	- Inpatient admissions by payer group - Post admission inpatient days - Outpatient visits	- Total cost - Average annual salary rate - Depreciation and interest costs per bed

	Method	Output variables	Input variables
Nong Y (1999): Six Singapore public hospitals	DEA -No restriction on the functional form of the production relationship -No requirement for knowledge of price for variables -Flexibility in using multiple variables	-Number of day surgery admissions -Number of inpatient cases -Number of outpatient visits	-FTE of doctors -FTE of nurses -FTE of paramedical/pharmacists -FTE of administrative staff -Number of beds
Valdmanis (1999)	DEA -Appropriate technique to handle multiple inputs and outputs -No need to estimate production or cost function	- Paediatric inpatient days - Non-paediatric inpatient days by age group - Intensive care inpatient days - Surgeries - Emergency room visits -Ambulatory visits	- House staff - Physicians - FTEs of nurse - FTEs of other labour - Total admissions - Net plant assets

	Method	Output variables	Input variables
O'Neill (1998)	DEA -No requirement for prior information about the price of resources or products -Powerful in handling multiproduct firms	-DRG adjusted non surgical inpatient discharges, -DRG adjusted surgical inpatient discharges -Adjusted number of outpatient visits	-Number of beds -Total operational expenditures -Technological service index -FTE of medical and non medical staff
Ersoy et al (1997)	DEA It does not make assumptions about functional forms	- Number of separations - Outpatient visits - Surgical operations	- Number of beds - FTEs of specialist - Hospital based primary care physicians
Yong et al (1999):	SFA: No sensitivity to outliers, and as a result no sensitive to mismeasurement	-Weighted Inlier Equivalent Separations -Number of emergency visits -Number of on-campus medical and clinical visits	-Salary of staff in different categories (medical, nursing, administration)

APPENDIX B: INFORMATION SHEET

The measurement of efficiency for the Iranian SSO hospitals

Thank you for considering participation in this study which aims to measure the efficiency of the SSO hospitals, to analyse factors affecting efficiency, and to identify possible actions that would make an inefficient hospital more efficient.

This research is motivated to rectify the apparent dearth of literature on hospital efficiency measurement in Iran, ultimately to improve the health and wellbeing of the people of Iran. More specifically, beyond the simple measurement of hospitals' efficiency, the study seeks to enhance hospital performance by developing a new model for measuring hospital efficiency through the SSO hospital database.

You are invited to participate in this study because of your recognised expertise in the field of health service management, and (or) health economics. The information gained from the study will add to the body of knowledge concerning the improvement of the performance of the Iranian hospitals in general, and the SSO hospitals in particular.

It is expected that the findings of the study would provide a direction to policy makers and hospital managers in the SSO on issues such as improving performance measures, mobilizing resources and developing a strategic plan to improve efficiency.

The interviews/ discussions should run for approximately an hour and a half and will begin with a brief review of the different steps of the present study including objectives, methods, and the findings of the quantitative phase. Then, they will address questions concerning factors affecting hospital efficiency, both from within the hospital and from its surrounding environment; and identifying options for actions, in order of priority, that would make an inefficient hospital more efficient.

There will be no direct benefit to you from participating, neither are there any particular risks. As a study participant, you can refrain from answering any question you choose. You have also a right to withdraw from the study at any time. You may ask to have the tape recorder stopped at any stage during interview proceedings.

Confidentiality of information gathered will be upheld at all times. Only the researcher mentioned below will have access to the information provided. The identity of participants on audiotape can be masked if requested. Some material on the audiotape may be transcribed into written form. Any audiotape transcriptions will carry no label of identity but rather, be assigned an identification number known only to this researcher. This written material will, therefore, have no information which could lead to the identification of any participant.

Research results will be reported in the form of a thesis towards a PhD degree in the University of Adelaide. Findings may be at some time published in professional journals or presented at professional seminars. However, it should be noted that there will be no details included in the project or presentations which could identify you. All information collected as part of the study will be retained in a confidential and secured location.

If you have any question regarding the project or your involvement in it, please do not hesitate to contact the researcher by: phone: 6931017 or email: *hossein.hajialiafzali@student.adelaide.edu.au*

Or the supervisors of the study:

- John Moss by phone: 0061 8 83034620 or email: john.moss@adelaide.edu.au
- Afzal Mahmood by phone: 0061 8 83033586 or email: afzal.mahmood@adelaide.edu.au

This study has been approved by the Human Research Ethics Committee of the University of Adelaide. If you have any question or problem associated with your participation, or wish to discuss with someone independent of this project, please contact the Secretary on 0061 8 8303 6028.

Thank you for your help in this study

APPENDIX C: CONSENT FORM

FOR PEOPLE WHO ARE SUBJECTS IN A RESEARCH PROJECT

1. I, ………………………………………………………………… *(please print name)*

   consent to take part in the research project entitled:

   Efficiency measurement for hospitals owned by the Iranian Social Security Organization…………………………………………………………………………

2. I acknowledge that I have read the attached Information Sheet entitled:

   The measurement of efficiency for the Iranian SSO hospitals

3. I have had the project, so far as it affects me, fully explained to my satisfaction by the research worker. My consent is given freely.

4. Although I understand that the purpose of this research project is to improve the quality of medical care, it has also been explained that my involvement may not be of any benefit to me.

5. I have been given the opportunity to have a member of my family or a friend present while the project was explained to me.

6. I have been informed that, while information gained during the study may be published, I will not be identified and my personal results will not be divulged.

7. I understand that I am free to withdraw from the project at any time and that this will not affect medical advice in the management of my health, now or in the future.

8. I am aware that I should retain a copy of this Consent Form, when completed, and the attached Information Sheet.

   ……………………………………………………………………………………………

   (signature) *(date)*

WITNESS

I have described to ……………………………………………….*(name of subject)*

the nature of the procedures to be carried out. In my opinion she/he understood the explanation.

Status in Project**:** ……………………………………………………………………….

Name: ………………………………………………………………………………..

(signature) *(date)*

APPENDIX D: INTERVIEW GUIDE

(1) What is your name and position in SSO (or Iranian) health system?

(2) When you think of efficiency (hospital efficiency), what comes to mind?

(3) Do you think that selected variables can reasonably (considering data availability) capture the key hospital inputs and outputs?

(4) According to your experience, do you think that benchmark hospitals (or least efficient hospitals) are good-performing (poor performing) hospitals? How do you rank five best and five least efficient hospitals? **(Only for policy makers and experts)**

(5) In your opinion, what are the main factors affecting hospital efficiency in general, and SSO hospitals in particular? (Inside and outside of hospitals, SSO health system and Iranian health system)**(Only for policy makers and experts)**

(5-1) In your opinion, what are the main factors affecting your hospital efficiency? (Inside the hospitals, inside and outside of SSO health system) **(Only for mid-level mangers)**

(6) How can these factors affect hospital efficiency?

(7) How do you prioritize options for actions to improve hospital efficiency?

(8) (Summary is provided by the researcher), Does the summary provided adequately capture the key issues of today's interview (or discussion)?

(9) Is there anything that we should have talked about but we did not?

APPENDIX E: VALUES OF INPUT AND OUTPUT VARIABLES

Hospital	Beds	Medical Doctors	Nurses	Other staff	C/section	Major surgical interventions	Outpatient visits	Emergency attendances
ValiasrMazandran	201	51	197	166	653	176	290,306	58
Fayazbakhsh	496	162	411	219	621	6,766	529,909	60
ShariatiEsfahan	538	78	365	225	914	7,245	579,574	68
Zarand	66	21	86	76	635	846	102,260	23
RaziChalus	49	14	54	29	345	346	82,626	24
ChamranSaveh	73	42	64	50	563	500	106,067	28
THaydarieh	67	17	71	47	967	1,058	101,424	26
Bojnoord	76	16	52	46	425	954	123,971	42
AmirkabirAhvaz	51	45	81	81	722	1,353	377,088	10
Takestan	92	24	84	80	443	418	169,337	35
GharaziMalayer	116	20	82	70	589	977	115,136	14
AtyehHamedan	135	28	127	99	837	975	209,748	56
Khalij	106	30	109	61	622	213	112,111	23
EmamArak	140	20	102	74	738	475	137,678	48
Eslamshar	104	71	137	137	474	2,395	290,399	72
Khordad15	125	84	161	172	766	931	241,647	72
AlinasabTabriz	187	55	176	133	789	931	169,866	69
SabalanArdabil	135	53	106	84	1,112	239	149,968	21
GharaziEsfahan	182	55	179	119	717	5,602	378,515	48
Najafabad	119	43	103	101	701	2,006	179,675	5
SalmanBousher	110	45	115	65	1,021	698	94,919	42
Sanandaj	116	18	84	72	192	1,154	90,537	31
KashaniKerman	191	54	188	177	880	2,254	433,531	15
GharaziSirjan	119	39	111	114	598	626	176,580	6
ShKermanshah	166	43	140	139	1,079	4,004	180,923	53
GonbadGolestan	140	19	110	69	1,482	579	178,895	5
RasoulRasht	171	34	151	93	1,529	3,651	116,100	30
ShahryarKaraj	127	36	128	93	825	105	157,314	40
AlborzKaraj	171	35	176	133	811	227	105,214	32
ShahrKord	106	24	87	75	1,477	1,231	70,243	21
AmiralAhvaz	154	69	157	75	933	3,610	260,171	27

Hospital	Beds	Medical Doctors	Nurses	Other staff	C/section	Major surgical interventions	Outpatient visits	Emergency attendances
ShafaSemnan	102	14	79	38	417	108	77,291	37
Zahedan	135	41	144	97	531	2,942	145,789	58
RaziGhazvin	193	53	160	141	669	1,602	316,560	69
EmamUremeyeh	205	61	200	123	789	2,270	285,687	32
ShMashad17	285	44	133	146	848	2,556	361,874	74
Beheshtifars	203	67	241	120	568	4,074	286,467	96
BeheshtiKashan	338	102	207	154	425	1,710	214,925	5
Khoramabad	228	69	136	119	321	2,599	190,795	43
KargarYazd	203	44	179	126	793	1,414	243,560	25
ArasArdabil	36	14	35	40	303	51	67,618	5
Birjand	26	12	31	33	241	223	102,524	6
Abadan	67	24	56	61	735	1,913	22,046	22
Behbahan	70	26	69	56	421	704	181,145	22
EmamZanjan	91	30	97	54	1,099	228	145,789	44
ShazandArak	48	12	38	43	220	468	85,967	25
Saghez	42	33	53	48	148	129	106,009	44
KosarBroujerd	33	27	30	46	78	894	95,328	37
Neka	39	12	40	39	357	95	124,112	39
Hedayat	71	44	105	52	1,891	571	86,672	12
MehrBorazjan	16	8	40	28	210	64	3,425	1
ErshadKaraj	33	10	43	51	261	248	10,473	2
HashtgerdK	25	12	35	35	234	174	86,520	1
Mean	137	39	119	91	679	1463	180232	34
Standard Deviation	106	27	75	48	371	1661	122291	22

APPENDIX F: MATHEMATICAL SPECIFICATION OF DEA

The informatiomn in this Appendix has been obtained from Kirigia et al.

The technical efficiency of a decision making unit is in the form of an output to input ratio, and is computed by solving two fractional programming models, under the assumption of constant returns to scale (Model 1) and variables returns to scale (Model 2).

Model 1. DEA weights model, input-oriented, constant returns to scale (CRS)	Model 2. DEA weights model, input-oriented, variable returns to scale (VRS)
$\text{Eff} = \underset{u_r, v_i}{\text{Max}} \sum_r u_r y_{rj_0}$	$\text{Eff} = \underset{u_r, v_i}{\text{Max}} \sum_r u_r y_{rj_0} + u_0$
s.t.	*s.t.*
$\sum_r u_r y_{rj} - \sum_i v_i x_{ij} \leq 0 \quad ; \forall j$	$\sum_r u_r y_{rj} - \sum_i v_i x_{ij} + u_0 \leq 0 \quad ; \forall j$
$\sum_i v_i x_{ij_0} = 1$	$\sum_i v_i x_{ij_0} = 1$
$u_r, v_i \geq 0 \quad ; \forall r, \forall i.$	$u_r, v_i \geq 0 \quad ; \forall r, \forall i.$

Source: Kirigia et al. Mesaurement of technical efficiency of public hospitals in Kenya: using data envelopment analysis J Med Syst 2002, 26: 39-45.

Where
y_{rj} = the amount of output r produced by hospital j,
x_{ij} = the amount of input i used by hospital j,
u_r = the weight given to output r, ($r = 1, \ldots, t$ and t is the number of outputs)
v_i = the weight given to input i, ($i = 1, \ldots, m$ and m is the number of inputs)
n = the number of hospital,
j_0 = the hospital under assessment

REFERENCES

[1] Australian Institute of Health and Welfare. Health expenditure Australia 2004-05. Canberra: The Institute; 2006.
[2] McKee M, Healy J, editors. Hospitals in a changing Europe. Philadelphia: Open University Press; 2002.
[3] Mac Kee M, Henley S. The role of the hospital in a changing environment. Bull World Health Organ 2000; 78: 803-810.
[4] Barnum H, Kutzin J. Public hospitals in developing countries: resource use, cost, financing. Baltimore: The Johns Hopkins University Press; 1993.
[5] Veillard E, Champagne F, Klazinga N, Kazandjian V, Araph A, Guisset L. A performance assessment framework for hospitals: the WHO regional office for Europe PATH project. Int J Qual Health Care 2005; 17: 487-496.
[6] Yaisawarng S. Puthucheary N. Performance measurement and resource allocation. Sydney: The Treasury's Office of Financial Management; 1997.
[7] Jacobs R. Alternative methods to examine hospital efficiency: data envelopment analysis and stochastic frontier analysis. Health Care Manage Sci 2001; 4: 103-115.
[8] Hollingsworth B. Non parametric and parametric applications measuring efficiency in health care. Health Care Manag Sci 2003; 6:203-218.
[9] Kamrava SK. Database of Iranian hospital information. Tehran: MOH Publications; 1997.
[10] World Bank. Iran national health accounts. Tehran: The Organization; 2001.
[11] Department of Statistics. Annual statistics report. Tehran: The Iranian Social Security Organization; 2002.
[12] Egger M, Smith G, Altman D. Research reviews in health care. London: BMJ Books; 2001.
[13] Creswell JW. Research design: qualitative, quantitative, and mixed method approaches. 2nd edition. California: Sage Publications; 2003.
[14] Robbins L. The nature and significance of economic science. London: McMillan Press; 1984.
[15] Rutherford R. Routledge dictionary of economics.2nd ed. London: Routledge; 2002.
[16] Nunamaker TR. Using data envelopment analysis to measure the efficiency of non-profit organisations: a critical evaluation. Journal of Managerial and Decision Economics 1985; 6: 50-58.
[17] Pass C, Lowes B, Davies L. Dictionary of economics. 3rd ed. Glasgow: Harper Collins; 2000.
[18] Eatwell J, Milgate M, Newman P. The new palgrave: a dictionary of economics. London: The Mc Millian Press Limited; 1987.
[19] Sloman J, Norris K. Economics. 2nd ed. Sydney: Prentice Hall; 2002.
[20] Long MJ, Chesney JD, Fleming ST. A reassessment of hospital product and productivity changes over time. Health Care Financ Rev 1990; 11: 69-77.
[21] Rannan-Eliya RP, Somanathan A. The Bangladesh health facility efficiency study. Sri Lanka: Institute of Policy Studies; 2003.
[22] Duckett SJ, Jackson TJ. The new health insurance rebate: an inefficient way of assisting public hospitals. Med J Aust 2000; 172: 439-442.
[23] Mahapatra P, Berman P. Using hospital activity indicators to evaluate performance in Andhra Pradesh, India. Int J Health Plan Manage 1994; 9: 199-211.
[24] Peacock S, Chan C, Mangolini M, Johansen D. Techniques for measuring efficiency in health services. Canberra: Productivity Commission Staff Working Paper; 2001.
[25] Athanassopoulos AD, Shale E. Assessing the comparative efficiency of higher education institutions in the UK by means of data envelopment analysis. Abingdon: Education Economics; 1997.
[26] Cooper WW. Seiford LM, Tone K. Data envelopment analysis: a comprehensive text with models, applications, and references. Boston/Dordrecht/London: Kluwer Academic Publishers; 2000.
[27] Coelli T, Rao SP, Battese G. An introduction to efficiency and productivity analysis. Boston: Kluwer Academic Publishers; 1998.
[28] Seiford LM, Thrall RM. Recent developments in DEA: the mathematical programming approach to frontier analysis. J Econom 1990; 46: 7-38.
[29] Kwakye E. Relative efficiency of some selected hospitals in the Accra-Tema metropolis. In: Emrouznejad A, Podinovski V, editors. Data envelopment analysis and performance management [online]. 2004 [cited 2005 Nov. 22]. Available from: URL: WWW.DEAzone.com/DEA2004.
[30] Zere E. Hospital efficiency in Sub- Sahara Africa: evidence from South Africa. Helsinki: United Nations University Press; 2000.

[31] Pavananunt K. Hospital efficiency: a study of public community hospital in Thailand. In: Emrouznejad A, Podinovski V, editors. Data envelopment analysis and performance management [online]. 2004 [cited 2005 Nov. 22]. Available from: URL:WWW.DEAzone.com/DEA2004.
[32] Zere E, Mbeeli T, Shangula K, Mandlhate C, Mutirua K, Tjivambi B, et al. Technical efficiency of district hospitals: evidence from Namibia using DEA. Cost Eff Resour Alloc [serial online]. 2006 March 27; [cited 2006 July]; 4: [9 screens]. Available from: URL: http://www.resource-allocation.com/content/4/1/5
[33] Bhat R, Verma BB, Reuben E. An empirical analysis of district hospitals and grant-in-aid hospitals in Gujarat state of India. Ahmedabad: Indian Institute of Management; 2001.
[34] Owino W, Korir J. Public health sector efficiency in Kenya: estimation and policy implications. Kenya: Institute of Policy Analysis and Research; 1997.
[35] Kirigia JM, Emrouznejad A, Sambo LG. Measurement of technical efficiency of public hospitals in Kenya: using DEA. J Med Syst 2002: 26: 39-45.
[36] Chang H, Cheng MA, Das S. Hospital ownership and operting efficiency: evidence from Taiwan. Eur J Oper Res 2004; 159: 513-527.
[37] Al-Shammari M. A multi-criteria DEA model for measuring the productive efficiency of hospitals. Int J Oper Prod Manage 1999; 19: 879-890.
[38] Norman M, Stoker B. DEA analysis: the assessment of performance. Chichester: John Wiley and Sons; 1991.
[39] Ramanathan R. Operations assessment of hospitals in the Sultanate of Oman. Int J Oper Prod Manage 2005; 25: 39-54.
[40] Osei D, Almeida S, George M, Kirigia JM, Mensah AO, Kainyu LH. Technical efficiency of public district hospitals and health centers in Ghana: a pilot study. Cost Eff Resour Alloc [serial online]. 2005 September 27; [cited 2006 September]; 3: [13 screens]. Available from: URL: http://www.resource-allocation.com/content/3/1/9
[41] Yong K, Harris A. Efficiency of hospitals in Victoria under casemix funding: a stochastic frontier approach. Melbourne: Centre for Health program Evaluation; 1999.
[42] Rosko MD. Cost efficiency of US hospitals: a stochastic frontier approach. Health Econ 2001; 10: 539-551.
[43] Chaffai ME. Estimating input specific technical inefficiency. Eur J Oper Res 1997; 98: 95-112.
[44] Ozcan Y, Luke RD, Haksever C. Ownership and organizational performance: a comparison of technical efficiency across hospital types. Med Care 1992; 30: 780-794.
[45] Hollingsworth B, Parkin D. The efficiency of Scottish acute hospitals: an application of data envelopment analysis. IMA J Math Appl Med Biol 1995; 12: 161-173.
[46] Rosenmann R, Siddharatan K, Ahern M. Output efficiency of health maintenance organizations in Florida. Health Econ 1997; 6: 295-302.
[47] Burgees JF, Wilson PW. Variations in efficiency among US hospitals. INFOR, Can J Oper Res Inf 1998; 36: 84-102.
[48] O'Neill L. Multifactor efficiency in DEA with an application to urban hospitals. Health Care Manag Sci 1998; 1:19-27.
[49] Sahin I, Ozcan Y. Public sector hospital efficiency for provincial markets in Turkey. J Med Syst 2000; 24: 307-320.
[50] Jin-Yuan C, Wan TTH. The impact of the prospective payment system on the technical efficiency of hospitals. J Med Syst 2000; 24: 159-172.
[51] Chirikos TN, Sear AM. Measuring hospital efficiency: a comparison of two approaches. Health Ser Res 2000; 34: 1389-1408.
[52] Giokas DJ. Greek hospitals: how well their resources are used. Omega 2001; 29: 73-83.
[53] Hofmarcher M, Paterson I, Riedel M. Measuring hospital efficiency in Austria, a DEA approach. Health Care Manag Sci 2002; 5:7-14.
[54] Chern J, Wan TH. The impact of the prospective payment system on the technical efficiency of hospitals. J Med Syst 2000; 24: 159-172.
[55] Worthington AC. Fronteir efficiency measurement health care: a review of empirical techniques and selected applications. Med Care Res Rev 2004; 61: 135-170.
[56] Hollingsworth B, Dawson PJ, Maniadakis N. Efficiency measurement of health care: a review of non-parametric methods and applications. Health Care Manag Sci 1999; 2: 161-172.
[57] Ferrier GD, Valdmanis V. Rural hospital performance and its correlates. J Pro Analysis 1996; 7: 63-80.
[58] Hollingsworth B, Parkin D. The efficiency of Scottish acute hospitals: an application of data envelopment analysis. IMA J Math Appl Med Biol 1995; 12: 161-173.

[59] Grosskopf S, Valdmanis V. Measuring hospital performance: a nonparametric approach. Med Care 1993; 31: 525-532.
[60] Manhiem LM, Feinglass J, Shortell SM, Hughes EFX. Regional variation in Medicare hospital mortality. Inquiry 1992; 29: 55-65.
[61] Mobley LR, Magnussen J. An international comparison of hospital efficiency: does institutional environment matter? App Econ 1998; 30: 1089-1100.
[62] Chern JY. Wan T. The impact of the prospective payment system on the technical efficiency of hospitals. J Med Systs 2000; 24: 159-172.
[63] Eisenberg J. Doctors decisions and the cost of medical care. Ann Arbor: Health Administration Press; 1986.
[64] Webster R, Kennedy S, Johnson L. Comparing techniques for measuring the efficiency and productivity of Australian private hospitals. Canberra: Australian Bureau of Statistics; 1998.
[65] Maniadakis N, Thanassoulis E. Assessing productivity changes in UK hospitals reflecting technology and input prices. App Econ 2000; 32: 1575-1589.
[66] Wang BB, Ozcan Y, Wan TH, Harrison J. Trends in hospital efficiency among metropolitan markets. J Med Systs 1999; 23: 83-97.
[67]Harrison JP, Coppola MN, Wakefield M. Efficiency of federal hospitals in the United States. J Med Syst 2004; 28: 411-422.
[68] Zuckerman S, Hadley J, Iezzoni L. Measuring hospital efficiency with frontier cost functions. J Health Econ 1994; 13: 225-280.
[69] Long MJ, Chensey JD, Fleming ST. A reassessment of hospital product and productivity changes over time. Health Care Financ Rev 1990; 11: 69-77.
[70] Nolan T, et al. Quality of hospital care for seriously ill children in less-developed countries. Lancet 2001; 357: 106-110.
[71] Vitaliano DF, Torren M. Hospital cost and efficiency in regime of stringent regulation. East Econ J 1996; 22: 161-175.
[72] Linna M. Measuring hospital cost efficiency with panel data models. Health Econ 1998; 7: 415-427.
[73] Ozcan Y. Sensitivity analysis of hospital efficacy under alternative output/input and peer groups: a review. Knowl pol 1993; 5: 1-29.
[74] Valdmanis V. Sensitivity analysis for DEA models: an empirical example using public vs. NFP hospitals. J Public Econ 1992; 48: 185-202.
[75] O'Neill L. Multifactor efficiency in data envelopment analysis with an application to urban hospitals. Health Care Manag Sci 1998; 1: 19-27.
[76] Clewer A, Perkins D. Economics for health care management. London: Prentice Hall; 1998.
[77] Grosskpof S, Valdmanis V. Measuring hospital performance: a non-parametric approach. J Health Econ 1987; 6: 89-107.
[78]Gonzales Lopez B, Barber Perez P. Changes of the efficiency of Spanish public hospitals after the introduction of program-contracts. Invest Econ 1996; 20: 377-402.
[79] Ersoy K, Kavuncubasi S, Ozcan Y, Harris JM. Technical efficiencies of Turkish hospitals: DEA approach. J Med Syst 1997; 21: 67-75.
[80] Ozcan YA, LukeRD. A national study of the efficiency of hospitals in urban markets. Health Serv Res 1993; 27: 719-739.
[81] Rollins JK, Lee Y, Ozcan YA. Longitudinal study of health maintenance organization efficiency. Health Serv Manage Res 2001; 14: 249-262.
[82] Jacobs R. Alternative methods to examine hospital efficiency: data envelopment analysis and stochastic frontier analysis. Health Care Manag Sci 2001; 4: 103-115.
[83] Puig-Junoy J. Technical efficiency in the clinical management of critically ill patients, Health Econ 1998; 7: 263-277.
[84] Rosko M, Chilingerian J. Estimating hospital inefficiency. Does casemix matter? J Med Syst 1999; 23: 57-71.
[85] Bjorkgren M, Fries B, Hakkinen U, Brommels M. Casemix adjustment and efficiency measurement. Scand J Public Health 2004; 32: 464-471.
[86] Park H, Shin Y. Measuring case mix complexity of the tertiary care hospitals using DRGs. Health Care Manag Sci 2004; 7: 51-61.
[87] Morey RC, Ozcan YA, Retzelaff-Roberts DL, Fine DJ. Estimating hospital wide cost differentials warranted for teaching hospitals, an alternative to regression approaches. Med Care 1995; 33: 531-552.
[88] Yong K, Harris A. Efficiency of hospitals in Victoria under casemix funding: a stochastic frontier approach. Centre for Health Program Evaluation; 1999.
[89] Ozcan Y, Bannick RR. Trends in Department of Defense hospital efficiency. J Med Syst 1994; 18: 69-83.

[90] Magnusen J. Efficiency measurement and the operationalization of hospital production Health Serv Res 1996; 31: 21-37.
[91] Banker R, Charnes A, Cooper WW, Swarts J, Thomas DA. An introduction to data envelopment analysis with some of its models and their uses. Res Gov Accounting 1989; 5: 165-185.
[92] Patrick A, Renne M, George M. Ambulatory patient groups and redefining the roles of health care providers' delivery services in the USA. Health Manpow Manage 1996; 22: 16-20.
[93] Australian Institute Health and Welfare. Australian Health Statistics. Canberra: The Institute; 2002.
[94] Chilingerian JA. Exploring why some physicians' hospital practices are more efficient: taking DEA inside the hospital. In: Charnes A, Cooper WW, Lewin AY, Seiford LM, editors. Theory, methodology and applications. Boston: Kluwer Publications; 1993.
[95] Delfice LC, Bradford WD. Relative inefficiencies in production between solo and group practice physicians. Health Econ 1997; 6: 329-334.
[96] Partners for Health Reform/Plus. Management accounting system for hospitals (MASH) manual. Bethesda: The Institute; 2004.
[97]Morey R, Fine D, Loree S, Retzlaff-RobertsD, Tsubakitani S. The trade off between hospital cost and quality of care, an exploratory empirical analysis. Med Care 1992; 30: 677-698.
[98] Thanassoulis E, Boussofiane A, Dyson RG. Exploring output quality targets in the provision of perinatal care in England using data envelopment analysis. Eur J Oper Res 1995; 80: 588-607.
[99] Sahin I, Ozcan YA. Public sector hospital efficiency for provincial markets in Turkey. J Med Syst 2000; 24: 307-320.
[100] Aminloo H. Prediction of needed hospital beds in MOH and SSO. Tehran: Iranian Organisation for Planning Publications; 1997.
[101] Button KJ, Weyman-Jones TG. Ownership structure, institutional organization and measured X- efficiency. Amer. Econ. Rev 1992; 82: 439-445.
[102] Coulam R, Gaumer G. Medicare prospective payment: a critical appraisal. Health Care Fin Rev1991; 13: 45-77.
[103] Rosko M, Chilingerian J, Zinn J, Aarnoson W. The effects of ownership, operating environment, and strategic choices on nursing home efficiency. Med Care 1995; 33: 1-20.
[104] Rosko MD. Impact of internal and external environmentl pressures on hospital inefficiency. Health Care Manag Sci. 1999; 2: 63-74.
[105] Ozcan y, Luke R, Haksever C. Ownership and organizational performance: a comparison of technical efficiency across hospital types. Med Care 1992; 30: 781-794.
[106] Grosskopf S, Margaritis D, Valdamins V. Comparing teaching and non-teaching hospitals. Health Care Manag Sci 2001; 4: 83-90.
[107] Somanathan A, Hanson K, Dorabawila T, Perera B. Operating efficiency in public health facilities in Sri Lanka: measurement and institutional determinants of performance. Small Applied Research Paper No.12. Bethesda: Partnerships for Health Reform; 2000.
[108] Hughes A, Yaisawarng S. Operating environment adjusted efficiency of acute care public hospitals in New South Wales. Proceedings of the 2000 International DEA Symposium; 2000 July. 3-5; Ipswich, University of Queensland.
[109] Martin S, Smith p. Explaining variations in inpatient length of stay in NHS. J Health Econ 1996; 15: 279.
[110] Gary J, Young JD, Meterko M, Desal KR. Patient satisfaction with hospital care: effects of demographic and institutional characteristics. Med Care 2000; 38: 325-334.
[111] Mooney G, Russell EM, Weir RD. Choices for health care: a practical introduction to the economics of health care provision. London: McMillian; 1986.
[112] Ramanathan R. An introduction to DEA; a tool for performance measurement. London: Sage Publications; 2003.
[113] Thanassoulis E. Introduction to the theory and application of data envelopment analysis. Massachusetts: Kluwer Academic Publishers; 2001.
[114] Bowlin WF. Measuring performance: an introduction to data envelopment analysis. J Cost Anal 1998; fall: 3-27.
[115] Magnussen J. Efficiency measurement and the operationalization of hospital production. Health Serv Res 1996; 31: 21-37.
[116] Parkin D, Hollingsworth B. Measuring production efficiency of acute hospitals in Scotland, 1991-1994: validity issues in data envelopment analysis. App Econ 1997; 29: 1425-1443.
[117] Dyson RG, Allen R, Camanho AS, Podinovski V , Sarrico CS, Shale EA. Pitfalls and protocols in DEA. Eur J Oper Res 2001; 132: 245-259.

[118] Laine J, et al. The association between quality of care and technical efficiency in long-term care. Int J Qual Health Care 2005; 17: 259-267.
[119] Newhouse J. Toward a theory of nonprofit institutions: an economic model of a hospital. Am Econ Rev 1970; 60: 64-74.
[120] Norman M, Stocker B. DEA analysis: the assessment of performance. Chichester: John Wiley and Sons; 1991.
[121] Charnes A, Cooper W, Rhodes E. Measuring the efficiency of decision-making units. Eur J Oper Res 1978; 2: 429-444.
[122] Bryce CL, Engberg JB, Wholey DR. Comparing the agreement among alternative models in evaluating HMO efficiency. Health Serv Res 2000; 32: 509-528.
[123] Linna M, Hakkinen U. Determinants of cost efficiency of Finish hospitals: a comparison of DEA and SFA. In: Zweifel, editor. Health, the medical profession and regulation. Boston: Kluwer; 1998.
[124] Chaffai ME. Estimating input specific technical inefficiency: the case of Tunisian banking industry. Eur J Oper Res 1997; 98: 281-290.
[125] Emrouznejad A, Thanassoulis E. Performance Improvement Management; DEASoftV1.Birmingham: Aston University; 2005.
[126] Minichiello V, Sullivan G, Greenwood K, Axford R. Handbook for research methods in health sciences. Sydney: Addison Wesley; 1999.
[127] Patton M. Qualitative evaluation and research methods. 2nd ed. Newbury Park, CA: Sage Publications Inc; 1990.
[128] Van Leberghe W, Lafort Y. The role of hospital in the district: delivering or supporting primary health care. Geneva: World Health Organisation, Geneva; 1990.
[129] Dyson RG. Performance measurement and data envelopment analysis- rankings are rank! OR Insight 2000;13: 4-8.
[130] Roemer MI. National health systems of the world. New York: Oxford University Press; 1991.
[131] Pauly MV. Efficiency, incentives and reimbursement for health care. Inquiry 1970; 7: 114-131.
[132] Harris JE. The internal organisation of hospitals: some econometric implications. Bell J Econ 1977; 8: 467-482.
[133] World Health Organisation. A review of determinants of hospital performance. Geneva: The Organisation; 1994.
[134] WHO. The World Health Report 2000, Health systems: improving performance. Geneva: The Organisation; 2000.
[135] Murray C, Frenk J. A framework for assessing the performance of health systems. Bull World Health Organ 2000; 78: 717-730.
[136] Rootman I, Goodstadt M, Hyndman, B, McQueen D, Potvin L, Springett J, Ziglio E. Evaluation in health promotion: principles and perspectives. Copenhagen: European Regional Office of the World Health Organization; 2001.
[137] World Health Organisation Regional Office for Europe. The Vienna recommendations on Health Promoting Hospitals. Copenhagen: The Organization; 1997.
[138] Rootman I. Evaluation in health promotion: principles and perspectives. Copenhagen: World Health Organization Regional Office for Europe; 2001.
[139] Pelikan JM, Dietscher C, Krajic K, Nowak P. Core strategies for Heath Promoting Hospitals. Gamburg: World Health Organization Regional Office for Europe; 2001.
[140] Barbero M. Putting HPH policy into action. Barcelona: World Health Organization Regional Office for Europe; 2003.
[141] Baggs JG, Ryan SA, Phelps CE, Richeson JF, Johnson JE. The association between interdisciplinary collaboration and patient outcomes in medical intensive care. Heart Lung 1992; 21: 18-24.
[142] Harding A. Innovations in health care delivery: The corporatization of public hospitals. Baltimore: Johns Hopkins University Press; 2001.
[143] McKee M, Healy J. Hospitals in a changing Europe. Philadelphia: Open University Press; 2002.
[144] World Health Organisation Regional Office for Europe. The Vienna recommendations on health promoting hospitals. Copenhagen: The Office; 1997.
[145] Durant W: The Age of faith. New York: Simon and Shuster; 1950.
[146] Aiken L, Patrician P. Measuring organizational traits of hospitals. Nurs Res 2000; 49: 149-153.
[147] Aiken L, Sloane D. Effects of organisational innovations in AIDS care on burnout among hospital nurses. Work Occup 1997; 24: 455-479.

[148] Clarke S, Sloane D, Aiken L. Effects of hospital staffing and organisational climate on needlestick injuries. Am J Public Health 2002; 92: 1115-1119.
[149] Campbell SM, Roland MO, Buetow SA. Defining quality of care. Soc Sci Med 2000; 51: 1611-1625.
[150] Guyatt GH, Thompson PJ, Berman LB, Sullivan MJ, Townsend M, Jones NL, et al. How should we measure function in patients with chronic heart and lung disease? J Chronic Dis 1985; 38: 517-524.
[151] Sheldon T. Promoting health care quality: what role performance indicators? Qual Health Care 1998; 7: S45-S50.
[152] Jolley G. If only numbers count. Adelaide: South Australian Community Health Research Community; 2002.
[153] Aiken LH, Clarke SP, Sloane M. Hospital staffing, organization, and quality of care: cross-national findings. Int J Qual Health Care 2002; 14: 5-13.
[154] World Health Organisation. Standards for health promotion in hospitals: development of indicators for a self-assessment tool. Copenhagen: The Organisaation; 2004.
[155] Thomas LH, MacMillian J, McColl E, Priest J, Hale C, Bonds S. Obtaining patient views of nursing care to inform the development of a patient satisfaction scale. Int J Qual Health Care 1995; 7: 153-163.
[156] Campbell SM, Ronald MO, Buetow SA. Defining quality of care. Soc Sci Med 2000; 51: 1611-1625.
[157] Jenks SF, Cuerdon T, Burwen DR, Fleming B, Houck PM, Kussmaul AE, et al. Quality of medical care delivered to Medicare beneficiaries. JAMA 2000; 284: 1670-1676.
[158]Rubin HR, Pronovost P, Diette GB. The advantage and disadvantages of process-based measures of health care quality. Int J Qual 2001; 13: 469-474.
[159] Blumenthal D. Quality of care-what is it? N Engl J Med 1996; 335: 891-894.
[160] Irvine D. Managing for quality in general practice. London: Kings Fund Centre; 1990.
[161] Steffen G. Quality medical care: a definition. JAMA 1988; 260: 56-61.
[162] Pelikan JM, Dietscher C, Krajic K, Nowak P. Core strategies for Heath Promoting Hospitals. Gamburg: World Health Organization Regional Office for Europe; 2001.
[163] Lambie L, Mattke S. Selecting indicators for the quality of cardiac care at the health systems level in OECD countries. Paris: OECD Publications; 2004.
[164] American College of Cardiology. Guidelines for the treatment of AMI. Bethesda: The College; 1999.
[165] Ryan RJ, Antman EM, Brooks NH. ACC guidelines for the management of patients with AMI. J Am Coll Cardiol 1999; 34: 890-911.
[166] European Society of Cardiology. Task force on the management of acute myocardial infarction. Eur Heart J 2003: 24: 25-66.
[167] Jencks SF, Huff, ED, Cuerdon T. Change in the quality of care delivered to Medicare beneficiaries. JAMA 2003; 289: 305-312.
[168] Bowker TJ, Clayton TC, Ingham J. A British Cardiac Society survey of the potential for the secondary prevention of coronary disease. Heart 1996; 75: 334-342.
[169] Lee S, TranC, Flintoft V. quality indicators for congestive heart failure care. Can Med Assoc 2003; 19: 357-3654.
[170] American Medical Association.. Clinical performance measures for heart failure. Dallas: The Association; 2003.
[171] Lindsay MP, Kapral MK, Holloway R, Gladstone DJ, Tu JV, Laupacis A, et al. Canadian stroke quality of care study: identification of performance indicators for acute stroke care. Can Med Assoc 2005; OL 1-8.
[172] Quillen JE, Rossen JD, Oskarsson HJ, Minor RL Jr, Lopez JAG, Winniford MD. Acute effect of cigarette smoking on the coronary circulation: constriction of epicardial and resistance vessels. J Am Coll Cardiol 1993; 22: 642-647.
[173] Meade TW, Imeson J, Stirling Y. Effects of changes in smoking and other characteristics on clotting factors and the risk of ischaemic heart disease. Lancet 1987; 2:986-988.
[174] Hermanson B, Omenn GS, Kronmal RA, Gersh BJ. Beneficial six-year outcome of smoking cessation in older men and women with coronary artery disease. N Engl J Med 1988; 319:1365-1369.
[175] Berger H, Krajic K, Paul R. Health promoting hospitals in practice. Hamburg: Health Promotion Publications; 1999.
[176] Shearer, E., Caesarean section: Medical benefits and costs. J Soc. Sci. Med. 37: 1223-1231, 1993
[177] Anderson GM. Making sense of rising caesarean section rates. Br Med J 2004; 329: 696-697.
[178] Rahnama P, ZiaieS, Faghizadeh S. Impact of early admission in labor on method of delivery. Int J Gynaecol Obstet 2006; 92: 217-220.
[179] World Health Organisation. The World Health Report 2000, health systems: improving performance. Geneva: The Organisation; 2000.
[180]Graber AM, Phelps CE. Economic foundations of cost-effectiveness analysis. Health Econ 1999; 16: 1-31.

[181] Gerard K, Mooney G. QALY league tables: handle with care. Health Econ 1993; 2: 59-64.
[182] Ibrahim JE, Majoor JW, Boyce NW, McNeil JJ. Pilot hospital clinical indicators project. Canberra: Commonwealth Department of Health and Family Services; 1998.
[183] Ibrahim JE, Majoor JW, Boyce NW, McNeil JJ. Pilot hospital clinical indicators project. Canberra: Commonwealth Department of Health and Family Services; 1998.
[184] Eddy DM. Performance measurement: problems and solutions. Health Aff 1998; 17: 7-25.
[185] Brook RH, McGlynn EA. Measuring quality of care. N Engl J Med 1996; 335: 966-970.
[186] Montoya-Aguilar C. Measuring the performance of hospitals and health centers. Geneva: World Health Organization; 1994.
[187] Cairns J. Measuring health outcomes. Br Med J 1996; 313: 6.
[188] Paterson C. Measuring outcomes in primary care: patient generated measure. Br Med J 1996; 312: 1016-1020.
[189] Guiffrida A, Gravelle H, Ronald M. Measuring quality with routine data: avoiding confusion between performance indicators and health outcomes. Br Med J 1999; 319: 94-98.
[190] McElduff P, Lyratzopoulos G, Edwards R, Heller RF, Shekelle F, Roland M**.** Will changes in primary care improve health outcomes? Modeling the impact of financial incentives introduced to improve quality of care in the UK. Qual Saf Health Care 2004; 13: 191-197.
[191] Agency for Healthcare Research and Quality. Quality indicators- guide to inpatient quality indicators: quality of care in hospitals-volume, mortality, and utilization. Rockville: Agency for Healthcare Research and Quality; 2004.
[192] Agency for Healthcare Research and Quality. Guide to patient safety indicators. Version 3.1. Rockville: The Agency; 2007.
[193] Johantgen M, Elixhauser M, Bali JK, Goldfarb M, Harris DR. Quality indicators using hospital discharge data. J Comm J Qual Improv 1998; 24: 88-195.
[194] Ibrahim J, Majoor J, Boyce NW, McNeil J. Pilot hospital wide clinical indicators project: a study of the reliability, validity, and risk adjustment of the national hospital quality management program pilot set of hospital wide clinical indicators. Canberra: Commonwealth Department of Health and Family Services; 1998.
[195] Keeler E. Kahn K, Bentow S. Assessing quality of care for hospitalized Medicare patients with hip fracture. Springfield, VA: NTIS; 1991.
[196] Berlowitz D, Brand H, Perkins D. Geriatrics syndrome as outcome measures of hospital care, can administrative data be used? J Am Geriatr Soc 1999; 47: 692-696.
[197] Miller M, Elixhauser A, Zhan C, Meyer G. Patient safety indicators: using administrative data to identify potential patient safety concerns. Health Serv Res 2001; 36: 110-132.
[198] Geraci JM, Ashton CM, Kuykendal DH, Johnson ML, Wu L. In hospital complications among survivors of admission for congestive heart failure, chronic obstructive pulmonary disease, or diabetes mellitus. J Gen Intern Med 1995; 10: 307-314.
[199] Best W, Khuri S, Phelan M, Henderson w, Demakis J, Hur K, et al. Identifying patient preoperative risk factors and postoperative adverse events in administrative database. J Am Coll Surg 2002; 194: 257-266.
[200] Schwartz R, Gagnon JH, Murri QR. Administrative data for quality improvement. Pediatrics 1999; 103: 291-301.
[201] Gordis L. epidemiology. 3rd ed. Philadelphia: Elsevier Saunders; 2004.
[202] Rustein DD, Berenberg W, Chalmers TC. Measuring the quality of medical care: a clinical method. N Engl J Med 1976; 249: 582-589.
[203] Holland WW. The European Community atlas of avoidable death. 3rd ed. Commission of the European Communities Health Services Research. Oxford: Oxford University Press; 1997.
[204] Westerling R. Commentary: evaluating avoidable mortality in developing countries- an important issue for public health. Int. J. Epi 2001; 31: 973-975.
[205] Nolte E, McKee M. Measuring the health of nations: analysis of mortality amenable to health care. Br Med J 2003; 327: 1129-1139.
[206] Rustein DD, Berenberg W, Chalmers TC. Measuring the quality of medical care: a clinical method. N Engl J Med 1976; 249: 582-589.
[207] Holland WW. The European Community atlas of avoidable death. 3rd ed. Commission of the European Communities Health Services Research. Oxford: Oxford University Press; 1997.
[208] Clinical Outcomes Working Group. Clinical outcomes indicators. Edinburgh: The Scottish Executive; 2002.
[209] Rockall TA, Logan RF, Devlin HB. Variation in outcome after acute upper gastrointestinal haemorrhage. Lancet 1995; 346: 346-350.

[210] Gleason PP, Heehan TP, Fine JM. Association between initial antimicrobial therapy and medical outcomes for hospitalized elderly patients with pneumonia. Arch Intern Med 1999; 159: 2562-2572.
[211] Madge P, McColl J, Paton J. Impact of a nurse-led home management training programme in children admitted to hospital with acute asthma: a randomized controlled study. Thorax 1997; 52:223-228.
[212] Aubert RE, Herman WH, Waters J, et al. Nurse case management to improve glycemic control in diabetic patients in a health maintenance organization: a randomized, controlled trial. Ann Intern Med 1998; 129:605-612.
[213] William JK. Do health care report cards grade the wrong thing? Consumers' Res 2002; 40-41.
[214] Statistical Centre of Iran. Annual report. The Centre; 2004.
[215] Schieber G, Klingen N. Health financing reform in Iran: priciples and possible next steps. Tehran: World Bank; 1999.
[216] Social Security Statistics Department. Annual report. The Department; 2004.
[217] Social Security Organisation. Annual report. The Organisation; 2004.
[218] World Health Organization. Hospital statistics indicators. Geneva: The Organisation; 2000.
[219] Somanathan A, Hanson K, Dorabawila T, Perera B. Operating efficiency in public sector health facilities in Sri Lanka. Sri Lanka: Partnerships for Health Reform; 2000.
[220] Erosy K, Kavunucubasi S, Ozcan A. Technical efficiency of Turkish hospitals: DEA approach. J Med Syst 1997; 21: 67-74.
[221] Posnett J. Is bigger better? Concentration in the provision of secondary care. Br Med J 1999; 319: 1063-1065.
[222] Ferguson B, Sheldon TA. Concentration and choice in health care. London: Financial Times Healthcare; 1997.
[223] Sharkey P, Dehaemer M, Horn S. Assessing the severity of patient's illness to better manage health care resources. Interfaces 1993; 22: 922-938.
[224] Lopez GB, Perez BP. Changes of the efficiency of Spanish public hospitals after the introduction of program-contracts. Invest Econ 1996; 20: 377-402.
[225] The Iranian Plan and Budget Organization. Human development report of the Islamic Republic of Iran. Tehran: United Nations Publications; 2001.
[226] Iranian Ministry of Health. Hospital statistics. Tehran: Ministry of Health Publications; 2003.
[227] United Nations. Human development report 2001: making new technical work for human development. New York: United Nations Development Program; 2001.
[228] World Health Organization. Hospital statistics indicators. Geneva: The Organisation; 2000.
[229] Australian Institute of Health and Welfare. National health data dictionary. Version 11. Canberra: The Institute; 2003.
[230] Yazbeck AS, Peters DH. Health policy research in south Asia: building capacity for reform. Washington: The World Bank: 2003.
[231] Lasso P. Evaluation of hospital performance through simultaneous application of several indicators. Bull Pan Am Health Organ 1986; 20: 341-357.
[232] Tatchell M. Measuring hospital output. Soc Sci Med 1983; 17: 871-887.
[233] Sharkey P, Horn S, Dhamer M. Assessing the severity of patient's illness to better manage health care resources. Interfaces 1993; 23: 12-20.

[234] Mahapatra P, Berman P. Using hospital activity indicators to evaluate performance in Andhra Pradesh, India. Int J Health Plann Manage 1994; 9: 199-211.
[235] Bitran R. Technical and economic efficiency in the production of health services, phase 1: review of concepts and literature. Bethesda: Abt Associates Inc; 1992.
[236] Cooper, W.W., Seiford, L.M, Tone, K. Data Envelopment Analysis: a comprehensive text with models, applications, references and DEA-solver software. Boston: Kluwer Academic Publishers; 2000.
[237] McLaughlin CP, Coffey S. Measuring productivity in services. Int J Serv Ind Manag 1990; 1: 46-64.
[238] Farrell MJ. The measurement of productive efficiency. J R Stat Soc 1957; 120: 253-281.
[239] Grosskopf S, Valdmanis V. Measuring hospital performance; a non-parametric approach. J Health Econ 1987; 6: 89-107.
[240] Thanassoulis E. Introduction to the theory and application of data envelopment analysis: a foundation text with integrated software. Norwell: Kluwer Academic Publishers; 2001.
[241] Fried H, Lovell CA, Schmidt S. The measurement of productive efficiency: techniques and application. New York: Oxford University Press; 1993.

[242] Hollingsworth B, Dawson DJ, Maniadakis N. Efficiency measurement of health care: a review of non-parametric methods and applications. Health Care Manag Sci 1999; 2: 161-172.
[243] Charnes A, Cooper W, Rhodes E. Measuring the efficiency of decision-m making units. Eur J Oper Res 1978; 2: 429-444.
[244] Ramanathan R. An introduction to data envelopment analysis: a tool for performance measurement. New Delhi: Sage Publications; 2003.
[245] Ferrier GD, Valdmanis V. Rural hospital performance and its correlates. J Prod Anal 1996; 7: 63-80.
[246] Golany B, Roll. An application procedure for DEA. Omega 1989; 17: 237-250.
[247] Dyson RG, Allen R, Camanho AS, Podinovski V, Sarrico C, Shale E. Pitfalls and protocols in DEA. Eur J Oper Res 2001; 132: 245-259.
[248] Rich EC, Gifford G, Luxemburg M, Dowd B. The relationship of house staff experience to the cost and quality of inpatient care. JAMA 1990; 263: 153-171.
[249] Jacobs R, Smith P, Street A. Measuring efficiency in health care: analytic techniques and health policy. New York: Cambridge University Press; 2006.
[250] Charnes A, Cooper WW, Lewin AY, Seiford LM. Data envelopment analysis: theory, methodology and applications. Boston: Kluwer Academic Publishers; 1994.
[251] Galagedera DUA, Silvapulle P. Experimental evidence on robustness of data envelopment analysis. Journal of the Operational Research Society 2003; 54: 654-660.
[252] Ramanathan R. An introduction to DEA; a tool for performance measurement. London: Sage Publications; 2003.
[253] Coelli TA. A Guide to DEAP version 2.1: a data envelopment analysis computer program. Amidale: University of New England; 1996.
[254] Boussofiane A, Dyson RG, Thanassoulis E. Applied data envelopment analysis. Eur J Oper Res 1991; 52: 1-15.
[255] Avkiran NK. Investigating technical and scale efficiencies of Australian universities through data envelopment analysis. Socioecon Plann Sci 2001; 35: 57-80.
[256] Boussofiane A, Dyson RG, Thanassoulis E. Applied data envelopment analysis. Eur J Oper Res 1991; 52: 1-15.
[257] Bowlin WF. Measuring performance: an introduction to data envelopment analysis (DEA). J Cost Anl, 1998; 1: 3-27.
[258] Sahin I, Ozcan Y. Public sector hospital efficiency for provincial markets in Turkey. J Med Syst 2000; 24: 307-320.
[259] Seiford LM. Data envelopment analysis: the evolution of the state of the art (1978-1995). J. Productiv. Anal 1996; 7: 99-138.
[260] Chang H, Cheng M, Das S. Hospital ownership and operating efficiency. Eur J Oper Res 2004; 159: 513-527.
[261] Epstein MK, Henderson JC. Data envelopment analysis for managerial control and diagnosis. Decision Sci 1989; 20: 90-119.
[262] Parkin D, Hollingsworth B. Measuring production efficiency of acute hospitals in Scotland, 1991-1994: validity issues in data envelopment analysis. Appl Econ 1997; 29: 1425-1433.
[263] Ozcan Y. Sensitivity analysis of hospital efficiency under alternative output/input and peer groups; a review. Knowledge Pol 1993; 5:1-29.
[264] Hughes A, Yiasawarng S. Sensitivity and dimensionality tests of DEA efficiency scores. Eur J Oper Res 2004; 154: 410-422.
[265] Abramson JH, Abramson ZH. Survey methods in community medicine. London: Churchill Livingstone; 1999.
[266] Peat J. Health science research; a handbook of quantitative methods. Sydney: Allen & Unwin; 2001.
[267] Carmines E.G, Zeller R.A. Reliability and validity assessment. Newbury Park: Sage Publications; 1991.
[268] Guyatt G, Walter S, Norman G. Measuring change over time: assessing the usefulness of evaluative instruments. J Chronic Dis 1987; 40:171–178.
[269] Jensen G, Morrisey M. The role of physicians in hospital production. Rev Econ Stat 1986; 68: 432-442.
[270] Worthington AC. Frontier efficiency measurement in health care: a review of empirical techniques and selected applications. Med Care Res Rev 2004; 61: 135-170.
[271] McKillop D, Glass J, Kerr C, McCallion G. Efficiency in Northern Ireland hospitals: a non-parametric analysis. Econ. Soc. Rev 1999; 30: 175-196.
[272] Ersoy K, Kavuncubasi S, Ozcan Y, Harris J. Technical efficiency of Turkish hospital: DEA approach. J Med Syst 1997; 21: 67-74.

[273] Sahin I, Ozcan, Y. Public sector hospital efficiency for provincial markets in Turkey. J Med Syst 2000; 24:307-320.
[274] Magnussen, J. Efficiency measurement and the opertionalization of hospital production. Health Serv. Res 1996; 31: 21-37.
[275] Anderson G. Making sense of rising caesarean section rates. Br Med J 329: 696-697, 2004.
[276] Ministry of Health. Iran demographic and health survey 2000. Tehran: The Ministry; 2002.
[277] Emrouznejad A, Thanassoulis E. Performance Improvement Management*;* DEASoftV1. Birmingham: Aston University; 2005.
[278] Field K, Emrouznejad A. Measuring the performance of neonatal care units in Scotland. J Med Syst 2003; 27: 315-324.
[279] Andersen P, Petersen N. A procedure for ranking efficient units in data envelopment analysis. Manage Sci 1993; 39: 1261-1264.
[280] Athanassopoulos AD, Gounaris C, Sissouras A. A descriptive assessment of the production and cost efficiency of general hospitals in Greece. Health Care Manag Sci 1999; 2: 97-106.
[281] O'Neill L, Dexter F. Methods for understanding super-efficient data envelopment analysis with an application to hospital inpatient surgery. Health Care Manag Sci.2005; 8: 291-298.
[282] Coelli T, Prasada Rao D.S., Battese G.E. An introduction to efficiency and productivity analysis. Boston: Kluwer Academic Publishers; 1998.
[283] Maghary S, Lahdelma R. Data envelopment analysis: visualizing the results. Eur J Oper Res 1995; 85: 700-710.
[284] Grosskopf S, Valdmanis V. Measuring hospital performance. J Health Econ 1987; 6: 89-107.
[285] Maynard A. Rationing health care: an exploration. Health Policy 1999; 49: 5-11.
[286] Sheldon TA, Smith PC. Equity in allocation of health resources. Health Econ 2000; 9: 571-574.
[287] Mooney G. The demand for effectiveness, efficiency, and equity of health care. Theor Med 1989; 10: 195-205.
[288]Chern JY, Wan TH. The impact of the prospective payment system on the technical efficiency of hospitals. J Med Syst 2000; 24: 159-173.
[289] Ferrier MJ, Valdmanis V. Rural hospital performance and its correlates. J Prod Anal 1996; 7: 63-80.
[290] Ozcan YA, Luke RD, Haksever G. Ownership and organisational performance: a comparison of technical efficiency across hospital types. Med Care 1992; 30: 781-794.
[291] Gruca T, Nath D. The technical efficiency of hospitals under a single payer system: the case of Ontario community hospitals. Health Care Manag Sci 2001; 4: 91-101.
[292] Pope C, Mays N. Qualitative research in health care. London: BMJ books; 2000.
[293] Wolcatt HF. Writing up qualitative research. New Berry Park: Sage Publications; 1990.
[294] Pollitt C, Harrison S, Hunter D. General management in the NHS: the initial impact, 1983-88. Public Adm 1991; 69: 61-83.
[295] Morse JM. Qualitative nursing research: a contemporary dialogue. Newberry Park: Sage Publications; 1989.
[296] Patton MQ. Qualitative research and evaluation methods. Thousand Oaks: Sage Publications; 2002.
[297] Patton MQ. Qualitative evaluation and research methods. Newberry Park, Sage Publications; 1990.
[298] Lincoln YS, Guba EG. Naturalistic inquiry. Beverly Hills: Sage Publications; 1985.
[299] Glaser BG, Strauss AL. The discovery of grounded theory. Chicago: Aldine; 1967.
[300] Pilot DF, Beck CT. Nursing research: principles and methods. Philadelphia: Lippincott Williams & Wilkins; 2004.
[301] Cresswell J. Qualitative inquiry and research design: choosing among five traditions. Thousand Oaks: Sage Publications; 1998.
[302] Strauss AL. Qualitative analysis for the social scientist. Cambridge: Cambridge University Press; 1987.
[303] Darlington Y, Scott D. Qualitative research in practice: stories from the fields. Sydney: Allen & Unwin Pty Ltd; 2002.
[304] Crotty M. The foundations of social research: meeting and perspective in the research process. Sydney: Allen & Unwin Pty Ltd; 1998.
[305] Tutty L, Rothery M, Grinnell R. Qualitative research for social workers. Boston: Allyn & Bacon Publications; 1996.
[306] Grbich C. Qualitative research in health. Sydney: Allen & Unwin Pty Ltd; 1999.
[307] Krueger RA, Casey MA. Focus group interviews: a practical guide for applied research. Thousand Oaks: Sage Publications; 2000.
[308] Tavakol M, Murphy R, Torbati S. Medical education unit: an exploration of some curriculum issues. Medical Education Online 2006; 11: 1-8.

[309] Rice PL, Ezzy D. Qualitative research methods: a health focus. Oxford: Oxford University Press; 1999.
[310] Streubert HJ, Carpenter DR. Qualitative research in nursing: advancing the humanistic imperative. Philadelphia: Lippincott Williams and Wilkins; 2003.
[311] Mays N, Pope C. Assessing quality in qualitative research. Br Med J 2000; 320: 50-52.
[312] Norton PG, Stewart M, Tudiver F, Bass MJ, Dunn EV. Primary care research: traditional and innovative approach. California: Sage; 1991.
[313] Erzerberger C, Prein G. Triangulation: validity and empirically based hypothesis construction. Qual Quant 1997; 31: 141-154.
[314] Farmer T, Robinson K, Elliott SJ, Eyles J. Developing and implementing a triangulation protocol for qualitative health research. Qual Health Res 2006; 16: 377-394.
[331] Pell JP, Pell CH, Norrie J, Ford I, Cobbe S. Effects of socioeconomic deprivation on waiting time for cardiac surgery: retrospective cohort study. Br Med J 2000; 15-18.
[315] Dismuke CE, Sena V. Has DRG payment influenced the technical efficiency and productivity of diagnostic technologies in Portuguese public hospitals? Health Care Manag Sci 1999; 2: 107- 116.
[316] Hofmarcher MM, Paterson I, Riedel M. Measuring hospital efficiency in Austria- a DEA approach. Health Care Manag Sci 2002; 5: 7-14.
[317] Pannarunothai S, Boonpadong D, Wongkanarattanakoon P. Impact of a non-private practice allowance and fee-for service schemes for extra-office hours. Nonthaburi (Thailand): Ministry of Public Health; 1997.
[318] Liu X, Mills A. The effect of performance-related pay of hospital doctors on hospital behavior: a case study from Shandong, China. Hum Resour Health 2005; 3: 11-22.
[319] Oxley H, MacFarlen M. Health care reform: controlling spending and increased efficiency. Paris: OECD Publications; 1994.
[320] Walford V, Grant K. Hospital sector reform: improving hospital efficiency. London: DFID Health Systems Resource Centre; 1998.
[321]Newhouse JP: Free for all? Lessons from the RAND health insurance experiment. Cambridge: Harvard University Press; 1993.
[322] Steinbrook R. The cost of admission- tiered co-payments for hospital use. N Engl J Med 2004; 350: 2539-2542.
[323] Somanathan A, Hanson K, Dorabawila T, Perera B. Operating efficiency in public sector health facilities in Sri Lanka: measurement and institutional determinants of performance. Maryland: Partnership for Health Reform Project, Abt Associations Inc; 2000.
[324] Jordan SD, Productivity in rural hospitals. Nurs Manage 1994; 25: 58-62.
[325] Smith PC, Street A. Measuring the efficiency of public services: the limits of analysis. York: Centre for Health Economics; 2003.
[326]The Iranian Management and Planning Organization. Economic report for the year 2002. Tehran: The Organisation; 2003.
[327] World Health Organization. Country cooperation strategy for World Health Organization and Islamic Republic of Iran. Tehran: WHO Country Office in IR Iran; 2004.
[328] Chu H, Lui HZ, Romeis JC. Does capitated contracting improve efficiency? Evidence from California hospitals. Health Care Manage Rev 2004; 24: 344-352.
[329] Mill A, Bennett S, Siriwanarangsun P, Tangcharoensathien V. The response of providers to capitation payment: a case study from Thailand. Health Policy 2000; 51: 163-180.
[330] Martin JP. The experience of OECD countries in coping with rising health costs. Paris: OECD Publications; 2003.
[331] Preker AS, Harding A. Innovations in health service delivery: the corporatization of public hospitals. Washington: World Bank; 2003.
[332] Jakab MA, Preker S, Harding A, Hawkins L. The introduction of market force in public hospitals sector: from new public sector management to organizational reform. HNP Discussion Series. Washington: HNP Discussion Series; 2002.
334 Poikolainen K, Ekola J. Regional and social class variation in the relative risk of death from amenable causes in the city of Helsinki. Int J Epidemiol 1995; 24: 114-118.
335 Piers LS, Carson NJ, Brown K, Ansari Z. Avoidable mortality in Victoria between 1979 and 2001. Aus NZ J Public Health 2007; 31: 5-12.
336. Newhouse JP. Fronteir estimation: how useful a tool for health economics? J Health Economics 1994; 13: 317-322.
337 Hollingsworth B, Parkin D. Efficiency and productivity change in the English National Health Services. J Health Serv Res Policy 2003; 8: 230-236.