Public and Private Hospital Services Reform
An Investigation in Iranian Hospitals

Yaghoub Sheikh Zadeh, V.K. Seth, R.G. Vahidi, Ali Emrouznejad, Saeed Dastgiri*

Abstract

This research aimed to present a model of efficiency for selected public and private hospitals of East Azerbaijan province of Iran by making use of DEA approach in order to recognize and suggest the best practice standards. In other words, its aim was to suggest a suitable context to develop efficient hospital systems while maintaining the quality of care at minimum expenditures. It is recommended for inefficient hospitals to make use of the followings: transferring, selling, or renting idle/unused beds; transferring excess doctors and nurses to the efficient hospitals or other health centers; pensioning off, early retirement clinic officers, technicians/technologists, and other technical staff. The saving obtained from the above approaches could be used to improve remuneration for remaining staff and quality of health care services of hospitals, rural and urban health centers, support communities to start or sustain systematic risk and resource pooling and cost sharing mechanisms for protecting beneficiaries against unexpected health care costs, compensate the capital depreciation, increasing investments, and improve diseases prevention services and facilities in the provincial and national levels.

Key words: DEA, linear programming, efficiency, hospital efficient management, public and private hospitals reform

* - Yaghoub Sheikh Zadeh, Faculty of Management Studies, Delhi University, India, currently visiting BCIT, Canada;
- Vijay. K. Seth, Faculty of Management Studies, Delhi University, India;
- Reza G, Vahidi, Chairman of National Public Health Management Center (NPMC) and head of Public Health and Management Department, School of Public Health and Nutrition, University of Medical Sciences, Tabriz, Iran;
- Ali Emrouznejad, Operations & Information Management, Aston Business School, Aston University, UK;
- Saeed Dastgiri, Community Health and Epidemiology, Tabriz University of Medical Sciences, Iran, currently visiting University of Glasgow, UK;
Correspondence author: Yaghoub Sheikh Zadeh [yaghoub.sheikhzadeh@gmail.com].
1. Introduction

This research was designed on the basis of the clear guidance of WHO which emphasizes on “improving efficiency” as an objective, “cost-effectiveness” as an evaluation indicator, and “health sector reform” as an strategy [1].

An efficient health care system saves time, money, and human energy, and ultimately better serves patients in a more timely way. There are many ways to improve efficiency, including ensuring services are provided by the most appropriate health professionals, eliminating unnecessary paperwork/bureaucracy, performing the steps in a care process in parallel instead of sequentially, and last but not least, of course more important doing work with using less resources. A cost-effectiveness analysis takes into consideration the policy targets and then examines the total costs of different alternative options to achieve the target. A policy is cost-effective if it achieves the target at the lowest possible costs to
society. Health sector reform takes place within a broader public sector reform context, parallel to political reforms such as reallocation, decentralization, and financial reforms. Health systems provide the critical interface between life-saving, life-enhancing interventions and the people who need them. If health systems are weak, the effectiveness of these interventions is likely to be weak too. Health systems thus deserve the highest priority attention with a great effort to improve health and ensure that resources are wisely used.

A. Statement of the Problem

In the literature of economics, health care services are considered as both public and private goods (non-personal and personal services). Furthermore, non-personal services are divided into two types: pure and impure; therefore, generally speaking, health care services include three types of services: pure non-personal, impure non-personal, and personal. In other words, health care services are considered as pure public goods (pure non-personal services) since they are non-rival in consumption, i.e., when such goods are produced, the producer can not preclude their consumption. From a different perspective, since they don’t have complete non-rivalry feature (because someone’s consumption decreases the others consumption capacity), health care services can be considered as impure public goods (impure non-personal services). Also, health care services can be private goods (personal services). In other words, one’s consumption can reduce the possibility of the other’s consumption, and the producer sells the goods (services) exclusively to the consumers who can afford the prices. You can put a price on private goods (personal services) and ask the consumers to pay. Free rider is not possible about private goods (personal services) while this is a characteristic of public goods (non-
personal services). In economics and based on laws, governments are in charge of producing public goods (non-personal services) especially the pure ones because the private sector, which is seeking maximization of its benefits, has no motivation to produce them. Moreover, it is difficult to identify their real consumers. As James W. Henderson pointed out in “Health Economics & Policy”, “nonexcludable goods mean a situation in which it is difficult to limit access to a good or service to a specific group of customers. If the item is available to anyone, it becomes available to everyone.”

Even if they are identified, it is difficult to ask the consumers to pay; hence, the production of private goods (personal services) is principally and mostly in the developed countries ceded to the private sector; although the financing is on the basis of the tax-public fund system.

By the help of the above concepts and criteria, we can analyse and investigate about the philosophy of the public and private sector in the health care system and the responsibilities and limitations of each of them.

Since health care services, like other goods and services, should follow economic principles, it is necessary to use the minimum amount of scarce resources of production in order to achieve country’s health care objectives.

1. Research Questions

The main questions in this research are:

1- To what extent are the current public and private hospitals of the province (mixed system) efficient?

2- Which hospitals (public and private) have higher efficiency?

3- What changes can improve the hospitals’ efficiency/health care system?

According to Sophie Witter et al. in “Health Economics for Developing Countries: A Practical Guide”, “Technical efficiency means carrying out agreed activities using the least possible resources-or carrying the maximum activities possible using a fixed pot of resources. For example, if you alter the procedures in your clinic so that you can increase the number of patients you see (with quality remaining constant), then you have increased your technical efficiency. (If you see more patients but provide a poorer service to each one, then you have increased activity rates probably decreases efficiency.) Allocative Efficiency indicates that a “just the right balance between pain and gain” has been achieved, that is, directing resources to their most productive use. In health care terms, it means assessing which intervention will produce greatest health gains for a given investment of resources, and focusing on that activity. A hospital may be technically efficient, for example, in that all procedures are carried out using the minimum of resources necessary for those procedures. However, it may well be focusing on allocatively inefficient activities-expensive, high technology activities which benefit a small minority, rather than measures which offer more significant health gains.”

As Stephen Robbins et al. pointed out in “Management, “Efficiency refers to getting the most output from the least amount of inputs or “doing things right”…while effectiveness is often described as “doing the right things”-that is, those work activities that will help the organization reach its goals…whereas efficiency is concerned with the means of getting things done, effectiveness concerned with the end, or attainment of organizational goals.”

One fallacy in interpreting evaluation data is that of equating effectiveness with efficiency. As Issel pointed out in “Health Program Planning and Evaluation: A Practical,
Systematic Approach for Community Health”, effectiveness is the extent to which results are achieved, whereas efficiency is a ratio of the amount of effect achieved to the amount of effort or resources. According to Emmanuel Thanassoulis, in “Introduction to the Theory and Application of Data Envelopment Analysis”, “Scale efficiency measures the impact of scale size on the productivity of a decision making unit (DMU).” And finally, economic or cost efficiency is the situation in which (with the given state of technology) it is impossible to generate a larger welfare total from the available resources. In other words, the situation where some people cannot be made better-off by reallocating the resources or goods, without making others worse-off (Pareto Optimum).

2. Significance of the study

Since provision of health care services like production and provision of other goods and services follow the economic rules, thereby it is necessary and a must to use the scares resources at its minimum to achieve the health care system’s objectives (WHO, 1981). In regards to the above discussion and inefficient performance of hospitals at East Azerbaijani province gained from our experience, it is important to investigate the efficiency status of the public and private hospitals of East Azerbaijani province in a comparative study and to present a pattern for approaching a relatively ideal status through prescribing for intervention in the system. The effect of the suggested model then can be determined in some inefficient and selected hospitals by designing control and experimental groups.

In order to make the importance of the issue clear, we take a short look at the funding of health care in Iran. On the basis of Iran’s Budget Act in 2007/08 (1386, based on Iranian calendar), general budget of East Azerbaijan was 6,044,622 million Rials, that is, 4.53 percent of the whole national budget and credits of provincial health care sector was
1,609,197 million Rials (26.62 percent of the provincial budget) which 1,033,310 million Rials out of that figure exactly allocated to the health care programs (almost all to the public hospitals), and 3,889 million Rials allocated to the nonpublic health services plan (nearly all to the private sector, charities, or institutional health centers), i.e., that totally was 1,037,199 million Rials (64.45 percent of province health care university’s budget and 17.16 percent of the general budget of the province) [2].

It seems that most of this amount of money –if not all- has been allocated to the public hospitals (probably a limited amount is also given to private hospitals in the form of some plans). We should note that these amounts are usually increased with specific percentages every year depending on the incomes of the government – mostly oil incomes – and also extent of the expansionary or concretionary monetary and fiscal policies.

3. Necessity of the Study

In this study we intended to investigate the efficiency of the use of these huge financial resources which are spent in the hospitals of the province annually and by analysis of various kinds of efficiency indicators, to be able to help the system to optimize the use of public and private resources so that the saved amounts can be used for the promotion of human beings life, health and their well-being.

Isn't there indeed any way for the better allocation of limited and rare resources in the health care ground? Can a new plan be designed so as to emend health care system of the province and even the whole country by making use of the saved financial amounts through optimizing interventions and health economics rules and finally responding to health needs of people which are being considered as their right?

The key questions which are important to answer are: how much efficiency do third level health care providers (public hospitals) which consume an important part of annual health
care budget of the province have? How are the conditions of these hospitals when compared with one another? Which hospitals can be a model (best practice/ bench mark) for other ineffective hospitals and how?

What are the real, practical, precise, and scientific solutions of inefficiency and wasting the resources?

B. Iranian Health Care System

According to the WHO’s report, Iran as a oil exporter and medium income country, the fourth country in Asia with 30 provinces, 885 cities, and nearly 68,000 villages have 94 human development rank among 177 countries and 69.5 years life expectancy at birth. In Iran, with per capita health care expenditures (totally in both public and private sectors) $604 (compare with Norway $4,080, Malta $1733, Brazil $1520, Argentina $1,274, South Korea and Singapore $1,100, Lebanon $817), government (ministry of health and medical education) have responsibility to providing and financing primary health care (PHC) services. Recent remarkable progresses in health sector (PHC) such as establishing health networks (Khanehyeh Behdasht) have caused to improving various health indicators. However, one of the most important problems is that about 8 to 10 percent of people do not have access to any insurance plans, and then they have to tolerate the out-of-pocket and catastrophic payments to reach the health care services [3]. Limited and inadequate access to the health care services in some poor and less developed provinces cause to relatively significant lessening in the health care indices in these provinces [4].

In 1926 public health bureau (SAHIYYEH) was established in Iran and in 1941 ministry replaced it. In 1958, permission was issues, to let the private sector to provide health care services [5]. In 1979, after the revolution, in regards to the constitution (principle 44), the
economy of Iran is based on three axes: government, private, and cooperation, and in regards to principle 43, government is held responsible to be in charge of people’s health. However, after the revolution, the first steps towards privatization were taken according to the first 5-year economic, social, and cultural program. At the present time, health care services system of country has a mixed nature, in which public, private, and cooperative sectors are providing services.

In 2006, there were 773 treatment institutes (hospitals, maternities, home cares) and 116,474 beds in the whole country. Also, the number of (public, private, and other) institutes with their relevant beds were 505 public institutes (65.3%) with 79,772 beds (68.5%); 128 private institutes (16.6%) with 12,594 beds (10.8%); and 140 other institutes (18.1%) with 24,108 beds (20.7%) respectively [Table 1]. Furthermore, in that year, 8,288 health and treatment centers (treatment places [Darmanghah], Clinics, Paraclinics, and Health Centers) were active in all over country, where 77.1% governmental, 10.3% private, and 12.6% others [6]. Moreover, 70% of this health and treatment centers were located in urban and the rest (30%) in rural areas. In 2005, there were 16,725 active rural houses [Khaneh Behdasht] with 27,085 health staffs [Behvarz] that were able to cover more than 20 million people [7].

According to the recent country budget Act in 2008, it has been dedicated 57,301,090 million Rials credits to the health and hygiene section that was 7.2 percent of the total governmental general budget [8].

**C. East Azerbaijani Health Care System**

Based on the latest country’s divisions in 2004, East Azerbaijani Ostan (province) consists of 19 townships, 42 districts, 57 towns, and 141 rural districts. Moreover,
according to the general population and housing census in 1986, 1996, and 2006, Azerbaijani population with annually growth rate 0.85 percent has been increased from 3,077,882, to 3,325,540, and then to 3,603, 456 people respectively and the life expectancy was 70.7 years in 2005. In addition, the population of the province was almost 5.1 percent of the whole country’s population [9].

Active Treatment Institutes in Terms of the Ownership and the Number of Beds

In 2006, there were 38 treatment institutes (4.9 percent of the whole country) which their ownership status were as follows: 29 public (76.3%), 5 private (13.2%), and 4 other institutes (10.5%) [Table 1].

1. Active Beds

Based on the information in 2006, there were 5,964 active beds (5.1 percent of the active beds in the whole country) which their ownership situation were as follows: 4,867 public (81.6%), 537 privates (9%), and 560 beds others (9.4%) including treatment institutes affiliation to Social Security Organization, Charities affairs, Banks, and etc.) [Table 1].

2. Hospitals

25 out of 42 hospitals (about 60%) and the rest (17 out of 42, almost 40%) have been located in Tabriz and other townships respectively [10].

3. Treatment Places (Darmanghah)

In 2005, 170 treatment centers were active throughout the province; that is, almost 4.86 treatment centers were provided their services per one hundred thousand people [11].

4. Health and Treatment Centers

In 2006, 106 out of 408 (74%) in cities and 106 out of 408 (26%) health and treatment centers in the countries (rural districts) were active. Also, 319 out of these centers
(78.2%) belong to public, 51 centers (12.5%) private, and 38 centers (9.3%) others [Table 2].

**5. Rural Health house (Khaneh Behdasht Roostaei)**

In 2005, there were 1,061 active rural health houses in the province (6.4% of the whole country). In these house, 1,732 people (Behvarz, 68% male and 32% female) provided health services in 3,047 villages for 1,232,877 people [Table 3 and 4]. In other words, there were 8.62 rural health houses per ten thousand people.

**6. Value-added of Health and Social Working Sector**

This sector is divided up into four subsectors including public health care, private health care, veterinary, and social working. According to regional accounts, in 2003 value added of the province was 1,644.9 billion Rials which has been raised to last year remarkable percent (57.15%) while the whole country’s growth was just 40.74%. This caused an increase in the contribution of the provincial value added than the whole country from 3.65% in 2002 to 4.07% in 2003. The share of value added of health and social working sector in province and the whole country were 3.68% and 3.43% respectively in 2003 [Table 5].

**7. East Azerbaijani Health Care Budget in 2008**

According to the national budget Act in 2008, 1,919,738 million Rials were dedicated to the provincial health care plans (and not educational) which were equivalent to 3 percent of the national health care budget [12].

**8. Households’ Health Care Expenditures**

In 2006, an urban household’s health care expenditures on average were 5,345,000 Rials which consist of more than 10 percent of urban household’s total non-eatable expenditures. Furthermore, in 2005, a rural household’s health care expenditures on
average were 2,787,975 Rials (12 percent of rural household’s total non-eatable expenditures) [Table 6]. Thus, it is perceivable that health care expenditures were one of the most essential items in the provincial household’ consumption basket.

2. Literature Review

This section does not intend to do a comprehensive review of the health-related DEA literature. Rather, it plans to provide brief information about just a limited number of usages of this effective and developing method in the efficiency evaluation and various aspects of the health systems.

The DEA has been extensively used in the various sectors of the developed countries’ economies to estimating the degree of the efficiency and planning the health care systems.

In USA, Ozcan and Bannick [13] applied DEA to analyze the efficiency trends in defense hospital. Ozcan et al. [14] obtained psychiatric hospitals’ efficiencies through DEA. Huang [15] employed DEA in measuring the relative performance of Florida general hospitals. Huang [16] utilized DEA to determine the efficiency of rural primary care programs in North Carolina. In Connecticut, Chattopadhy and Ray applied DEA to calculate the scores of the technical, scale, and size efficiency of 140 nursing homes providing health care to the elderly [17]. Also, Shroff [18] used the DEA to examine the efficiency of 26 potential sites for a long-term health care facility in the Northern Virginia region.

In Europe, Kamal Field and Ali Emrouznejad [19] examined both technical and scale efficiency using data envelopment analysis in a selection of 22 neonatal care units in Scotland. Also, Parkin and Hollingsworth [20] utilized DEA to examine production
efficiency of acute hospitals in the same country, Scotland [21]. Hollingsworth and Parkin [22] applied DEA to investigate data of neonatal services for a sample of 49 units in the United Kingdom by technical efficiency and economies of scale, to measure the potential cost savings if the units were to run efficiently. Jacobs [23] using 232 UK hospitals (Trusts) dataset compared the efficiency rankings of cost indicators with those resulted using Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). Linna et al. [24] applied a two-stage procedure to examine the technical and cost-efficiencies (TE and CE) of oral care provision in Finland’s health centers. Thanassoulis et al. [25] using DEA investigated service quality targets regarding perinatal-care in England. Kooreman [26] applied DEA to estimate efficiency of home cares in the Netherlands.

There is just limited number of international efficiency comparing in the Europe. Linna et al. [27] compared degree of the cost-efficiency between 47 Finland’s public hospitals and 51 Norway’s ones. The other significant research is related to Locus Steinman [28] to comparing efficiencies scores between 105 Germany’s hospitals and 251 of Swiss’ ones. Furthermore, the powerful DEA approach method has been gradually used in the developing and even some poor countries in Africa. Ersoy et al. [29] analyzed technical efficiencies of Turkish hospitals using the DEA method. Majumdar [30] applied DEA to measure relative efficiency points within the Indian pharmaceutical sector. Chang [31] applied DEA to determine technical efficiency of six class one public hospitals in Taiwan for five years. Using a variable return to scale (VRS) for DEA model, Wan et al. [32] investigated the technical efficiency among 57 nursing units, in a third level care medical centre in Taiwan (Republic of China).
In Africa, some studies intended to apply DEA in the health industry. Kirigia et al. [33] employed DEA to assess the technical and scale efficiency, and productivity change over a four-year period among 17 public health centers in Seychelles. Kirigia et al. [34] used DEA to find out what portion of 55 public hospitals of Kwazulu–Natal Province of South Africa were operating efficiently, and for those inefficient hospitals, what inputs and outputs contribute most to inefficiency. Kirigia et al. [35] applied DEA to estimate the technical efficiencies among 155 primary health care clinics in Kwazulu–Natal Province of South Africa. Eyob [36] estimated the technical efficiency among 86 public hospitals in Eastern, Northern, and Western Cape Provinces of South Africa. In Zambia, Felix Masiye et al. [37] estimated technical, allocative, and economic (cost) efficiencies for 40 private and public health centers. This study figured out that private centers had been run more efficient than public ones. In other study on 18 public hospitals, 8 charity hospitals (affiliated to the church), and 4 private hospitals (overall 30 hospitals) Masiye [38] estimated technical efficiency. Kirigia et al. [39] assessed technical efficiencies of 32 public health centers and 54 district level public hospitals in Kenya. In Ghana, Daniel Osey et al. [40] analyzed technical and scale efficiencies of 17 district hospitals and 17 health centers.

In Iran, there has been no such study but for the one done on 53 social security organization hospitals just with analyzing efficiency scores by Hossein Hajialiafzali [41] in 2002. Therefore, the present study is the first in its own kind in Iran.

3. Research Plan and Methodology

A. Research Plan
1. General Goal

The present study tries to prepare the ground for optimizing interferences by presenting a given economic model, i.e., obtaining Pareto optimal in the management of the province and whole country’s hospitals through concept of cost-minimization, efficiencies, and DEA approach.

2. Objectives

In this study, we are planning to present a model for the sample hospitals by making use of efficiency criterion and identify the best practice standards. In other words, we plan to establish efficient hospital systems maintaining a high quality and downsizing. Which hospitals are efficient and inefficient in the public and private sectors in the samples of the province? How much reduction in hospitals’ inputs can convert inefficient hospitals to efficient ones? What are the impressive variables? And which variables do not play any roles in enhancing efficiency? In other words, which variables are sensitive to efficiency and which ones not? In this way, changes which improve hospitals are identified and the way for presenting a new model is paved. This model can be tested in one or two selected hospitals by interference in the system. If they responded positively, this interference will also be made in other ineffective hospitals of the province and the ground for structural reforms is prepared. It should be noted that the saved amounts can be used for investment in various ways of preventing physical and mental diseases (for example establishing gymnasiums, health clubs, healthy nutrition, etc). Finally, successful accomplishment of these reforms can pave the way for extending these reforms to regional and national levels and even introduce Iran as a successful example for other developing countries. The findings of this research can help to save huge amount of unnecessary expenditures and it can improve the health care and services. In
fact, the health care expenditures like educational expenditures are considered as an investment rather than consumption. Thereby, the optimal use of present scarce facilities and resources will lead the system to new potentials in providing health care services. Sustainable development will flourish when a successful health care system can bring about a healthy and happy population, since the very nature of development depends on capable, healthy and intelligent people. It is clear that the findings of this research can be useful for policy-makers, executive managers, experts of economy, and health care decision makers as well.

3. Research Questions

The main questions in this research are:

1- To what extent are the current public and private hospitals of the province (mixed system) efficient?

2- Which hospitals (public and private) have higher efficiency?

3- What changes can improve the hospitals’ efficiency/health care system?

B. Methodology

1. Sample Size and Sampling: Hospitals’ Efficiency

In the present research, data and information obtained from the third level hospital were used. In general, there are 42 first, second, and third level (rank) hospitals in the East Azerbaijan province as follows: 25 out of 42 hospitals have been located in Tabriz (nearly 60 percent) and the rest (about 40 percent) in other districts in the province. 33 hospitals out of 42 public ones (79% = 5% army forces [Sepah and Artesh] + 5% Social Security Organization [Alinasab and 29 Bahman hospitals] + 69% [29 hospitals] are affiliated to Tabriz Medical Sciences University). 6 hospitals out of 42, private hospitals
(14%), are affiliated to the following organizations: 1 hospital out of 42, Zakaria nonprofit hospital (2%, affiliated to Tabriz Azad University), 1 hospital out of 42, Tabriz Amir-al-momenin Charity hospital (2%, general and urology), and finally 1 hospital out of 42, Fajr hospital (2% affiliated to Janbazan Affairs Organization).

Based on the initial proposal, ten (5 public and 5 private) hospitals were to be investigated in regards to their efficiency and other issues considering the approved research design. To this end, after precise investigation of the statistical data and its specifications and considering the research goals, holding several meetings with Tabriz Medical Science University authorities and considering the financial situation of the project, it was finally decided that 11 sample hospitals (6 samples from the first class public hospitals and 5 samples from the private ones) to be selected; that is, one sample more than what already was approved (26 percent of the whole provincial hospitals).

The first class public hospitals which were selected includes Imam, Nikokari, Alzahra, Sina, Kodakan (all located in Tabriz) and Amir-al-momenin hospital which is the only first class hospital (from point of view of both the general and ward evaluations) out side of Tabriz (located in Maragheh). Since all of the province’s private hospitals have been located in Tabriz, thus all five private sample hospitals were selected from Tabriz.

In regards to the Islamic Azad University’s hospital (Zakaria hospital) which is a non-for-profit hospital (neither public nor private), there remains just 6 private hospitals named Shams, Bahbod, Shahryar (Azar), Nor Nejat, Shafa, and Mehr (ophthalmic hospital). And only one (Shams) out of these 6 hospitals has been recognized as a class one hospital and the rest just class two by the evaluation of health authorities/provincial vice chancellorship of treatment. In the meanwhile, except Mehr hospital which was an ophthalmology hospital, the rest run as general ones. As a result, 5 sample of private
hospitals out of 6, the total provincial private hospitals are as follows: Shams, Behbod, Shahryar, Nor Nejat, Shafa (all general, almost 83% of total private hospitals). In other words, Mehr (ophthalmalogy) private hospital is the only one which was not investigated. Finally, it was mentioned and highlighted that 7 out of 11 selected hospitals (6 public hospitals and one private one) have been chosen among the class one and important provincial hospitals. In other words, considering 20 out of total number of the provincial hospitals (48%) have been evaluated as class one (in a general evaluation), the selected samples (hospitals) in this research have covered almost 35% of whole class one hospitals. Thereby 10 hospitals out of 25, the total number of Tabriz hospitals (40%) have been selected as the samples.

If “number of active bed” is taken into account as a measure of “size of hospital” and we look at the samples from this point of view, according our investigation, 1,759 out of 5,964 total numbers of the provincial active beds (29.49%) belong to the selected hospitals; in other words, this study investigates almost 29.49% of the population under study [Table 1].

2. Data Collection and Tools

Statistical data of this investigation have been gathered by various tools such as questionnaire, interview, documental profiles review including the regulation booklet of the ministry of health, booklets, professional magazines, annual reports of creditable domestic and international organizations such as the WHO and UNDP, internet sources, websites affiliated to Tabriz Medical or other universities, research centers and national or foreign medical statistical data institutes.

In this study, in addition to the DEASoft – V1, some other soft-ware such as Excel 2003, SPSS 15, and LINDO 6.1 has been extensively used to analyze the data.
The information and data has been collected by referring to the hospitals personally and filling out the questionnaires about the inputs, outputs, and health services’ prices.

The contents of the hospitals’ questionnaires were gathered for the periodical and time series data in the late 2005 and in 2005-7 respectively. The collected data were as follows: the number of specialist physicians, general physicians, residents, nurses, medical staff with a bachelor degree or higher, medical staff with a diploma or lower, passive and active beds, emergency patients, outpatients, inpatients, mortalities after 24 hours of admission, land and building sizes (areas), price of the hospitals’ land and buildings, and medical equipments.

3. Methods: Data Envelopment Analysis and Statistical Test

To estimate the efficiency’s score, instead of using parametric methods such as econometrics we used Data Envelopment Analysis (DEA), a nonparametric method, due to the following reasons:

DEA can handle multiple input and multiple output models; it does not require an assumption of a functional form relating inputs to outputs; decision making units (health centers) are directly compared against a peer or combination of peers; and inputs and outputs can have very different units of measurement [42]. Note that the nonparametric methods like the DEA do not need to estimate the parameters the same as what we do in the parametric methods like regression [43]. In the meanwhile, Spearman’s correlation coefficient tests (2-tailed) were applied between potential double variables and examined multiple variables regression tests in various scenarios to achieve significant results. Furthermore to determine the different kinds of efficiencies, we can look at the issue from two perspectives: comparison based on the whole systems function; for example, the efficiency of each hospital can be investigated with regard to
its technical efficiency or cost-effectiveness; or comparison based on different wards, programs, and/or hospital given goals. In our study we use the first perspective; i.e. the analysis of the whole system or hospital.

4. DEA’s Conceptual and Mathematical Framework

Through the production process, inputs (production factors) are converted into outputs (medical and health services) by hospitals and medical centers. The inputs can be divided up into three general groups as follows: labour force, materials, and capital; although each group can be exposed into smaller components. The labour force contains professional staff such as physician, nurse, paramedic, manager, and supporting employee and nonprofessional one like driver, guardian, and butler. The materials consist of drug, all nondrug materials, and other product to serve medical outcomes. And finally, the capital contains land, building, medical equipments, vehicle, and bed. The relationship between inputs and resulting outputs (production process) has been revealed by diagram 1. It is obvious that hospitals and medical centers use from multiple inputs for producing multiple outputs.

![Diagram 1- A Simplified system of one typical hospital](image-url)
The DEA model is a unique, almost unacquainted especially in Iran, and powerful to estimate and analyze of efficiency of multiple inputs and multiple outputs which can have very different units of measurement. As Ali Emrounejad mentioned in his homepage, “The measurement of relative efficiency where there are multiple possibly incommensurate inputs and outputs was addressed by Farrell and developed by Farrell and Fieldhouse focusing on the construction of a hypothetical efficient unit, as a weighted average of efficient units, to act as a comparator for an inefficient unit.

A common measure for relative efficiency is:

$$\text{Efficiency} = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}}$$

which introducing the usual notation can be written as

$$\text{Efficiency of unit } j = \frac{u_1 y_{1j} + u_2 y_{2j} + \ldots}{v_1 x_{1j} + v_2 x_{2j} + \ldots}$$

where

- $u_1 = \text{the weight given to output } i$
- $y_{1j} = \text{amount of output } i \text{ from unit } j$
- $v_1 = \text{weight given to input } i$
- $x_{1j} = \text{amount of input } i \text{ to unit } j$.

(Note efficiency is usually constrained to the range $[0,1]$).

The variables of the above problem are the weights and the solution produces the weights most favourable to unit $j_0$ and also produces a measure of efficiency.

According to Joses M. Kirigia et al. (2004), the algebraic model is as follows:
Note that as Ali Emrouznejad pointed out in his home page the above DEA model is a fractional linear program. To solve the model it is first necessary to convert it into linear form so that the methods of linear programming can be applied. The linearisation process is relatively straightforward. For the objective function it is necessary to observe that in maximising a fraction or ratio it is the relative magnitude of the numerator and denominator that are of interest and not their individual values. It is thus possible to achieve the same effect by setting the denominator equal to a constant and maximising the numerator.

where: $\text{TE}_0$ is the technical efficiency score for decision making unit $j0$; $U_r$ = 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 health centers; $t$ = the number of outputs; $m$ = the number of inputs; $\varepsilon$ = a small positive number; $Y_{rj}$ = amount of output $r$ produced by health center $j$; $X_{ij}$ = amount of input $i$ used by health centers $j$; and $j0$ = the health centers under assessment. To ensure analytic tractability to linear programming methods this model can be converted into the following linear program:

Model 1. DEA ratio model.

$$\text{TE}_0 = \text{Max} \sum_{j0} \frac{U_r y_{rj0}}{\sum_i V_i x_{ij0}}$$

s.t.

$$\frac{\sum_r U_r y_{rj0}}{\sum_i V_i x_{ij0}} \leq 1; \forall j$$

$$U_r, V_i \geq \varepsilon; \forall r, \forall i$$

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where $\lambda_j$ are dual variables, i.e. the shadow prices related to the constraints limiting the efficiency of each DMU to be no greater than 1. Where a constraint is binding, a shadow price will be normally positive and when the constraint is nonbinding the shadow price will be zero. In the solution to the primal model therefore a binding constraint implies that the corresponding DMU has an efficiency of 1 and there will be a positive shadow price or dual variable. Hence positive shadow prices in the primal, or positive values for the $\lambda_j$ in the dual correspond to and identify the peer group for any inefficient unit. $S_r$ and $S_i$ are slack variables; if DMU $j_0$ is efficient, the slacks will equal to 0 and the efficiency measure $Z_0$ equal to 1. Otherwise, if $j_0$ is inefficient $Z_0$ will be less than 1 and some slacks may be positive.”

Shadow price is the amount that the objective function value would change if the named constraint changed by one unit. The shadow prices are valid up to the allowable increase or decrease in the constraint, that is, in each problem, they depend on the number of constraints. In face, the shadow price is the change in the objective value of the optimal solution of an optimization problem obtained by relaxing the constraint by one unit, other things being equal. In other words, since constraints often are determined by resources, a comparison of the shadow prices of each constraint provides valuable insight into the most effective place to apply additional resources in order to achieve the best
improvement in the objective function value. The shadow price reflects economic value of each unit of the resource.

4.1. Strengths and weaknesses of DEA

There are some pros and cons of using DEA as follow:

4.1.1. Strengths of DEA

We chose to employ DEA approach to estimate technical efficiency of individual hospitals and health centers because of its unique strengthens:

It can handle multiple input and multiple output models/scenarios typical of hospitals and health centers;

It does not require an assumption of a functional form relating inputs to output (as regression methods do);

Health facilities are directly compared against a peer or combination of peers;

Inputs and outputs can be very different units;

It does not require information on prices of inputs and outputs.

It does not need to estimate the parameters (as regression model dose).

4.1.2. Weaknesses of DEA

Even though we chose to use DEA, we were fully aware that it has two main limitations:

It attributes any deviation from the "best practice frontier" to inefficiency, while some could be due to statistical noise, e.g. epidemics or measurement errors.

Given that DEA is deterministic/nonparametric technique, it is difficult to conduct statistical tests of hypotheses concerning the inefficiency and the structure of the production function [44].

Important note: it is worth mentioning that the effectiveness numbers gained by this method are relative and are not absolute. In other words, efficiency or inefficiency of the
hospitals are evaluated in comparison with one another so when we say X hospital is efficient, it means that it is efficient as compared with its peer hospitals; while if for example Y hospital were also chosen among samples, X hospital perhaps would not have been selected as an efficient hospital. This means that in DEA, one or more hospitals are selected as efficient through a complex and repetitive linear program as efficient hospitals and the extent of inefficiency of other inefficient selected hospitals is evaluated as compared just with efficient hospitals. Therefore, when we say a hospital is efficient, it does not mean it is a fully efficient hospital with no deficiencies. Other aspects such as the quality of services, patients' satisfaction, service providers' satisfaction, innovation, delivered services for emergency patients, or some services provided for patients at the “end stage” by some important and central hospitals with high costs, are vital issues which require enough attention to themselves. In DEA method, the implicit assumption is that other conditions prevailing in hospitals are constant and similar.

4.2. Input and Output Orientation

In DEA, input orientation method is applied for health care industry because as Emmanuel Thanassoulis pointed out in “Introduction to the Theory and Application of Data Envelopment Analysis: A Foundation Test with Integrated Software”, “hospitals have relatively little control over the output levels which would be patients of various categories needing treatment. They would have more control over the input levels, likely to be resources such as doctors, nurses etc, input orientation is appropriate when inputs are controllable”. [45] Despite of this and in some cases, the output-oriented DEA model was used for the health centre analysis. According to Daniel Osei et al. “given their primary health care orientation, with a strong bias towards health promotion and disease prevention, they can influence a great number of people seeking, for example, antenatal
and postnatal care, family planning services, birthing services, immunisations and health education, through their public health outreach work among communities.” [46]

However, in this study, the input-oriented DEA model was applied for the hospital analysis.

4.3. Constant, Decreasing, and Increasing Returns to Scale

As Emmanuel Thanassoulis mentioned in “Introduction to the Theory and Application of Data Envelopment Analysis: A Foundation Test with Integrated Software”, “A proportion correspondence is said to exhibit increasing returns to scale (IRS) if a redial increase in input levels (i.e. keeping input mix constant) leads under Pareto-efficiency to a more than proportionate radial increase in output levels; If the redial increase in output levels is less than proportionate we have decreasing returns to scale (DRS) and otherwise we have constant returns to scale (CRS) [47].

Those hospitals and health centers manifesting CRS can be said to be operating at their most productive scale sizes. In order to operate at the most productive scale size, a health facility displaying DRS should scale down both outputs and inputs. If a health facility is exhibiting IRS, it should expand both outputs and inputs in order to become scale efficient [48].

5. Scale Efficiency

The scale efficiency values for each analyzed health unit can be obtained by the ratio between the scores for technical efficiency with constant and variable returns [49].

6. Allocative Efficiency [50]

The relationship between the quantities of inputs and the resulting quantities of outputs is described by a production function (PF). PF describes the maximum output feasible for a
given set of inputs and a given level of technology (i.e., a given state of knowledge about the various methods that might be used to transform inputs into outputs).

Suppose, for example, the inputs are full time nursing time and full time clinic officers time per year, and that they are used to produce outpatient care, proxied by outpatient visits. That production function can be depicted graphically (see Fig. 1) using an isoquant (IS), i.e. a curve that shows all the possible combinations of inputs that yield the same output. AB is the isocost, i.e. the minimum cost line.

![Fig. 1 Health centers technical and allocative efficiencies](image)

Technical efficiency (TE) is about ensuring no resources are wasted, i.e. the maximum amount of output is obtained from the available inputs (Kirigia et al., 2001). Health centers I, Q and S are technically efficient because they are operating on the production function or isoquant or efficiency frontier. Their efficiency score is one (or 100%). Health centers P and T are inefficient because they are using more nurses and clinic officers time to produce the same level of output as health centers I, Q and S. The extent
of technical inefficiency of health center ‘P’ can be expressed as: \([1-(OQ/OP)]\) (Zere et al., 2000), which is the amount by which all inputs could be proportionately reduced without a reduction in output. Allocative efficiency (AE) is about using resources to produce outputs with the highest possible value. AE implies the isoquant (IS) and isocost (AB) lines are tangential. Even though health centers I and Q are technically efficient, they are allocatively inefficient. Health center S is both technically and allocatively efficient. Allocative efficiency of facility P=OR/OQ.

The formulation for determining the degree of allocative efficiency for the \(j_0\) th health center is given by estimating the linear program formulation below (Daniel et al., 2005):

\[
\sum_{j=1}^{N} \lambda_j Y_{ij} \geq \ldots (r = 1, 2, \ldots, R) \tag{1}
\]

\[
\sum_{j=1}^{N} \lambda_j X_{ij} - Z_i = 0 \ldots (i = 1, 2, \ldots, M') \tag{2}
\]

\[
\sum_{j=1}^{N} \lambda_j X_{ij} \leq X_{ij0} \ldots (i = M' + 1, \ldots, M') \tag{3}
\]

\[
\sum_{j=1}^{N} \lambda_j \geq 1 \tag{4}
\]

\[
\text{Min} \sum_{i=1}^{M} P_{i} Z_i \tag{5}
\]

\[
\sum_{i=1}^{M'} P_{ij} Z_i = \sum_{i=1}^{M'} P_{ij} X_{ij0} \tag{6}
\]

Constraint: (1) insures the composite frontier health center equals or exceeds the level of each output actually obtained by the \(j_0\) th health center; (3) ensures that the frontier health center enjoys no more of a favorable situation than does the \(j_0\) th health center; (4) assumes constant or increasing returns to scale prevail; (5) the objective function and (2) determine the most cost effective use of each of the controllable resources so as to meet the specified output vector \((Y_1, j_0, Y_2, j_0, \ldots, Y_R, j_0)\), at minimum total cost, \(\sum_{i=1}^{M'} P_{ij} Z_i\) [51].

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7. Economic Efficiency or Cost Efficiency

Economic efficiency (or cost efficiency) (CE) combines both productive efficiency (producing without waste, on the production possibilities frontier) with allocative efficiency (allocating resources to their most highly valued uses) (Skaggs and Carlson, 1996). Therefore, cost efficiency of facility as follows:

\[ CE = P = \frac{OR}{OP} = \left( \frac{OQ}{OP} \right) \times \left( \frac{OR}{OQ} \right) = TE \times AE, \] [52].

8. Inputs and Outputs

In this study, there were done adequate statistical and experimental analyses to obtaining finalized inputs and outputs. Spearman’s correlation coefficient tests (2-tailed) were applied between potential double variables and examined multiple variables regression tests in various scenarios to achieve significant results. Also, sensitivity analysis and several experimental tests through relatively many potential input-output variables were used; and considering Emanuel Thanassoulis point of view [53] that “the ultimate aim is that the input-output set used should conform to the exclusivity, exhaustiveness and exogeneity requirements and should involve as few variables as possible”; and of course taking into account practical statistical data gathering possibilities, some indices, experience, expertise opinion [54]; some of variables were combined together if applicable and then named in the same group as new variable and others just omitted from the model and ultimately the following inputs and outputs were selected and finalized for analyzing:

**Inputs**

Input 1: number of specialist physicians and upper

Input 2: number of general physicians + number of nurses + number of residents + number of medical team having a degree (bachelour) or upper
Input 3: number of medical team having 14 years diploma or lower + number of nonmedical and support staff

Input 4: number of active beds

**Outputs**

Output 1: number of emergency patients

Output 2: number of outpatients

Output 3: number of inpatients × average daily inpatients’ residing

Average inpatient’s residing in one given period equals ratio of day bed occupancy rate to number of whole released patients and mortalities in that period. In the present study, it was used statistical data of average residing in the various wards of the East Azerbaijani hospitals (average daily residing = 33 ÷ 9.24 = 1.64) [55].

**4. Results: Data Analysis**

**Data related to estimating allocative efficiency**

It is clear that in order to calculate allocative efficiency score, we need the information related to production costs and prices in addition to quantities. In fact, one of the main factors limiting calculation of allocative efficiency is more technical and financial facilities needed and being able to estimate the costs and prices related to inputs and outputs properly. That’s why some researchers, in addition to the reasons mentioned before, reduce the number of their inputs and outputs to make calculation of allocative efficiency feasible.

Anyway, the prices of the data 1, 2, and 3 figured out 1,100,000, 656,000, and 504,000 Rials respectively on the base of the country’s standard monthly basic salary of PhD
holder (equivalent to specialist); arithmetic mean of monthly basic salary of professional
doctor (708,000 Rials), master degree holder (698,000 Rials), and bachelor degree holder
(562,000 Rials); and arithmetic mean of monthly basic salary of diploma holder (540,000
Rials), high school diploma holder (521,000 Rials), and under high school diploma
(451,000 Rials) [56]. In the meanwhile, the price of data 4, that is, the value or cost of the
each hospital bed was estimated almost 4,000,000 Rials using cost opportunity concept
and based on the current and market value. Assuming 15 years as life span and zero Rials
as scrap value, monthly depreciation cost using straight line depreciation method was
calculated 2,222 Rials. Finally, medical tariffs in 2005 (1384) and 2006 (1385) were
applied to estimate the price of outputs 1 and 2 [57]; i.e. general and specialist
physicians’ visiting fees were consider as the price of each unit of the outputs 1 and 2
[58]. And also, hospital residing cost in 3-bed room or more in both public and private
sectors was separately taken into account as price of output 3 [59]. Note that in allocative
efficiency’s estimating process relative prices, rather than absolute ones, are effective.
Table 8 reveals mean and standard deviation amounts for inputs and outputs of the eleven
hospitals. In Table 9, there are general means of technical, scale, and allocative
efficiencies of the selected hospitals. Table 10 and 11 shows the situation of
technological structure and the scores of technical, scale, allocative, and cost efficiencies
about all selected hospitals in both public and private hospitals separately. It is
particularly important to note that the extent of effectiveness amounts ranges from 0
(completely inefficient) to 1 (100% that is efficient).

Finally, the structure of technology is defined by returns-to-scale properties. The shape of
the efficiency frontier (and therefore DEA scores) will depend upon whether constant
returns to scale (CRS) or non-increasing returns to scale (NIRS) or variable returns to
scale (VRS) are assumed. In this study, it is reasonable to anticipate that hospital size is more likely to be influenced by market environment more than institutional or geographical constraints, implying that a CRS assumption is likely to be thick. Thus, the less restrictive CRS assumption is specified [60].

Based on tables 10 and 11, 45% of selected hospitals are run under CRS and the rest (55%) under VRS. Consideration of technical efficiency results confirms this issue. In other words, all hospitals under CRS obtained technical efficiency scores 1 (100%), while the inefficient hospitals -with technical efficiency scores less than one- had been run under VRS. This means that efficient hospitals do not need to change their inputs and outputs’ amounts to improve their efficiency scores since they had already been located on the production possibilities frontier (Imam, Nikokari, Sina, Kodakan, and Behbod hospitals), while on the contrary, ineffective hospitals with regard to technical issues were located under the production possibilities frontier and therefore need to enhance their activities (revising inputs and outputs’ quantities and some policy making issues) so as to reach their optimum points (Alzahra, Amir-al-momenin, Shams, Shahryar, Nor Nejat, and Shafa hospitals).

Out of the 11 hospitals included in the analysis, 5 (45%) were technically and scale efficient, whereas the remaining 6 (55%) were technically and scale inefficient. Two out of 6 (33%) of technically and scale inefficient hospitals belonged to public sector and the rest (4 hospitals, 67%) technically and scale inefficient were under private sector’s ownership. Among the six inefficient hospitals, 2 (33%) had a TE score of less than 50% (both private), 2 (33%) between 51 and 74% (one private and one public) and the rest (2, 33%) between 75 and 99% (one private and one public). In the meanwhile, Behbod hospital was the only one that had technical and scale efficiency of 100% and was under
CRS. As a result, private hospitals were relatively more technically and scale inefficient than public ones.

In general, the selected hospitals had an average TE score and a standard deviation of 0.79 and 0.24 respectively. Also, the inefficient hospitals had an average TE score of 61% and a standard deviation of 18%. This implies that on average, they could reduce their utilization of all inputs by about 39% without reducing outputs. This is just the concept of downsizing that has already been determined through the initial proposal’s goals. It has to be mentioned that under VRS consumption, only Alzahra (public) and Shams (private) hospitals were chosen as inefficient ones with technically efficient scores 0.85 and 0.66 respectively. Moreover, in a cross-sectional perspective and considering that the inefficient hospitals in public and private sectors had average TE scores of 67% and 59%, this reveals that on average, public and private hospitals are able to reduce their consumption of all inputs by almost 33% and 41% respectively without reducing outputs via optimizing economical management.

In this study also it has been proved that the average allocative efficiency scores among the inefficient public and private hospitals were 72% and 70% respectively (almost the same) implying there is potential for decreasing total inputs in both public and private hospitals by about 30% using the existing capacity/size through re-allocating their resources (physician, nurse, other staff, and bed) and producing the right services for the right people at the right price.

From an economic (cost) efficiency point of view, average scores of this index have been obtained 62% and 40% in public and private inefficient hospitals respectively. As a result, it figured out that the inefficient hospitals are faced with a huge gap to being cost-efficient so that they could minimize by about 38% and 60% of their idle expenditures.
respectively without reducing health services (outputs) using least-cost method to converting into cost-efficient units.

Furthermore, although Nikokari, Sina, and Kodakan hospitals were classified beside technically efficient public ones, while considering allocative and cost efficiencies’ viewpoint, they were dealing with severe problems. For example, since Sina hospital had 50% allocative and cost efficiencies’ scores; each of Imam (public) or Behbod (private) hospitals was able to deliver exactly the same amount of medical services provided in Sina hospital with spending only half of its total expenditures through creation of efficient and effective policy making, reorganization and optimization of economical management.

The digits into the parentheses in TE column in Table 10 indicate the number of times each hospital had been selected as the best practice in repetitive process of linear programming. Optimum hospitals from technical efficiency view of point were Imam (public) and Behbod (private) hospitals which had been referenced 8 times each as bench mark. Next ranks belonged to Nikokari (7 times), Kodakan (4 times), and Sina (3 times) hospitals, and the rest of those did not achieved any point in this regard (Alzahra, Amir-al-momenin, Shams, Shahryar, Nor Nejat, and Shafa hospitals). It is necessary to note that the referenced hospitals are those that were able to deliver the same amount of medical services using relatively less amounts of inputs were being employed by inefficient hospitals. In other words, the referenced hospitals were those that could provide relatively more medical services (to inefficient ones) using the same amounts of inputs had been spent in inefficient hospitals.

From scale efficiency view of point, out of the 6 inefficient hospitals, 2 (33%) had a scale efficiency score less than 50% (both private), 1 (17%) between 51 and 75% (public), and
the rest 3 hospitals (50%) between 76 and 99% (one public and two private ones). In other words, the number of both technical and scale inefficient hospitals was the equal (6 hospitals) and the only difference was an increase in scale efficiency scores of two inefficient Alzahra and Amir-al-momenin hospitals to 97% and 99% respectively. The amounts of technical and scale efficiencies of the rest selected hospitals were the same as technical efficiencies scores.

The mean and standard deviation of scale efficiency scores among the selected hospitals were 83% and 24% respectively. In other hand, the mean of scale efficiency scores among the inefficient hospitals was 70% (with a standard deviation of 26%) revealing there is potential for enhancing total outcomes by almost 30% using the existing capacity and size.

Based on Table 9, mean of allocative and cost efficiencies for the selected hospitals were 76% and 61% respectively. Furthermore, Tables 10 and 11 present interesting data of allocative and cost efficiencies in both individual public and private hospitals: the mean of allocative efficiencies of public and private hospitals were 77% and 76% (almost equal) and the mean of cost efficiencies of public and private hospitals were 68% and 52% respectively. As a result, while allocative efficiencies of public and private hospitals on average were almost equal, cost (economic) efficiencies of public hospitals on average were higher than private ones. In this study, it was figured out that just one of public hospitals (Imam) and one of private hospitals (Behbod) out of all 11 selected ones (18% of all samples) were efficient and had the best performance from point of view of all 4 measures: Technical, scale, allocative, and cost efficiencies (score efficiency of 1 or 100% for all four indices). It means the procedure, method, and quality and style of management of these bench mark hospitals should be inspired and a source of the rest
inefficient hospitals. Among the 9 allocative inefficient hospitals, one (11%) had AE score of less than 50% (Shahryar private hospital), 5 hospitals (56%) between 51% and 75% (three public and two private) and the rest (3, 33%) between 75 and 99% (one private and two public). Also, 4 out of 9 cost-inefficient hospitals (44.5%) had CE score of less than 50% (one public and three private), 4 hospitals (44.5%) between 51% and 75% (three public and one private), and the rest (Nikokari public hospital, 11% of total sample) between 76% and 99% (i.e. 94%). Note that all cost-inefficient hospitals should able to deliver given medical services with relatively lower costs.

5. Discussion and Conclusion

A. Discussion

DEA method revealed that 55 percent of 11 selected hospitals were technical and scale inefficient. To improve efficiency scores, either their costs (inputs) should be cut for delivering given medical services (outputs) or their quantity of medical services must be increased, subject to fixing hospital’s expenditures, that is, optimal value. It is clear that we can practically reduce a certain percentage of the costs by increasing a certain percentage of medical services simultaneously. Table 12 presents exact amounts of required changes of inputs and outputs in order to convert inefficient hospitals into efficient ones.

The observed inefficiency shows that these hospitals have made use of too much input as compared with efficient ones, in other words they have not been able to provide enough medical services using this amount of resources. Table 12 also contains valuable information on possibility of reducible amount of each input in inefficient hospitals. Authorities and policy makers of Iran’s health care system can make use of the
percentage of variation in each input in order to determine the actual targets of their interventions. For example, Shams hospital as an inefficient hospital is basically able to downsize input 1 (number of specialist and post specialist physicians), input 2 (number of general physicians + number of nurses + number of residents + number of medical team having a degree (bachelor) or upper, input 3 (number of medical team having 14 years diploma or lower + number of nonmedical and support staff), input 4 (number of active beds) 48.0, 36.2, 118.4, and 111.6 units respectively without perceiving any negative impact on its medical services. Furthermore, this hospital could consider the percentages mentioned in the parentheses as clear suggestions of policy making and planning pattern and reduces its inputs of 1, 2, 3, and 4; during a specific period of time, up to 34.8, 34.8, 39.7, and 60.0 percent respectively without any reduction in the quantity of medical services (outputs). On the other hand, this hospital can likely choose to increase its second output (accepting more outpatients) instead of reducing its inputs. Based on our findings, an increase in outputs of 1 and 3 does not have any impacts on the efficiency of Shams hospital. It means that this hospital’s efficiency score is not sensitive to outputs 1 and 3. Finally, it is worth noting that this hospital can choose one of these three options: 1- decreasing inputs, 2- increasing outputs, or 3- a mix of decreasing and increasing inputs and outputs simultaneously. What is important is that by using this policy, inefficient hospital moves towards its optimum production level and converts into an effective unit.

In this study it was specified that 82 percent of the selected hospitals were run under allocative and cost inefficiency’s status. Therefore, to improve the status of allocative and cost inefficiency, it is necessary to take all the items of costs into consideration to make sure that they are being used in the most worthwhile means.
Inefficient hospitals can take two different perspectives: (i) to do nothing and insist on continuing to operate with the current inefficiencies; (ii) to do something as follows: ending current inefficiencies via issuing inefficiency warning to those staffs who work under acceptable standard level, terminating contracts of the excess staff and/or taking over the excess staff’s contract, benchmarking management procedures and organization from efficient hospitals.

It is necessary that the policy makers of health system make a set of policies and develop methods which are based on Table 12 findings to improve the efficiency of inefficient hospitals as follows:

1. Transferring excess inputs of inefficient hospitals to efficient ones such as specialized physicians, general physicians, residents, nurses, medical staff, nonmedical and support staff, and finally active beds. This policy would remarkably strengthen these hospitals’ efficiency and potentially will improve provincial health care financial situation via using idle and/or excess human recourses and facilities in order to enhance the capacity of medical services to respond to people’s legitimate expectations.

2. Sending excess administrative and subordinate staff on early retirement. The saving could be used to improve remuneration and benefits for the remaining staff.

3. In regards to excess beds, either: (i) transfer them to efficient hospitals; (ii) sell them; or (iii) enter into a contract with private clinics practitioners or hospitals to use them at a price, which should not be less than the marginal costs.

4. In general, the authorities and managers should take provincial saving and frugality and excess non-wage expenditure into account either: (i) to improve the degree of responsiveness of hospitals to patient’s legitimate expectations; (ii) to improve rural and urban health centers quality of services; and (iii) to support communities to start or
sustain systematic risk and resource pooling and cost sharing mechanisms for protecting beneficiaries against unexpected health care costs. The saved funds could be used to boost the capacity of the existing community-based health insurance schemes. According to Carrin et al. [61] the government has four basic functions for enhancing the capacity of Nonprofit Health Insurance Schemes (NPHIS): that of promoter of health insurance, monitor of NPHIS activities, trainer in all dimensions of insurance, and that of co-financier [62].

5. The government role in health care section should be gradually changed to like what is in Canada, France, or Sweden from mostly ownership to stewardship and monitoring. In other words, the government acts unfairly like an influential player or party who has the first chance of winning this game, instead of being impartial arbiter, and doing its vital duties which are taking care of principle players (private sector), preparation and observation of standards, regulations and rules of the game. Please note that we do not mean to eliminate all public hospitals and giving the whole health care system to the private sector. Rather, we mean that the government should change its role from extremist ownership and incumbency to controlling and watching the services provided by the private sector in this regard. For the time being, the government is too laden and cumbersome to be accurately able to perform these vital responsibilities. Almost, in the most developed countries which have a modern health care system, the private sector provides the main medical services together with a very limited number of public hospitals; but the difference is that the government and/or insurance companies is the financial mediator between the patient and hospital. In other words, the government as public funder has the main responsibility of monitoring and financing of delivered health and medical services by the private sector [63].
B. Conclusion: Intervention in the System

The impacts of operationalizing the findings of this study and interfering in the system can be different for public and private hospitals. The savings from allocating resources in the public sector can help the process of converting a big and ineffective government to a small but effective one by resorting to economics thought and pave the way for the formation of a welfare state from the reserved resources which is one of the main needs of Iran’s society. It is crystal clear that the very same idea can be applicable in other public sectors such as education, banks, and other public departments.

In accordance to our findings, policy makers need to abandon the view that the way to achieve an optimal health for Iran’s society goes only through the road of Ministry of Health and Medical Education.

To achieve a healthy and happy society for the present and future generations, various ministries such as Health and Medical Education, Education, Roads and Transportation, Welfare and Social Security, Labor and Social Affairs, Ministry of Justice, Ministry of the Interior, Housing and Urbanization, Science and Researches, Economic Affairs and Finance, and organizations such as Physical Education, the Environment Protection Organization, Standard, and Audio-Visual Organization should get together with a systemic and harmonized view of sectoral planning, so as to present some ways for the improvement of health of Iranian society with clear and realistic goals and defined practical plans with practical guidelines and procedures.

To achieve this goal, we suggest in addition to establishing a Central National Health Committee in the Health and Medical Education Ministry, a National Health Office can be established in each ministry or organization which acts under the direct supervision of
the Central Committee headed by deputy minister of Health and Medical Education. The members of this central committee can be representatives of these ministries and organizations and also some representatives from the presidency office (management and planning organization), the parliament, the judiciary, the broadcasting organization, Physical Education, and the Environmental Organizations. Similar committees and offices can be established in provinces headed by medical science universities of each province with the very same goals. To guarantee the execution of this plan, pure, decisive, legal, financial, and executive support of all three systems of Legislative, Judiciary, and Law-Enforcement is required.

In other words, we should create a condition in which instead of accepting patients at the hospitals, assist them in finding their ways into the gymnasiums, sports, healthy nutrition, and social exuberance together with proper education just as is done in developed countries. For example, since Iran is one of the countries with a high rate of car accidents [64], we can gradually transfer part of Iran’s annual budget from the ministry of Health and Medical Education to Roads and Transportation ministry (under the supervision of National Health Committee) so as to invest on safety of roads. In this way there would be a significant reduction in the rate of accidents and consequently the budget required by hospitals will be automatically decreased because of a reduction in the amount of demand. Another example is preparing programs to familiarize people with appropriate driving rules and maintaining the rule of fastening seatbelts in the mass media such as Broadcasting organization under the supervision of National Health Committee and presenting plans such as refresher courses for the traffic police, driving institutes and traffic organization. These plans can include providing situations in which the authorities and experts of the above-mentioned departments can observe the system of transportation
and hold workshops about the new theoretical and practical traffic rules in developed countries such as Canada, Australia, UK, the United States, and Japan [65]. This cannot be done unless there is proper education (in all levels and for all age groups specially for primary and base education and mental development and establishing good social manners in children from early ages), social security (welfares, life, unemployment insurance, incapacity and disability insurances, enough old-age pension and so on), employment (having a decent job which is safe), improving the quality and safety of roads, reforms in traffic rules, educating people to drive safely (note that all these are performed in developed countries at the moment. These countries spend these costs in first levels for prevention purposes and sometimes for refreshment and pleasurable purposes such as gymnasiums and sport clubs instead of hospitals), increasing people's income by reforming the policy-making plans and inappropriate social, economic, cultural, and political structures; group efforts to preserve and improve the environment, creating possibilities to have safe and convenient houses, full observation of food and technical standards without ignorance, having fair judiciary and concerned police, etc. It is important to note that all these ministries', organizations', and related departments' final goal is to preserve health and mind of human beings and improving their mental and spiritual state which is feasible through having an organized and comprehensive plan. Otherwise, most of the costs in Ministry of Health and Medical Education are considered as a kind of wasting national resources. Considering the tendency of general international economic system towards privatization, the results of this study can provide the necessary resources for compensation of the costs of private hospitals' depreciation and connection to the network of international health care markets (globalization) by optimizing the private sector and also enhancing new
investments and eventually change the path into a smooth one by reinforcing privatization.

C. Suggestions for the Future Researchers

1. To adopt practical and strategic policies in Iranian health care management field, research projects on technical, scale, allocative, and costs efficiencies in the regional and national level need to be approved with full support and enough financial aids. For example, the present study can be applied in urban health centers, rural health houses, clinics, and medical paraclinics and in all East Azerbaijani hospitals and also other provinces and even at the national level.

2. An analysis of cost-efficiency and cost-effectiveness in health and other medical centers and hospitals are necessary to present principled optimization solutions. Therefore, there is a need to increase the number of such kinds of studies. Moreover, it is suggested that efficiency and effectiveness investigations be applied in various wards of hospitals.

3. Considering the financial limitations of this study, only 11 hospitals were studied, but to achieve more reliable results, more samples (hospitals or medical centers) are needed (at least 35% or more).

4. Studying the details related to efficient and in efficient units not only will help us to recognize relatively efficient peers and allocate the existing necessary possibilities to them, but also they would be very valuable tools for optimized planning and management of relatively efficient units.
5. To calculate technological and productivity change via Malmquist indices), we need statistical data related to various years (time series); so this effective index is also suggested to be considered in future researches.

The experts and executive policy makers of the province and deputy director general of health and treatment center of the province can consider a selection of the following points to improve the effectiveness of the hospitals and perform some reforms in medical services:

D. Acknowledgment

During this work we have collaborated with many colleagues and people for whom we have great regard and wish to extend our warmest thanks to all authorities and those who have helped us with our work in East Azerbaijan Office of Treatment Deputy Minister of Ministry of Health, provincial public and private hospitals, and Tabriz University of Medical Sciences, Iran.

Footnotes


3. See the following source regarding out of pocket payments and catastrophic payments in Iran:

5. Treatment vice-president of Tabriz Medical University, retrieved on Aug. 27, 2005 from: http://healthdata.tbzmed.ac.ir/


10. In this study, Asad Abadi Public Treatment Center that was converted into an Outpatient Treatment Center in 2006, Teeth and Mouth Dentistry Collage Hospital, inactive Haft-e-Tir Public Hospital (affiliated to Tabriz Medical University), inactive Tabriz Private Hospital, and other medical research centers affiliated to Tabriz Medical University like Diabetic and Pulmonary Research Center have not been taken into account.


And also see:


Also, for more information refer to:


47. Mostly extracted from Daniel Osei et al., Ibid, p.7.


55. Interview with Dr Ali Emrouznejad from Auston University in Feb. 2008.

56. Treatment vice-president of Tabriz Medical University, Retrieved on Feb. 27, 2008 from: http://healthdata.tbzmed.ac.ir/

57. Human Resources Management Office, Tabriz Medical Science University.

58. Treatment vice-president of Tabriz Medical University, Retrieved on Jan. 11, 2008 from: http://healthdata.tbzmed.ac.ir/

It seems the medical tariffs in 2006-7 and 2007-8 mostly have been influenced by beneficiary and political groups, individuals and forces rather than being indicators of scarcity and real relative prices; therefore, in this study, it has been utilized tariffs of 2004-5 and 2005-6 which are much better indicators of real relatively prices. It is necessary to note that in calculating allocative efficiency, we have to take relative prices into account and not absolute prices.

http://www.sokhangoo.net/index.php?option=com_content&task=view&id=444&Itemid=51

60. Treatment vice-president of Tabriz Medical University, Retrieved on Jan. 15, 2008 from: http://healthdata.tbzmed.ac.ir/

It is necessary to emphasize that, as we mentioned it before, in this study, technical efficiency has been calculated based on input-oriented DEA model (cost-minimization); therefore, output prices were not practically used.


In the meanwhile, all information related to technical efficiency (VRS) has been revealed in Appendix 2: DEA-Model 2. 


64. For obtaining more information regarding this subject, see the following workshop (was held on Mordad 11, 1386, Iranian Calendar):
Yaghoub Sheikhzadeh (2007) An Acquaintance with Health Care Systems of Canada and Ten Developed Countries: USA, England, France, Germany, Netherlands, Denmark, Sweden, Japan, Australia, and New Zealand, workshop, presented at NPMC, Tabriz, Iran.

65. Iran has one of the highest traffic accident rates in the world, one Iranian dies every 24 minutes from car accidents. Up to 22,000 deaths, and 87,000 injured in an average 200,000 cases reported each year related to car accidents. Retrieved on Feb. 22, 2008 from:
http://english.peopledaily.com.cn/200301/06/eng20030106_109613.shtml

66. In 2004/05, Tehran, Ghilan, Khorasan, Esfahan provinces have been recorded the highest car accident rates 20.8, 10.9, 8.8, 8.1, and 6.8 respectively. Mortal accident in Ardabil, Ilam, Chahar Mahal va Bakhtiari, Boshehr, Fars, Kordestan, Khoozestan provinces have been dropped 85, 71, 67, 47, 45, and 42 percent respectively while this figure have been increased in West Azerbaijan, East Azerbaijan, and Kermanshah 180, 143, and 133 percent respectively…. the main reasons of high car accident are as follows: increasingly vehicle demand to existing roads, lack of constant trainings to boosting cultural level, lack of efficient and effective monitoring on traffic, absence of drivers’ adequate and related knowledge, inattention to laws and regulations, unseasonable expediency, illegal speed, using drugs, technical problems, vehicle exhaustion, road engineering and sign problems, and other general delinquencies. Retrieved on Feb. 22, 2008 from:

### References

**A. Farsi (dates based on Iranian calendar):**


2. East Azerbaijani Management and Planning Organization (1387) Statistical Year Book of East Azerbaijan 1384.

3. Economical, Social, and Cultural Report: Year 1384 (Bahman 1385) Economic and Planning Deputy Minister.

4. Iran Statistical Centre, retrieved on Feb. 15, 2008 from:


8. Treatment vice-president of Tabriz Medical University, retrieved on Aug. 27, 2005 from: http://healthdata.tbzmed.ac.ir/


B. English


75. Sheikhzadeh, Yaghoub (2007) An Acquaintance with Health Care Systems of Canada and Ten Developed Countries: USA, England, France, Germany, Netherlands, Denmark, Sweden, Japan, Australia, and New Zealand, workshop, presented at NPMC, Tabriz, Iran.


79. Tabriz Medical Science University, Human Resources Management Center.


Appendix 1: Tables

Table 1- The number of active treatment institutes in terms of ownership situation and their beds in 2006/07 (1385)

| Iran and E.Azarbaijan Province | Total | Affiliated to Ministry of Health | Private | Others
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Institute</td>
<td>Bed</td>
<td>Institute</td>
<td>Bed</td>
</tr>
<tr>
<td>E.Azarbaijan</td>
<td>38</td>
<td>5,964</td>
<td>29</td>
<td>4,867</td>
</tr>
<tr>
<td>Whole country</td>
<td>773</td>
<td>116,474</td>
<td>505</td>
<td>79,772</td>
</tr>
<tr>
<td>Ratio of E.Azarbaijan to the whole country</td>
<td>4.9</td>
<td>5.1</td>
<td>5.7</td>
<td>6.1</td>
</tr>
</tbody>
</table>

© Including treatment institutes affiliated to Social Security Organization, charities, banks, etc.

Table 2- East Azarbaijani health and treatment centers in terms of geographical situation (including treatment center [Darmangah], Clinic, Para-clinic, and Health center) in 2005/06 (1384)

<table>
<thead>
<tr>
<th>Total</th>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>408</td>
<td>302</td>
<td>106</td>
</tr>
</tbody>
</table>


Table 3- Active rural health houses (Khaneh Behdasht) and their covered population

<table>
<thead>
<tr>
<th>Iran and E.Azarbaijan Province</th>
<th>Active health houses</th>
<th>Covered population</th>
<th>Health staff (Behvarz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male and female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>E.Azarbaijan</td>
<td>1,061</td>
<td>-</td>
<td>1,580</td>
</tr>
<tr>
<td>Whole country</td>
<td>16,725</td>
<td>20,446,916</td>
<td>27,085</td>
</tr>
<tr>
<td>Ratio of E.Azarbaijan to the whole country</td>
<td>6.3</td>
<td>-</td>
<td>5.8</td>
</tr>
</tbody>
</table>

© This amount is related to 2003/04 (1382)

### Table 4- Active rural health houses (Khaneh Behdasht) and their health staffs (Behvarzan)

<table>
<thead>
<tr>
<th>Active health houses</th>
<th>Health staffs (Behvarzan)</th>
<th>Covered Villages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male and female</td>
<td>Male</td>
</tr>
<tr>
<td>Active health houses</td>
<td>1,063</td>
<td>1,732</td>
</tr>
</tbody>
</table>


### Table 5- East Azarbajani Value-added in the Health and Social Work sector and its subsectors comparing with the whole country in 2002/03 (1381) and 2003/04 (1382)

<table>
<thead>
<tr>
<th>#</th>
<th>Activity Description</th>
<th>2002/03 (1381)</th>
<th>2003/04 (1382)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>The whole country</td>
<td>Province</td>
</tr>
<tr>
<td>66</td>
<td>Public Health Care</td>
<td>10,249.5</td>
<td>458.2</td>
</tr>
<tr>
<td>67</td>
<td>Private Health Care</td>
<td>16,322.1</td>
<td>500.2</td>
</tr>
<tr>
<td>68</td>
<td>Vehement</td>
<td>4,967.3</td>
<td>20.9</td>
</tr>
<tr>
<td>69</td>
<td>Social Work</td>
<td>1,673.9</td>
<td>67.3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>28,609.2</td>
<td>1,046.7</td>
</tr>
</tbody>
</table>


### Table 6- East Azarbajani household’s health care expenditures, urban (in 2006/07: 1385) and rural (in 2005/06: 1384) unit: Rial

<table>
<thead>
<tr>
<th>Description</th>
<th>Urban (in 2006/07: 1385)</th>
<th>Rural (in 2005/06: 1384)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average household expenditures</td>
<td>52,097,614</td>
<td>23,189,852</td>
</tr>
<tr>
<td>on non-food</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health care sector</td>
<td>5,345,000</td>
<td>2,787,975</td>
</tr>
<tr>
<td>Health care costs</td>
<td>3,976,293</td>
<td>2,366,998</td>
</tr>
<tr>
<td>Social insurance and medical</td>
<td>1,368,707</td>
<td>420,973</td>
</tr>
<tr>
<td>costs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7- Settled and unsettled population and households of the province and total country, 2006/07 (1385) Census

<table>
<thead>
<tr>
<th>East Azerbaijan</th>
<th>Total</th>
<th>Population</th>
<th>Settled in urban areas</th>
<th>Unsettled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Households</td>
<td>Population</td>
<td>Households</td>
<td>Population</td>
</tr>
<tr>
<td>Total country</td>
<td>17,501,771</td>
<td>76,495,782</td>
<td>12,405,584</td>
<td>48,259,964</td>
</tr>
<tr>
<td>East Azerbaijan</td>
<td>911,930</td>
<td>3,603,456</td>
<td>635,966</td>
<td>2,402,539</td>
</tr>
</tbody>
</table>

Source: Statistical Centre of Iran, retrieved on Feb. 21, 2008 from http://kamar.sci.org. ir/

Table 8- Mean and Standard Division

<table>
<thead>
<tr>
<th>Input and Output</th>
<th>Efficient Hospitals</th>
<th>Inefficient Hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Division</td>
</tr>
<tr>
<td>Input 1</td>
<td>119.0</td>
<td>83.2</td>
</tr>
<tr>
<td>Input 2</td>
<td>529.6</td>
<td>589.3</td>
</tr>
<tr>
<td>Input 3</td>
<td>411.0</td>
<td>455.5</td>
</tr>
<tr>
<td>Input 4</td>
<td>225.4</td>
<td>186.4</td>
</tr>
<tr>
<td>Output 1</td>
<td>34,972.8</td>
<td>15,773.1</td>
</tr>
<tr>
<td>Output 2</td>
<td>168,866.8</td>
<td>93,104.7</td>
</tr>
<tr>
<td>Output 3</td>
<td>111,384.0</td>
<td>102,821.2</td>
</tr>
</tbody>
</table>

Input 1: number of specialist physicians and upper
Input 2: number of general physicians + number of nurses + number of residents + number of medical team having a degree (bachelor) or upper
Input 3: number of medical team having 14 years diploma or lower + number of nonmedical and support staff
Input 4: number of active beds
Output 1: number of emergency patients
Output 2: number of outpatients
Output 3: number of inpatients × average daily inpatients’ residing

Table 9- Mean and Standard Division of Efficiencies

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Technical Efficiency</th>
<th>Scale Efficiency</th>
<th>Allocative Efficiency</th>
<th>Cost Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.79</td>
<td>0.83</td>
<td>0.76</td>
<td>0.61</td>
</tr>
<tr>
<td>Standard Division</td>
<td>0.24</td>
<td>0.24</td>
<td>0.19</td>
<td>0.27</td>
</tr>
</tbody>
</table>
### Table 10 - Technical, Scale, Allocative, and Cost Efficiencies in Public Hospitals

<table>
<thead>
<tr>
<th>Hospitals (DMUs)</th>
<th>Technical Efficiency*</th>
<th>Scale Efficiency</th>
<th>Allocative Efficiency</th>
<th>Cost Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital 1: Imam</td>
<td>1.00 (8)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Hospital 2: Nikokari</td>
<td>1.00 (7)</td>
<td>1.00</td>
<td>0.94</td>
<td>0.94</td>
</tr>
<tr>
<td>Hospital 3: Alzahra</td>
<td>0.82 (0)</td>
<td>0.97</td>
<td>0.70</td>
<td>0.57</td>
</tr>
<tr>
<td>Hospital 4: Sina</td>
<td>1.00 (3)</td>
<td>1.00</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Hospital 5: Kodakan</td>
<td>1.00 (4)</td>
<td>1.00</td>
<td>0.67</td>
<td>0.67</td>
</tr>
<tr>
<td>Hospital 6: Amir-al-Momenin</td>
<td>0.51 (0)</td>
<td>0.51</td>
<td>0.80</td>
<td>0.41</td>
</tr>
<tr>
<td>Mean</td>
<td>-</td>
<td>0.89</td>
<td>0.77</td>
<td>0.68</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>-</td>
<td>0.20</td>
<td>0.18</td>
<td>0.24</td>
</tr>
</tbody>
</table>

* Figures into parentheses show how many times each hospital has been referenced as a “benchmark”. Technical efficiency scores were obtained based on constant return to scale.

### Table 11 - Technical, Scale, Allocative, and Cost Efficiencies in Private Hospitals

<table>
<thead>
<tr>
<th>Hospitals (DMUs)</th>
<th>Technical Efficiency*</th>
<th>Scale Efficiency</th>
<th>Allocative Efficiency</th>
<th>Cost Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital 7: Shams</td>
<td>0.65 (0)</td>
<td>0.99</td>
<td>0.96</td>
<td>0.62</td>
</tr>
<tr>
<td>Hospital 8: Behbod</td>
<td>1.00 (8)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Hospital 9: Shahryar</td>
<td>0.81 (0)</td>
<td>0.81</td>
<td>0.48</td>
<td>0.39</td>
</tr>
<tr>
<td>Hospital 10: Nor Nejat</td>
<td>0.40 (0)</td>
<td>0.40</td>
<td>0.75</td>
<td>0.30</td>
</tr>
<tr>
<td>Hospital 11: Shafa</td>
<td>0.49 (0)</td>
<td>0.49</td>
<td>0.61</td>
<td>0.30</td>
</tr>
<tr>
<td>Mean</td>
<td>-</td>
<td>0.67</td>
<td>0.74</td>
<td>0.76</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>-</td>
<td>0.24</td>
<td>0.28</td>
<td>0.22</td>
</tr>
</tbody>
</table>

* Figures into parentheses show how many times each hospital has been referenced as a “benchmark”. Technical efficiency scores were obtained based on constant return to scale.
Table 12- Input Reductions and/or Output Increases Needed to Make Individual Inefficient Hospitals Efficient

<table>
<thead>
<tr>
<th>Inefficient Hospitals</th>
<th>Inputs</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input 1</td>
<td>Input 2</td>
</tr>
<tr>
<td>Alkaffra (%)</td>
<td>10.9 (18.1)</td>
<td>-49.7 (18.1)</td>
</tr>
<tr>
<td>Amir-al-momenin** (%)</td>
<td>10.2 (48.6)</td>
<td>33.0 (48.6)</td>
</tr>
<tr>
<td>Total Public</td>
<td>21.1</td>
<td>82.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Private</th>
<th>Input 1</th>
<th>Input 2</th>
<th>Input 3</th>
<th>Input 4</th>
<th>Output 1</th>
<th>Output 2</th>
<th>Output 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shams (%)</td>
<td>48.0 (34.8)</td>
<td>36.2 (34.8)</td>
<td>118.4</td>
<td>111.6 (60.0)</td>
<td>0.0 (0.0)</td>
<td>208,324.0 (567.0)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td>Shahryar (%)</td>
<td>115.0 (82.7)</td>
<td>9.7 (18.6)</td>
<td>22.0 (18.6)</td>
<td>64.8 (64.8)</td>
<td>1,859.2 (51.0)</td>
<td>6,896.3 (56.8)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td>Nor Nejat (%)</td>
<td>38.8 (80.8)</td>
<td>15.0 (60.0)</td>
<td>51.6 (60.0)</td>
<td>38.3 (76.6)</td>
<td>0.0 (0.0)</td>
<td>6,538.0 (126.2)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td>Shafa (%)</td>
<td>59.5 (83.8)</td>
<td>16.4 (51.3)</td>
<td>44.1 (51.3)</td>
<td>61.0 (80.2)</td>
<td>1,933.9 (181.9)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
</tr>
<tr>
<td>Total Private</td>
<td>261.3</td>
<td>77.3</td>
<td>236.1</td>
<td>275.7</td>
<td>3,793.1</td>
<td>221,758.3</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*Amounts in cells show quantities of inputs and outputs and figures in parentheses reveal the percent of required increase or decrease of inputs or outputs to current situation.

** Amir-al-momenin hospital is located in Maragheh and the rest are located in Tabriz.

Input 1: number of specialist physicians and upper
Input 2: number of general physicians + number of nurses + number of residents + number of medical team having a degree (bachelor) or upper
Input 3: number of medical team having 14 years diploma or lower + number of nonmedical and support staff
Input 4: number of active beds
Output 1: number of emergency patients
Output 2: number of outpatients
Output 3: number of inpatients x average daily inpatients' residing