Table(3)

Public hospitals' general, internal, and external technical efficiency indices and The causes of inefficiency for the year 1433H

Hospitals	G.T.E.index	Hospitals ranking	I.T.E.index	E.T.E.index	Causes of inefficiency
Al-Mojama	71	15	74.1	89.2	B
Al-Ola	100	1	100	100	-
King Fahd in Jeddah	84	9	100	97.2	B
King Khalid in Hail	84	9	100	91.5	B
King Fahd in Hofuf	100	1	100	100	-
Hira in Mecca	65	19	66.4	92.7	A&B
Hafer Al- Batin	80	12	99.6	99.2	B
King Khalid in Tabuk	100	1	100	100	-
Al Amal in Dammam	82	12	82.7	99.1	B
Prince Salman in Riyadh	78	14	92.2	91.5	A&B
King Fahd in Al-Baha	100	1	100	100	-
King Saud in Bisha	82	11	80.3	89.4	A&B
King Khalid in Najran	70	17	74.1	98.7	B
King Fahd in Medina	100	1	100	100	-
King Abdul Aziz in Jeddah	100	1	100	100	-
king Fahd in Jizan	71	15	81.8	97.2	B
Ohed in Medina	100	1	100	100	-
Al-Amal in Jeddah	60	20	66.4	92.6	A&B
Al-Qurayyat	65	18	72.4	90.5	A&B
Al Amal in Riyadh	100	1	100	100	-
Average	84.6	-	89.5	96.4	A&B

Where: G.T.E.index: General technical efficiency& I.T.E.index: Internal technical efficiency & E.T.E.index: External technical efficiency & A: Hospitals internal operation & B: Hospitals external Environment.

Table(4)

Optimization required in King Fahd hospital in Jeddah to reach efficiency

Inputs and Outputs	A- Reduce Inputs Target				B- Maximizing Output Target		
	Actual Value	Target values	Optimization required	%	Target values	Optimization required	%
No. of beds	612	895	-174	-28.4	600	-12	-2
No.of doctors	515	386	-129	-25	515	0	0
No.of nurses	904	569	-335	-40	775	129	-14.3
No.of Allied Health	320	244	-76	-20	320	0	0
No.of visits reviewers	270528	257002	13526	5	347628	77100	28.5
No.of inpatients	6776	6246	530	10	9622	2846	42
No.of laboratory tests	12038	10594	1444	12	13843	1805	51
No.of patients benefiting from radiography	73223	73223	0	0	97093	23870	32.6

*Referred hospital: King Abdul Aziz hospital in Jeddah.

Appendix

Table(1)

Evolution of MOH's hospitals and its share of total government spending

Years	No. of hospitals	No. of beds	Gov. budget(SR. millions)	MOH budget	%
1990/1991	116	26886	245	12	4.9
1995/1996	176	26955	280	16.7	6
2000/2001	189	27826	335	19.7	5.9
2005/2006	209	28430	380	22.8	6
2010/2011	230	30214	4500	25.2	5.6
2011/2012	244	33277	475	29.52	6.2

Source: Health statistical year book, Riyadh, Saudi Arabia, Ministry of Health. Different issues

Table(2)

Inputs and output of selected hospitals

Hospitals	Inputs				Output			
	No.of doctors	No.of nurses	No. of beds	No.of Allied Health	visits reviewers	No.of inpatients	patients benefiting from radiography	laboratory tests
Al-Mojama	169	390	262	216	93066	11524	35081	73331
Al-Ola	100	251	133	132	36680	7851	23860	45495
King Fahd in Jeddah	515	904	612	320	270528	6776	73223	12038
King Khalid in Hail	664	165	939	861	27487	73732	13232	36581
King Fahd in Hofuf	163	336	150	186	60646	1614	39799	71287
Hira in Mecca	168	371	202	176	84244	9091	29122	665636
Hafer Al- Batin	480	788	439	369	12157	2655	88778	127643
King Khalid in Tabuk	782	166	951	703	52282	5787	200933	17823
Al Amal in Dammam	156	322	200	177	94334	14315	42426	82547
Prince Salman in Riyadh	533	977	910	681	36834	55327	13547	414305
King Fahd in Al-Baha	170	322	215	184	109379	11383	39070	114589
King Saud in Bisha	169	390	262	216	93066	11524	35081	73384
King Khalid in Najran	156	322	200	177	94334	14315	42426	82547
King Fahd in Medina	693	148	910	101	30069	55603	13212	215908
King Abdul Aziz in Jeddah	386	569	895	244	257002	6246	73223	10594
king Fahd in Jizan	230	145	310	101	30069	5560	13212	21590
Ohed in Medina	497	105	742	545	19886	27874	10666	18529
Al-Amal in Jeddah	214	601	350	315	11197	49527	67332	133165
Al-Qurayyat	163	356	150	186	60646	16144	39799	71282
Al Amal in Riyadh	436	106	597	449	191196	24181	82759	125587

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periods, and compare hospitals with each other, in order to ensure good utilization of their resources and they have high efficiency.

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- **First option (increasing output)**: King Fahd Hospital should use its current inputs, and in order to reach general efficiency (compared with referred hospital: King Abdul Aziz University in Jeddah) it should increase reception of patients in different outpatient clinics by (28.5%) , increase the number of inpatients by (42%), increase the number of laboratory tests in its centers by (51%), and increase reception of patients benefiting from radiography at its center by (32.6%), and it can increase outputs by the lower level of inputs such as beds and nurses.
- **Second option(Reduce inputs):** King Fahd Hospital could use its current inputs to achieve general efficiency, through decreasing the number of beds by (174) bed or (-28.4%), decreasing the number of doctors by (129) Doctor or (- 25%), reducing the number of nurses by (335) or (-40%), and also reducing the number of medical assistance by (76) or (-20%). It can also increasing the number of visitors, the number of inpatients auditors and laboratory tests by (5%), (10%), (12%), respectively.

6. Conclusion

The research question addressed in this paper is whether reformed government hospitals to operate under private sector management increased technical efficiency for these hospitals. Using data from the MOH's Statistical Yearbook for the year 2011 to calculate and analyze technical efficiency by using Data Envelopment Analysis. The study found that (60%) of selected hospitals have low efficiency due to either internal factors or external factors or to both. Therefore, the study suggested two options to raise the level of efficiency either by increasing output or reducing input, and it applied on one of inefficient hospitals compared with efficient hospital.

The study recommends that redistribute health resources such as hospitals manpower from efficient hospitals to inefficient hospitals. In addition, determine the reasons of not achieving hospital efficiency in order to reach optimum utilization of available resources, by comparing its levels (input / output) with the referred hospital levels (input /output). Moreover, measure the hospitals performance on a regular basis (for example, yearly) in order to highlight the performance of those hospitals during the

the goal is to maximize output and maintaining the same amount of inputs, the selected hospitals should increase its services by (16.8%).

To identify the main reasons for not achieving hospital efficiency, we calculate the external productive efficiency, which reflects efficiency level of hospitals managers to overcome the environmental factors.

It is clear from table (3) that the hospitals average general technical efficiency index reached (84.6%), while the average internal technical efficiency is (89.5%), and the average external technical efficiency is (96.4%). This means that the general technical inefficiency in the sample of hospitals is mainly due to the low level of management in overcoming the external environmental factors rather than Low level of efficient management of internal operations.

Government hospitals that could not achieved the relative efficiency divided into two categories:

- Inefficient hospitals due to management weakness to overcome the environmental or external factors only, which are: Al-Mojama hospital , King Khalid hospital in Hail, hospital Hafer Al- Batin,,Al Amal Hospital in Dammam, King Khalid hospital in Najran, King Fahd hospital in Jizan, and King Fahd hospital in Jeddah.
- Inefficient hospitals due to management weakness to overcome both internal and external factors, and the weakness of external operations, which are: King Saud Hospital Bisha, hospital Hira in Mecca, Prince Salman hospital in Riyadh, Al-Amal in Jeddah, and hospital Qurayyat.

One of the main advantages of DEA (in addition to select inefficient DMU) is to specify the amounts inefficiency in these units and suggest suitable quantities in order to achieve the relative efficiency, Whether the goal is to maximize outputs or reduce inputs. The analysis also provides information about referred DUMs for every inefficient hospitals in the same area until it reaches the general efficiency level.

Table (4) shows the required or appropriate improvement in the King Fahd hospital in Jeddah, until it reaches the level of general efficiency, by adopting one of the following options:

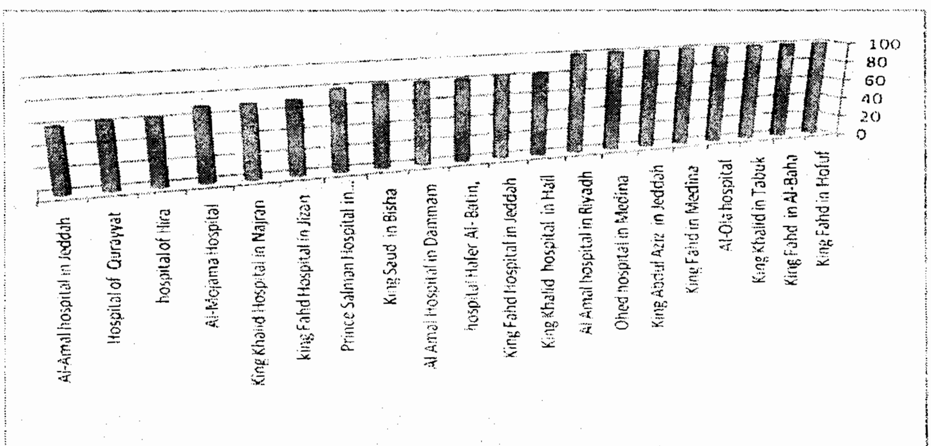
system to overcome the external factors or environmental variables that are beyond of the control of management, or because both of them?

Full efficiency index could divided into two sub-indices as follows:

1- Internal technical index or (internal operation efficiently): It reflects the level of efficiency of hospitals under assessment in using available resources (inputs) to provide the best services to the beneficiaries (outputs). This index was derived from the application of (BBC) model.

2- External technical index: It reflects the hospital level of efficiency to overcome the environmental factors that affect hospital. (such as: hospital location either densely populated or low, mediation and nepotism, the nature of the civil presence in the hospital, the demographics of the city, the proportion of residents in the city,.... etc.). These factors have negative impact on the level of provided services (outputs). This index was calculated by dividing the full efficiency index on the efficiency of operations.

Figure(2) productive efficiency of public hospitals Index



The table (3) shows the general relative efficiency of the hospitals sample. The average relative efficiency of all hospitals is (84.6%). This means, in order to become efficient hospitals, they either have to provide the same level of output by using (84.6%) of the current inputs (number of doctors, nurses, medical assistance groups), or to reduce the inputs by (15.4%) to provide the current levels of services. While if

This model estimates the technical efficiency depending on the size of existing operations in the DMU to provide services to the beneficiaries at the time of the measurement. The model also allows the possibility of having constant or increasing or decreasing returns to scale of inefficient units resulting from the change in the amount of inputs in order to get efficiency.(Cooper & Joe Zhu, 2003)

The study will adopt the two models for measuring the efficiency of health services provided by the reformed hospitals in various regions of the Kingdom. Accordingly, number of specialists, number of nurses, number of allied health and number of beds are used as input variables; while the number of patients visit outpatient, number of patients admissions to hospital, number of laboratory tests, and number of beneficiaries of radiological imaging are used as output variables.

To make sure getting accurate results from DEA, we take into account the balance between the number of inputs and outputs and the number of hospitals involved in the evaluation, where the total number of inputs and outputs should not exceed the number of DUM. (Charnes, Cooper & Siford: 1994)

5. Empirical results

The results of measuring the relative efficiency in the selected sample of hospitals, using both (BBC) and (CCR) indicate that the number of hospitals that achieved general relative efficiency is (8) hospitals out of (20) which represents (40%). These hospitals are: King Fahd in Hofuf, King Fahd in Al-Baha, King Khalid in Tabuk, Al-Ola hospital, King Fahd in Medina , King Abdul Aziz university in Jeddah, Ohed hospital in Medina and Al Amal hospital in Riyadh. While there are (12) hospitals have not achieved general relative efficiency, it arranged from the worst to the least worst as follows: Al-Amal hospital in Jeddah, Hospital of Qurayyat, hospital of Hira, Al-Mojama Hospital, King Khalid Hospital in Najran, King Fahd Hospital in Jizan, Prince Salman Hospital in Riyadh, King Saud in Bisha, Al Amal Hospital in Dammam, hospital Hafer Al-Batin, King Fahd Hospital in Jeddah, and King Khalid hospital in Hail As it shown on Figure(2)

In order to identify the main reasons of inefficacy of the (12) hospitals. Is it because inefficiency of administrative process or because the inability of the managerial

Subject to

$$\frac{\sum_{r=1}^{t} u_r \, y_{rjo}}{\sum_{i=1}^{m} v_i \, X_{rjo}} \leq 1 \qquad j=1,2,\ldots\ldots n \qquad (2)$$

$u_r, v_i \geq 0$ for all r and i

Where:

y_{rj}: output r from unit j
X_{rj}: input I to unit j
u r : weighted of output r
v i : weighted of inputs i
m: number of inputs (i=1,2,3,……m)
t= number of outputs (t=1,2,3,….t)

The main assumption of CCR model is that the change in the quantity of inputs used by the inefficient unit has fixed effect on its amount of services (outputs) when it shift to the boundary of frontier, this property called Constant Returns to Scale (CRS). This assumption will be valid if and only if all DUMs operate at the optimum level. But in reality there are many obstacles that prevent DUMs from achieving the optimum level such as imperfect competition and funding constraints.(Charnes et.al, 1994)

- The second formulation is developed by Banker, Charnes and Cooper (BCC model) that minimizes the inputs needed and constrains the sum of the weighted output at unity. The adopted DEA model represents the dual of the first linear programming formulation. The linear programming dual is expressed as the following: (AL-Shammari, 1999)

Min μ Z_0

Subject to:

$$X_{ij0} Z_0 \geq \sum^{n} \mu_i X_{ij0} \qquad : \quad i=1,2,\ldots\ldots m$$

$$\sum_{j=1}^{n} \mu_i X_{ij0} \geq y_{rj0} \qquad : \quad r=1,2,\ldots.t$$

$$\mu_j \geq 0 \qquad : \quad j=1,2,\ldots\ldots n$$

$$\sum_{j=1}^{n} \mu_j = 1 \qquad (3)$$

comparative ratio of outputs to inputs for each unit, with the score expressed as 0–1 or 0–100%. A DMU with a score less than 100% is inefficient compared to other units. It is used to identify best practices and is increasingly becoming a popular and practical management tool. DEA has been initially used to investigate the relative efficiency of nonprofit organizations but now, its use has spread to hospitals, school, banks, and network industries, among others.

In the first stage, DEA assesses efficiency by estimating a frontier based on input or output orientation. Then, each DMU is assigned an efficiency score by comparing the output and input ratio of the DMU on the efficient frontier. Mathematically, technical efficiency for each DMU is computed as follows: (Lavado and Cabanda, 2009)

Consider a system under evaluation, consisting of n DMUs. The inputs and outputs of every DMU are all nonnegative and every DMU has at least one positive input and one positive output, i.e., $x \geq 0$, $x \neq 0$ and $y \geq 0$, $y \neq 0$. Then, the economic efficiency of DMU is defined as follows:

$$\text{Efficiency} = \frac{\text{Weighted sum of inputs of } DMU_P}{\text{Weighted sum of outputs of } DMU_P} \qquad (1)$$

In this case, the DMUs can be easily compared. However, since the input costs and output prices are not always precisely available, DEA models are generally utilized for this purpose.(Eslami et. Al.,2009) It can be solved by one of two linear programming formulations:

- The first formulation is (CCR) that maximizes the outputs that can be obtained and constrains the sum of the inputs to be unity.(AL-Shammari, 1999).

$$\text{Max}_{u,v}\ h_o = \frac{\sum_{r=1}^{t} ur\ y_{rjo}}{\sum_{i=1}^{m} vi\ X_{rjo}}$$

Saudi government started to adopt this system in 1400, when AMI company was responsible for full operation of King Fahd Hospital in Baha. In 1411, the MOH applied this system in many hospitals in KSA such as: King Abdul Aziz University in Jeddah , King Saud Hospital in Bisha, and Al-Amal hospitals group in Riyadh, Jeddah and Dammam. According to the MOH statistics , there are currently about 37 hospital affiliated with the MOH operated according to full operating system .

4. Data and methodology

4.1 Data

To investigate efficiency in the reformed public hospitals in Saudi, we select a sample of (20) hospitals that operating under fully operational system, we obtain health data for the year 2011 from MOH's Statistical Yearbook. See Table(2)

4.2 Methodology

Data Envelopment Analysis (DEA) is an empirically based methodology that eliminates the need for some of the assumptions and limitations of traditional efficiency measurement approaches. The basic DEA model as introduced by Farrell in 1957 and later developed by Charnes, Cooper and Rhodes (CCR Model) uses an oriented radial measure of efficiency, which identifies a point on the boundary with the same mix of inputs (input orientation) or outputs (output orientation) of that of the observed unit.(Kontodimopoulos and Niakas, 2005)

DEA is a technique to measure relative efficiency of a set of decision-making units (DMUs) having similar multiple inputs to produce similar multiple outputs. The relative efficiency of a DMU is defined as the ratio of the sum of its weighted outputs, to the sum of its weighted inputs.

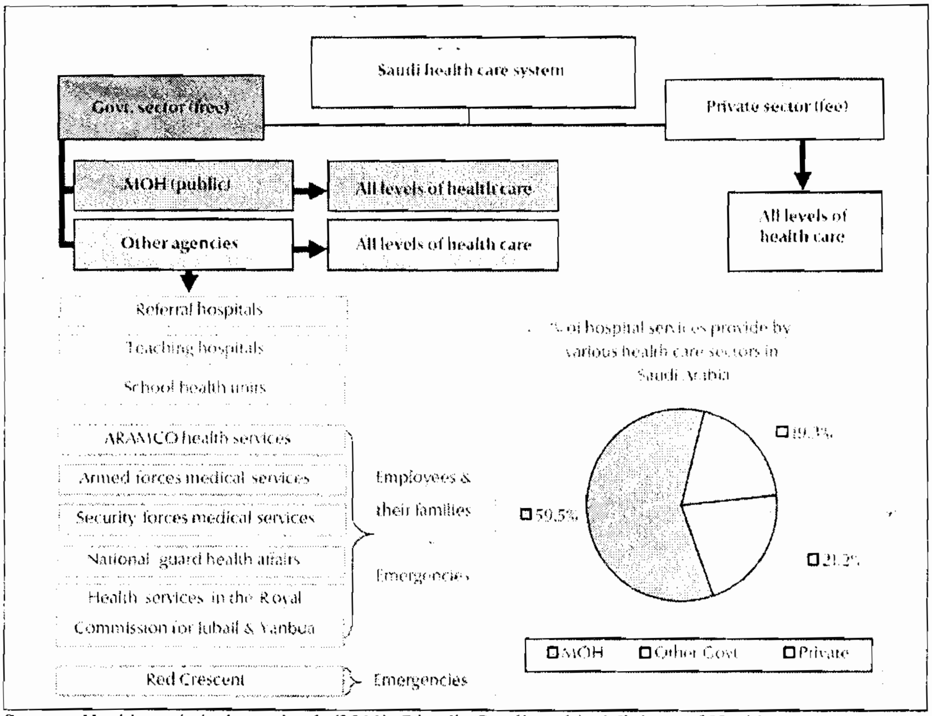
The objectives are to identify units that are relatively inefficient and setting targets for them based on examining the operational practices of the units classified as efficient. The underlying concept of DEA is based on Pareto optimality(Charnes et. al., 1985). A DMU is considered relatively efficient if there is no other DMU or a combination of DMUs which can produce at least the same amount of all outputs with less of one input and not more of any other input(Cooper et.al., 2004) It computes the

- Saudi government's desire to increase the opportunities for the private sector to manage, operate and maintenance projects that set up by the government in the framework of the free economy policy.
- The success of the first experiment to run some military hospitals affiliated to the Ministry of Defense and Aviation by the private sector for nearly 30 years ago, and it followed with running King Faisal specialist hospital and the research center by specialized international company. These experiments have achieved tangible success where medical center archived rapid advancement in the level of health services to cope with the technical development in the field of health care and providing the best possible quality services .(Ateeq, 2002)
- MOH's desire to cope with modern methods that applied in many countries in North America, Europe and East Asian countries in the field of management, operation and maintenance hospitals which confirmed success of the private institutions in carrying out these tasks in reducing the cost and improving the level of service performance.

The previous factors have led Saudi government to shift from "self-operating system" to new operating system by private companies as a method of privatization. Saudi government followed gradient progress policy which began running hospitals through bilateral cooperation agreements between Saudi government and the governments of other countries, then it followed by partial operation system and comprehensive operation system, and ended up to full operating system.

The current study focuses on the "full operating system" that followed by the Kingdom after the emergence of cons in other phases of operating systems.

Full operating system means that one of the private sector companies fully run the government hospital under a formal contract between the company and government , where the role of the MOH is only a supervisory role. The most important characteristic of this system relative to other systems is that all of the hospital staff (doctors, nurses,...etc.) in hospital are following the responsible operating company, where functional advantages are equivalent to them, This was missing in other systems.



Source: Health statistical year book,(2011), Riyadh, Saudi Arabia, Ministry of Health.

Before the year 1399 hospitals run and managed by MOH, which known " self-operating system", where MOH was responsible for hiring all Saudis and foreigners hospital staff according to the civil service system. But there are a number of factors led to the transformation from self-operating system to a system based on private sector participation in the operation of hospitals, which are: (Alhusaini, 2006)

- MOH established new five large and modern high-tech hospitals during the years of National Development Plan II (1395-1400) in Jeddah, Jizan, Hofuf, Medina and Al Khobar, but it had not available qualified human resources capable to run these facilities, therefore, MOH held bilateral cooperation agreements between Saudi government and other countries, where the new hospitals had been running by specialized staff from these countries.
- MOH's desire in carrying out planning, organization, supervision and controlling functions, which eventually would lead to integration in provision the high quality and efficient health services and ensuring its continuity.

referral hospitals, Red Crescent Society and the teaching hospitals, each of these agencies provides services to a defined population, usually employees and their dependants. Additionally, all of them provide health services to all residents during crises and emergencies(Mufti, 2000) Jointly, the government bodies operate 39 hospitals with a capacity of (10822 beds) The private sector also contributes to the delivery of health care services, especially in cities and large towns, with a total of 125 hospitals (11833 beds) and 2218 dispensaries and clinics Figure(1) shows the health care system in KSA.

MOH provides health services at 3 levels: primary, secondary and tertiary .PHC centers supply primary care services, both preventive and curative, referring cases that require more advanced care to public hospitals (the secondary level of care), while cases that need more complex levels of care are transferred to central or specialized hospitals (the tertiary level of health care). (Health statistical year book, 2011).

The MOH supervises 20 regional directorates-general of health affairs in various parts of kingdom. Each regional health directorate has a number of hospitals and health sectors and every health sector supervises a number of PHC centers. The role of these 20 directorates includes implementing the policies, plans and programs of the MOH; managing and supporting MOH health services; supervising and organizing private sector services; coordinating with other government agencies; and coordinating with other relevant bodies.

The advancement in health services, combined with other factors such as improved and more accessible public education, increased health awareness among the community and better life conditions, have contributed to the significant improvements in health indicators, however, number of issues pose challenges to the health care system, such a shortage of Saudi health professionals, the health ministry's multiple roles, limited financial resources, changing patterns of disease, high demand resulting from free services, an absence of a national crisis management policy, poor accessibility to some health care facilities, lack of a national health information system, and the underutilization of the potential of electronic health strategies.

Figure(1) Current structure of the health care sectors in Saudi Arabia

It is clear from previous studies, they tried to measure the impact of ownership on hospital efficiency using DEA , but that there is rarity of studies that tried to measure the impact of privatization of management on the efficiency of public hospitals in general and Saudi Arabia in particular. This reflects the importance of the current study that attempt to measure the efficiency of the reformed Saudi government hospitals.

3. The case of Kingdom of Saudi Arabia

Health services in Saudi Arabia have increased and improved significantly during recent decade. The first public health department was established in Mecca in 1925 based on a royal decree from King Abdulaziz. This department was responsible for sponsoring and monitoring free health care for the population and pilgrims through establishing a number of hospitals and dispensaries. While it was an important first step in providing curative health services, the national income was not sufficient to achieve major advances in health care, the majority of people continued to depend on traditional medicine and the incidence of epidemic diseases remained high among the population and pilgrims .The next crucial advance was the establishment of the MOH in 1950 under another royal decree.

Thirty years later, the 5-year development plans were introduced by the government to improve all sectors of the nation, including the Saudi health care system. Since then, substantial improvements in health care have been achieved in Saudi Arabia. (Walston et.al, 2008). Currently the Ministry of health (MOH) is the major government provider and financer of health care services in Saudi Arabia, with a total of 244 hospitals (33277 beds) and 2037 primary health care (PHC) centers. See table(1) in appendix. These services comprise 60% of the total health services in Saudi Arabia (Health statistical year book, 2011). The other government bodies include referral hospitals(e.g. King Faisal Specialist Hospital and Research Centre), security forces medical services, army forces medical services, National Guard health affairs, Ministry of Higher Education hospitals (teaching hospitals), ARAMCO hospitals, Royal Commission for Jubail and Yanbu health services, school health units of the Ministry of Education and the Red Crescent Society. With the exception of could be mainly explained by past policy-makers' decisions on the size of the hospitals or their role within the regional health care service. Finally, non-profit private hospitals exhibited a higher total inefficiency while both non-profit and for-profit hospitals are characterized by higher levels of scale inefficiency than public ones. Consequently, Nayar and Ozcan (2008) concluded that DEA is constructive technique for health care managers to investigate opportunities in accordance to efficiency improvement. Kirigia et al.(2008) stated that in the context of hospitals, efficiency meant providing maximum services out of obtainable resources or minimizing the use of available resources to produce a given level of services.

Al-Shayea (2011) applied DEA for measuring the relative efficiencies of units delivering similar services. This technique is applied to study the performance and efficiency of King Khalid University hospital departments. The results showed that only two departments out of nine have 100% efficiencies throughout the 12 months period.

M. Sahin and Bulent (2011), investigated the efficiencies of hospitals in Turkey with respect to their ownerships for the years (2001-2006) by adopting DEA, they found that the average efficiencies of state hospitals remarkably increased while the average efficiencies of private hospitals decreased especially after the starting of reforms in the state-owned hospitals. Barnum, et al.(2011), developed efficiency indicators valid for non-substitutable variables by using a sample of 87 community hospitals, they compared the new measures' efficiency estimates with those of conventional DEA measures. DEA substantially overestimated the hospitals' efficiency on the average, and reported many inefficient hospitals to be efficient. Further, it greatly overestimated the efficiency of some hospitals but only slightly overestimated the efficiency of others, thus making any comparisons among hospitals questionable. These results suggest that conventional DEA models should not be used to estimate the efficiency of hospitals unless there is empirical evidence that the inputs (outputs) are substitutable. If inputs (outputs) are not substitutes, efficiency indicators valid for non-substitutability should be employed, or, before applying DEA, the non-substitutable variables should be combined using an appropriate weighting scheme or statistical methodology.

inefficient scores. Kooreman (1994) analyzed the technical efficiency of Dutch nursing homes with respect to the use of labor. Using DEA, White and Ozcan (1996) studied the effect of church-ownership on hospital efficiency, using a sample of California hospitals.They found that religious hospitals were more efficient than secular (public) nonprofit hospitals.

Chilingerian and Sherman(1997) have explored the use of DEA to identify "best practice" primary care physicians, and have calculated the potential savings if inefficient physicians were to adopt "best practice" patterns. Similarly, Ozcan (1998) used DEA to examine primary care physicians' efficiency in the treatment of obits media by analyzing geographic variations in practice patterns, and the impact of inefficient practice patterns on the cost of treatment. Both Harris, Ozgen and Ozcan (2000) and Ferrier and Valdmanis (2004) applied DEA methods to analyze the effects of a merger on hospital efficiency. Harris, Ozgen and Ozcan (2000) found scale efficiency to be the dominant source of efficiency improvements, but did not find improvements in technical efficiency one year after a merger. Ferrier and Valdmanis (2004) used methods very similar to those used in this study to evaluate the effects of hospital mergers. They compared efficiency scores one year before, the year of and one year after the merger using matched pairs of hospitals. They also found no significant change in technical efficiency in the year after a hospital merger. However, disruptions associated with consolidations likely take more than a single year to resolve themselves and improvements in technical efficiency can only then emerge. For example, Dranove and Lindrooth (2003), evaluating cost savings, did not identify savings until at least two years after a merger.

Dino Rizzi and Vincenzo Rebba(2006), applied DEA method to measure the efficiency of 85 (public and private) hospitals in Veneto, a Northern region of Italy. The empirical analysis allowed to verify the role of weight restrictions and of demand in measuring the efficiency of hospitals operating within a National Health Service (NHS). They found that the imposition of a lower bound on the virtual weight of acute care discharges weighted by case-mix (in order to consider policy-maker objectives) reduced average hospital efficiency. Moreover, they showed that, in many cases, low efficiency scores were attributable to external factors, which were not fully controlled by the hospital management; especially for public hospitals low total efficiency scores derivation of the efficient production function. Method summarizes all inputs and outputs into a single virtual input and single virtual output. DEA is one of the most applied technique for evaluating hospital efficiency (Linna et al., 2006& Bakar et al., 2010). DEA enables the use of multiple inputs and outputs at the same time for hospital efficiency studies. Literature review of DEA studies on hospital efficiency shows that there are a number of studies applied in many developed and developing countries. The first DEA model developed by Charnes et al. (1978), named the CCR model, was based on the assumption of Constant Return to Scale (CRS) in order to measure the efficiency of decision making units (DMU). Later, Banker et al. (1984) enhanced the CCR model and developed the BCC model using the Variable Return to Scale (VRS), in 1984, they used empirical data from a sample of North Carolina hospitals to compare efficiency to characterizations obtained from DEA of econometric models. The DEA model was able to identify inefficiencies and uncover return to scale possibilities in individual hospitals that were not evident in the trans-log model. In addition, they reported that DEA's efficiency estimates appeared to be more closely related to the degree of capacity utilization than were the trans -log estimates.

Valdmanis (1990) used DEA and he found that public non-profit hospitals were more efficient than private non-profit hospitals. Dittman et.al,(1991), attempted to demonstrate how DEA can be useful to hospital administrators and health care planners. They used actual data collected by the American hospital association through its monitored data service. They found that the efficiency with which a hospital operates may well depend upon the local or regional labor market, the competition among health care providers in that market, and the demographics of the service area. DEA is based on the generalized notion of convexity which assumed that the performance arrived at by taking any linear weighted combination of other hospitals' inputs and outputs represents a feasible and achievable technology, They concluded that inefficiency score and the resource conservation potentials were based on a unit's so-called contraction path, where all of the controllable inputs were required to be reduced by the same factor.

Ozcan, Luke and Haksever (1992) used DEA to show that government and non-profit hospitals were indistinguishable from one another regarding their percentages of sector, in order to identify which hospitals are more efficient(According to providing the greatest quantity of services or outputs) by using available inputs, and which hospitals are not. In addition, determine the amount of inputs that have to be reduced (or output have to be raised) for less efficient hospitals in order to achieve the required efficiency.

In order to achieve the study objectives, the second section of this paper reviews the relevant empirical literature on measuring efficiency of hospitals using DEA techniques. The third section presents the experiences of Saudi Arabia in managing public hospitals since 1399. The fourth section illustrates data, and methodology. The fifth section describes and discusses the results of our analysis, and the final section is conclusion and recommendations.

2. Literature review

Efficiency is a component of productivity and refers to the comparison between actual and optimal amounts of inputs and products. The comparison can take the form of the ratio of actual to maximum potential products obtainable from the given inputs, or the ratio of minimum potential to actual inputs required for producing the given products. In both cases, the optimum is defined in terms of production possibilities and accounts for the impact of differences in the operating environment and production technology. Efficiency has become one of the most attractive work areas of healthcare management literature. Some authors(White and Ozcan, 1996) argued that hospitals were profit organizations while some others did not agree with them(Lynch and Ozcan, 1994). Harris et al.(2000) argued that hospitals, whether are economic organizations or not have limited resources to gain maximum value like all other organizations. Studies on hospital efficiency mostly focus on the issue of maximum gain with limited resources (Sorkis and Talloru, 2002). The interest on hospital efficiency has increased because of the desire to control the increasing costs. Accordingly, hospital resources and their processes became critical and, as a result, the number of studies has increased in recent years.

Modeling efficiency measurement is a non-parametric way was introduced first by Farrell (1957) including that measurement of price and technical efficiencies and the

Thirty years. Since1980,the Saudi government began to contract with foreign companies or national corporate companies to manage some of public hospitals of the ministry of health. This system is known as "Operating Hospitals System".

This system passed through several stages, starting from operational phase through bilateral agreements between the Saudi government and other countries, and it ends with fully operational phase where private companies run the entire hospital, while the ministry of health supervises only.

Over the past few decades, there has been an increasing interest in the measurement of hospital efficiency in developing countries. Measuring efficiency requires a conceptual framework with which to specify the production process, identify the determinants of performance, and derive efficiency measures in terms of well defined variables. There are two types of techniques to assess the various efficiency components in the health sector: economic evaluation: which compares a number of health programs or health care interventions in terms of their costs and benefits; and benchmarking analysis which compares individual service providers against best-practice standards of the production process. The choice of measurement methods in hospital efficiency assessment has been widely argued in the literature, few authors have offered a framework to specify variables that reflect different hospital functions, the quality of the process of care and the effectiveness of hospital services.
Data Envelopment Analysis (DEA) is one of the benchmarking analysis technique that widely used for the efficiency measurement of hospitals. It is popular in evaluating hospital efficiency because it is applicable to the multiple input-output that is essential for the nature of a health care system. The data generated from (DEA) can also become the health care manager's guide for department and program improvement. (Hollingsworth et al.,1999). In this study, number of specialists, number of nurses, number of allied Health and number of beds are used as input variables; while number of patients visit outpatient, number of patients admissions to hospital, number of laboratory test, and number of beneficiaries of radiological imaging are used as output variables.
The study aims at using Data Envelopment Analysis (DEA) to evaluate and measure the efficiency of a sample of public hospitals that have been managed by private

1. Introduction

Since the late 1980s, many developing countries have initiated efforts to improve their health systems. A number of factors prompted these efforts: the movement from state-controlled economies to market-oriented economies; insufficient funding for health in times of financial crisis; the lack of basic health services for many citizens; and the poor quality, low accountability, and inefficiency of existing health services. To address these issues, many governments launched health sector reforms, which are intensive long-term efforts to strengthen and improve health systems and, ultimately, improve the nations' health.

Health sector reform may involve a number of strategies, policies, and interventions designed to strengthen the health system so that it can better achieve public health goals. Countries' approaches to health sector reform vary widely: Some governments implement sweeping reforms, while others enact narrower changes. Most reform measures can be grouped into three broad categories: financing changes, organizational changes, and policy changes.

Organizational changes try to overcome weak management structures and a lack of performance incentives in the public sector. Typical reform measures have included decentralizing authority, promoting public-private partnerships, and integrating services. Reproductive health managers and advocates interested in influencing how services are funded and provided need to become familiar with the objectives, principles, and strategies of health sector reform and to take part in policy discussions at the national and local levels.

Health care industry in Saudi Arabia is growing rapidly and will continue to provide excellent and challenging opportunities for providers. Where it continues to provide massive support to existing as well as new projects in order to see that health services are accessible to all people at all levels of care-primary, secondary, and tertiary. The experience of Saudi Arabia in contracting with the private sector to manage and operate the public hospitals of the Ministry of Health of Saudi is a unique experiences that Parallel with the universal health renaissance in Saudi Arabia during the last

Outline

Measuring Efficiency of Reformed Public Hospitals in Saudi Arabia: An Application of Data Envelopment Analysis

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الملخص

تهدف الدراسة إلى التحقق من مدى كفاءة الخدمات المقدمة في المستشفيات العامة في المملكة العربية السعودية التي يتم إدارتها من قبل القطاع الخاص من خلال نظام التشغيل الكامل، وذلك من خلال تطبيق تحليل مغلف البيانات على عينة من المستشفيات التي طبق هذا النظام عليها بلغت (٢٠) مستشفى. وقد تم الاعتماد على البيانات الصحية التي تصدرها وزارة الصحة السعودية في كتابها الإحصائي السنوي لعام ٢٠١١. وقد توصلت الدراسة أنه رغم تحقيق المملكة لعدة إيجابيات من إتباع هذا الأسلوب مثل:استقطاب الكوادر البشرية المتميزة، والنهوض السريع بمستوى الخدمات الصحية الحكومية، وجذب رؤوس الأموال الوطنية إلى القطاع الصحي، وتخفيف العبء الإداري عن القطاع الحكومي، إلا أنه يُلاحظ انخفاض متوسط الكفاءة النسبية لمستشفيات العينة، حيث بلغت نسبة المستشفيات التي لم تحقق الكفاءة النسبية التامة (٦٠%) ويرجع ذلك لعدة أسباب تمثلت في عدم قدرة إدارة المستشفيات على حل بعض المشكلات الداخلية أو الخارجية التي تواجهها بشكل كامل الأمر الذي أثر بشكل سلبي على أدائها في تقديم خدماتها الصحية. وقد أوصت الدراسة بأنه يمكن رفع كفاءة المستشفيات من خلال عدة طرق أهمها:إعادة توزيع الموارد(مثل الطاقة البشرية) بين المستشفيات العامة، بالإضافة إلى علاج المشاكل التي أدت إلى عدم تحقيق المستشفيات للكفاءة المطلوبة في تقديم الخدمات، وأخيراً وضع معايير لقياس أداء المستشفيات بشكل دوري (سنوي مثلاً) ومقارنتها بأداء المستشفيات الأخرى وذلك للتأكد من مدى كفاءة استخدامها للموارد المتاحة.

Abstract

The study aims at investigating efficiency of public hospitals that have been reformed to operate under the management of the private sector through the full operating system. The study applied Data Envelopment Analysis(DEA) on the sample of reformed hospitals based on the ministry of health data for 2011. The study concluded that although the Saudi government achieved many positives results such as: attracting the excellence human resources, rising of the level of government health services, attracting national capital to the health sector, and reducing the administrative burden for the government sector, there are (60%) of the study sample had not achieved relative efficiency due to different reasons. The study recommends that efficiency of hospitals could be raised by several ways: Re-distributing of resources such as manpower between public hospitals, addressing the factors that led to the inability of hospitals to achieve the required efficiency, and finally developing criteria for measuring the performance of hospitals periodically(annually for example) and compare the performance with other hospitals in order to ensure the extent of the efficiency of use of available resources.

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