A.H. Kassam
Production Engineering and Metallurgy Dept.
University of Technology
Baghdad, Iraq
allakassam@yahoo.com

A.A. Mohammed Ali
Production Engineering and Metallurgy Dept.
University of Technology
Baghdad, Iraq
Asmaa.albayati@yahoo.com

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Efficiency Analysis of Healthcare Sector

Abstract- *Hospital efficiency & Productivity analysis, is an important issue in the health economics. Furthermore, the study analyze the efficiency and productivity in the hospitals, from two viewpoints: firstly, Data Envelopment Analysis (DEA) used to measure the relative efficiency of the hospitals with applying (CCR) approach. Secondly, Luenberger Productivity Indicator (LPI) used to measure the change (progress) in productivity of consecutive time periods. The study model has been tested and implemented on four case studies based on changing in inputs and outputs variables, of three hospitals in the study district (Baghdad) to analyze their efficiency, in two years period (2014-2015), with three inputs variables and five outputs variables. The results of using DEA technique shows that Al- Alwaiya Children's hospital only still efficient in four cases, while, other hospitals (Ibn Al-Balady & Fatima Al-Zahraa) change their efficiency by changing the case, then by using LPI technique, the results indicate that the (Ibn Al- Balady) hospital has productivity growth in three cases. The Fatima Al-Zahraa hospital has productivity decline in two cases and has growth in one case only. Finally the Al- Alwaiya Children's hospital has productivity growth in all cases during period (2014 – 2015).*

Keywords- *Hospitals Efficiency, Productivity, Data Envelopment Analysis, Luenberger Productivity Indicator.*

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1. Introduction

Public hospitals represent an essential part in health care system in any society, and particularly in Iraq. They represent the most vital part for many reasons, such as the growth of urban settlements (medium and big cities) at the expense of rural settlements shrinkage, and also the nature of the services given by these hospitals, which are characterized by very high standard with high specialization [1].

Most of researchers agree that efficiency is related to the utilization of resources. According to (Lovell), the efficiency of a production unit is defined in terms of a comparison between actual and optimal quantity of inputs and outputs [2].

The efficiency measures are more accurate than of productivity in meaning that they employ a comparison with the most efficient frontier, and for that they can complete those of productivity, based on the ratio of outputs to inputs.

(Pritchard), clarify some definitions which related with productivity: first, the productivity is output/input, in other term is measure of efficiency; second, the productivity refers to broader concept that makes the organization has a better function; and another definition states that Productivity is composition of both, effectiveness and efficiency [3].

Figure (1) shows the relation between productivity, efficiency and other similar terms as (profitability, performance, and effectiveness), that explained by (Triple p) model [4].

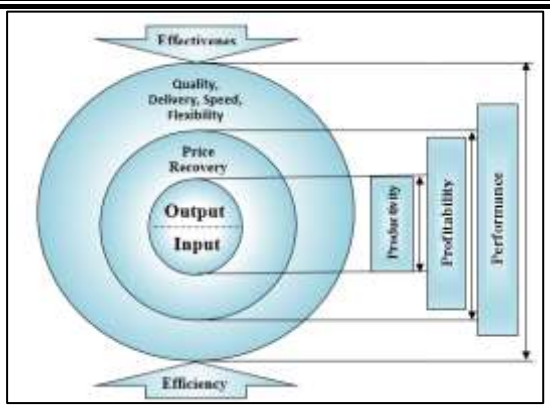

Figure 1: The (Triple P) model [4]

There are many measurement approaches to estimate the productivity and efficiency [5] such as: partial factor productivity, total factor productivity, index number approaches, parametric & non parametric approaches. In this research two methods are used, non parametric Data Envelopment Analysis (DEA) to estimate relative efficiency for each Decision Making Unit (DMU) & Luenberger Productivity Indicator (LPI) to measure the change (progress) in productivity of consecutive time periods.

I. Data Envelopment Analysis (DEA)

(DEA) evaluates the relative technical efficiency with 'linear programming model' by using (input & output) variables from similar and homogeneous DMUs. In (DEA) model there are two models approaches are: (CCR approach) & (BCC approach).

The CCR approach [5], assume a constant returns-to-scale (CRS), strong disposability of inputs and

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outputs, and convexity of the production possibility set. Under the assumption of CRS, any scaled-up or scaled-down versions of the input combinations are also involved in the production possibility set. However, the constraint over returns-to-scale may be relaxed to allow units to be compared given their scale of operations. So, to allow returns-to-scale to be variable (constant, increasing or decreasing), develop (BCC) model, called variable returns-to-scale (VRS) [6]. Also, (DEA) model has two assumptions: (1) Input oriented (outputs are held constant and inputs are decreased). (2) Output oriented (inputs are held constant and outputs are increased) [7]**.** In this research CCR (minimization problem) dual form is used rather than primal form, due to fewer constrains. The models (1) and (2) indicates to dual form of input & output oriented CCR-DEA respectively.

$$\left.\begin{aligned} & min_{\theta.\lambda}\theta_h \\ s.t.\ & \sum_{i=1}^{I} x_{li}\lambda_i \le \theta x_{lh} \quad l = 1,2,\dots,L \\ & \sum_{i=1}^{I} y_{ki}\lambda_i \ge y_{kh} \quad k = 1,2,\dots,K \\ & \lambda_i \ge 0 \quad i = 1,2,\dots,I \end{aligned}\right\} model(1)$$

$$\left.\begin{aligned} & max_{\theta.\lambda}\,\theta_h \\ s.t.\ & \sum_{i=1}^{I} x_{li}\lambda_i \le x_{lh} \quad l = 1,2,\dots,L \\ & \sum_{i=1}^{I} y_{ki}\lambda_i \ge \theta_h y_{kh} \quad k = 1,2,\dots,K \\ & \lambda_i \ge 0 \quad i = 1,2,\dots,I \end{aligned}\right\} model(2)$$

Where:

- x_{li} , y_{ki} are inputs and outputs for each DMU;
- x_{lh} , y_{kh} representing the inputs and outputs for DMU_h;
- θ_h is the factor by which an: (1) (input set x_{lh} is adjusted to attain the minimum input level x_{li} in county hospital *i*, in order to reach the efficient frontier) in input oriented, (2) (output set y_{kh} is adjusted to attain the maximum output level y_{ki} in county hospital *i*, in order to reach the efficient frontier) in output oriented.
- λ = variables weights.

Based on input oriented model if $\theta = 1$, DMU_h the relative technical efficiency is efficient; and if $\theta < 1$, DMU_h is inefficient, while in output oriented model if $\theta = 1$, DMU_h the technical efficiency is efficient; and if $\theta > 1$, DMU_h is inefficient.

II. Luenberger Productivity Indicator (LPI)

The second technique Luenberger productivity indicator (LPI) introduced by (Chambers) [8], used to determine the change in productivity over consecutive years. It is based on (Directional distance function). The directional distance function calculates the smallest changes in a given direction in inputs & outputs, which are needful for a maker to reach the production frontier.

The Luenberger productivity indicator is defined as:

$$\mathrm{L}(z_p, z_{p+1}) = [D_p(z_p, g) - D_{p+1}(z_{p+1}, g)] + \frac{1}{2}[D_{p+1}(z_{p+1}, g) - D_p(z_{p+1}, g) + D_{p+1}(z_p, g) - D_p(z_p, g)] \quad (1)$$

Where, L (z_p, z_{p+1}) is Luenberger productivity indicator,$D_{p+1}(z_{p+1}, g)$, $D_p(z_{p+1}, g)$, $D_{p+1}(z_p, g)$, $D_p(z_p, g)$, are directional distance function values as described in models (3), (4), (5) and (6).

z_p= (x_p, y_p) denotes inputs and outputs in period p, and g = $(-g_x, g_y)$ is the directional vector indicating that the inputs are to be contracted and the outputs increased simultaneously. A direction vector g = (x, y) is use in this study research, to measures the smallest changes in inputs & outputs. Thus, the (directional distance function) is comparable to the (proportional-distance-function), that introduced by (W. Briec) [9]. Productivity improvement is represented by a positive value of the index (L), and productivity declines by negative value. The Luenberger productivity indicator (L) can be decomposed in to terms: efficiency change (catch – up) and technological change (frontier shift). The efficiency change (EFFCH) measures efficiency change between time periods (p) and (p+1), and expresses as:

$$\mathrm{EFFCH} = D_p(z_p, g) - D_{p+1}(z_{p+1}, g) \quad (2)$$

While, the technological change (TECH) express the shift of technology between the two time periods.

$$\mathrm{TECH} = \frac{1}{2}\left[D_{p+1}(z_{p+1}, g) - D_p(z_{p+1}, g) + D_{p+1}(z_p, g) - D_p(z_p, g)\right] \quad (3)$$

To estimate LPI, four maximization problems needed to be solved; two for within-period distance functions ($D_p\ (z_p, g), D_{p+1}\ (z_{p+1}, g)$) and two for mixed-period distance functions ($D_p\ (z_{p+1}, g), D_{p+1}\ (z_p, g)$).

$$\left.\begin{aligned} & D_p\,(z_p, g) = \mathrm{Max}\,\beta \\ s.t.\ & \sum_{h=1}^{H} \lambda_h\, x_{ip}^h \le (1 - \beta) x_{ip}^o \\ & \sum_{h=1}^{H} \lambda_h\, y_{jp}^h \ge (1 + \beta) y_{jp}^o \\ & \lambda_h \ge 0, \quad h = 1, \dots\dots\dots, H \end{aligned}\right\} model\ (3)$$

$$\left.\begin{aligned} & D_p\,(z_{p+1}, g) = \text{Max}\,\beta \\ s.t. & \sum_{h=1}^{H} \lambda_h\, x_{ip}^h \le (1-\beta) x_{i(p+1)}^o \\ & \sum_{h=1}^{H} \lambda_h\, y_{jp}^h \ge (1+\beta) y_{j(p+1)}^o \\ & \lambda_h \ge 0, \qquad h = 1, \dots\dots\dots, H \end{aligned}\right\} \quad model\ (4)$$

$$\left.\begin{aligned} & D_{p+1}\,(z_p, g) = \text{Max}\,\beta \\ s.t. & \sum_{h=1}^{H} \lambda_h\, x_{i(p+1)}^h \le (1-\beta) x_{ip}^o \\ & \sum_{h=1}^{H} \lambda_h\, y_{j(p+1)}^h \ge (1+\beta) y_{jp}^o \\ & \lambda_h \ge 0, \qquad h = 1, \dots\dots\dots, H \end{aligned}\right\} \quad model\ (5)$$

$$\left.\begin{aligned} & D_{p+1}\,(z_{p+1}, g) = \text{Max}\,\beta \\ s.t. & \sum_{h=1}^{H} \lambda_h\, x_{i(p+1)}^h \le (1-\beta) x_{i(p+1)}^o \\ & \sum_{h=1}^{H} \lambda_h\, y_{j(p+1)}^h \ge (1+\beta) y_{j(p+1)}^o \\ & \lambda_h \ge 0, \qquad h = 1, \dots\dots\dots, H \end{aligned}\right\} \quad model\ (6)$$

Where i = (1... I) and j = (1... J), indexes denote inputs and outputs respectively, h = (1... H), denote number of hospitals, λ_h is the variables weights, x_{ip}^h, $x_{i(p+1)}^h$ are quantities of input *i* for DMU_h in periods p and (p+1) respectively, $y_{jp}^h, y_{j(p+1)}^h$ are quantities of output *j* for DMU_h in period p and (p+1) respectively, $x_{ip}^o, x_{i(p+1)}^o$ are quantities of input *i* for DMU_o in period p and (p+1) respectively, $y_{jp}^o, y_{j(p+1)}^o$ are quantities of output *j* for DMU_o in period p and (p+1) respectively.

2. Literature Survey

Hospital productivity and efficiency analysis, is a significant issue in the health economics. Furthermore there are many studies that deal with productivity and efficiency analysis in the hospitals using different measurement approaches in different countries. Barros et al. (2007) [10] applied Luenberger productivity indicator (LPI), to estimate the efficiency and the change in productivity of Portuguese hospitals over seven periods from (1997 to 2004). They found the selected sample of hospitals didn't meet productivity growth through the study periods.

Abou El-Seoud (2013) [11] used the (DEA) technique to analyze relative efficiency of the public hospitals in KSA, of a sample (20) hospitals for year (2011). He found that (60%) of hospitals have low efficiency due to external factors and/or internal factors. Kirigia and Asbu (2013) [12] evaluated the relative technical and scale efficiency and explain the inefficiencies of 20 public secondary level community hospitals in Eritrea, based on data generated in 2007, using (DEA) method and (Tobit) regression analysis. They found that 68% hospitals were variable returns to scale technically efficient; and only 42% hospitals achieved scale efficiency. On average, inefficient hospitals could have increased their outpatient visits by 5.05% and hospital discharges by 3.42% using the same resources. Jat and Sebastian (2013) [13] used (DEA) performed with input orientation and variable returns to scale (VRS) assumption, to estimate the Technical Efficiency (TE) of the 40 public district hospitals from January to December 2010 in Madhya Pradesh, India. They found half of the study hospitals were operating inefficiently. Torabipour et al. (2014) [14] analyzed data and measured the productivity of (12) teaching and non-teaching hospitals of Ahvaz County of (4) year period from (2007 to 2010), using the (DEA) technique and Malmquist indices with an input-orientation approach. They found there was not a considerable difference in average productivity changes among teaching and non-teaching hospitals except in year (2009). Cheng et al. (2015) [15] applied the (DEA) to estimate the technical and scale efficiency, and productivity growth using Malmquist index of 114 sample county hospitals selected from Henan province, China, from 2010 to 2012.They found there was considerable space to improve technical efficiency in Henan county hospitals. The hospitals experienced productivity progress during 2010–2012, however, there are adverse change in pure technical efficiency.

3. The Study Methodology

The methodology of the study in general consists of a relevant model, as shown in Figure (2), which consists of three modules: The first module (Specify the Goal and Related Data), includes: (1) Define the goal of the study. (2) Identifying the number of DMUs (hospitals) to be estimate the relative efficiency. (3) Identifying the input & output variables to be use in the study. The second module (Data Envelopment Analysis) consists of four components: (1) Estimate the relative efficiency by applying (CCR) input oriented and output oriented measurement models. (2) Apply (a) Input oriented (CCR) approach to measure relative technical efficiency with reducing inputs while holding outputs constant, and (b) Output oriented (CCR) approach to measure (relative technical efficiency) with increasing outputs while holding inputs constant. (3) Summarizing the reference set.

(4) Identify efficient DMUs and inefficient DMUs. The third module (Luenberger indicator), consist of three components: (1) Identify number of years to be measured the progress in productivity of DMUs. (2) Solve the (directional distances functions) values by Selecting the direction vector g = (x, y) that based on the proportional modulation of (inputs and outputs) simultaneously. (3) Quantify the progress of Productivity Change, which can decomposed into: (a) efficiency change (EFFCH) and (b) technological change (TECH) over time periods.

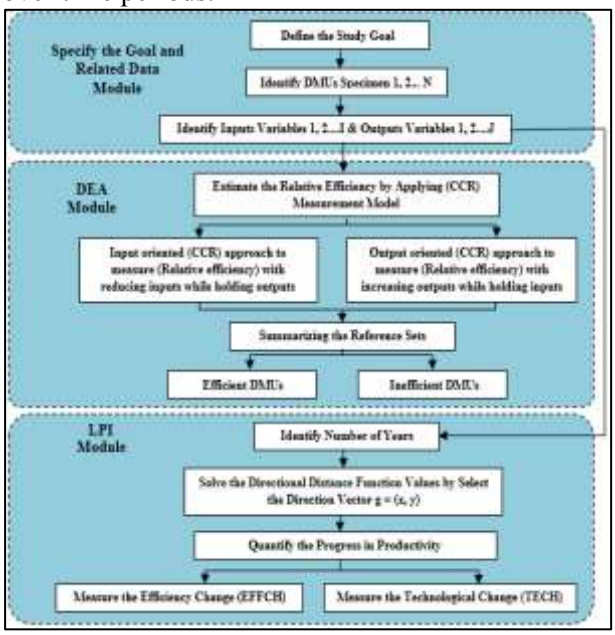

Figure 2: Model of efficiency and productivity analysis in hospitals

4. Data and Results

The study model is implemented on three hospitals (Al- Alwaiya Children's Hospital, Fatima Al-Zahraa Hospital and Ibn Al- Balady Hospital) in study district (Baghdad). By using four case studies are shown in Table (1).

Table 1: Case study specification

Cases	Indicators	
	Inputs	**Outputs**
I	1) No. of Doctors, 2) No. of Nurses, 3) No. of Health personnel.	1) No. of Outpatient, 2) No. of Laboratory tests, 3) No. of radiography test, 4) No. of sonar tests 5) No. of emergency visits.
II	1) No. of Doctors, 2) No. of Nurses, 3) No. of Health personnel	1) No. of Outpatient, 2) No. of Laboratory tests, 3) No. of radiography test, 4) No. of emergency visits.
III	1) No. of Doctors, 2) No. of Health personnel	1) No. of Outpatient, 2) No. of Laboratory tests.
IV	1) No. of Health personnel	1) No. of radiography test, 2) No. of Outpatient, 3) No. of sonar tests.

Based on changing in inputs & outputs variables, of three inputs variables: No. of (doctors, nurses, health personnel), and five output variables: No. of (outpatient visits, laboratory tests, sonar tests, radiography test and emergency visits).

I. DEA Module

DEA technique used to estimate the relative efficiency for each hospital by applying input & output oriented CCR models (1) and (2) respectively. The relative efficiency score for each hospital was obtained by running the linear programing formula in Excel software as in Figure (3). The summary of efficiency scores and reference sets of each hospital are presented in Table (2).

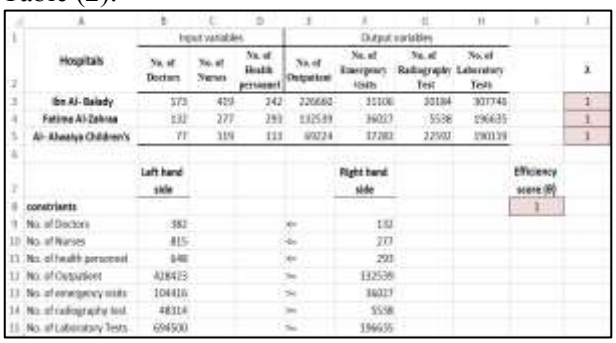

Figure 3: Spreadsheet of DEA model implementation using excel software

From the Table (2), the efficiency score in input oriented case (I) of the three hospitals are equal to (1), this is because the hospitals have the average inputs convergent to each other, signifying all are relatively efficient. Except the Ibn Al- Balady hospital in 2015, it has efficiency score equal to (0.999). This may be caused from the average of inputs in Ibn Al- Balady hospital is relatively slightly higher than other hospitals. In output oriented case I, very small amount of inefficiency appears in Fatima Al-Zahraa hospital, caused from the outputs average is relatively slightly lesser than its peers. In spite of this small amount of inefficiency, there is no reference sets, denoting that the Fatima Al-Zahraa hospital is very close to efficiency frontier. The results of case II in input oriented show that, only Fatima Al-Zahraa hospital is inefficient, which has relative efficiency score in two years (2014 and 2015) less than one (0.88391), (0.71451), respectively. The source of this inefficiency is from two main reasons first, the radiography test, which has small value if compared with its peers. The second reasons is because extracting the sonar test from this case, which has value in Fatima Al-Zahraa higher than value in the other hospitals. The hospitals Ibn Al-Balady and Al- Alwaiya Children's are on efficient frontier, thus, the Fatima Al-Zahraa needs about the value of λ_1 (0.389) to reach efficient frontier as Ibn Al- Balady, and about λ_3 (0.642) in 2014,

(1.326) in 2015, to reach efficient frontier as Al-Alwaiya Children's in wards, of decreasing the inputs with constant outputs. The output oriented results of case II, show that, the Fatima Al-Zahraa hospital is also inefficient as in input oriented, but the values differ from input oriented, which the output oriented based on increasing the outputs with constant inputs.

The Fatima Al-Zahraa hospital need value about (0.440) to reach Ibn Al- Balady hospital's efficiency, and value about (0.726) in 2014, (1.855) in 2015 to reach Al- Alwaiya Children's hospital's efficiency.

Table 2: Relative efficiency score and reference sets of cases (I, II, III and IV)

Cases	Hospitals	Input Oriented Approach					Output Oriented Approach				
		λ_1	λ_2	λ_3	Efficiency Score (θ)	Reference sets	λ_1	λ_2	λ_3	Efficiency Score (θ)	Reference sets
Case I 2014	Ibn Al-Balady	1	0	0	1	-	1	0	0	1	-
	Fatima Al-Zahraa	0	1	0	1	-	0	1	0	1	-
	Al- Alwaiya Children's	0	0	1	1	-	0	0	1	1	-
Case I 2015	Ibn Al-Balady	0.999	0	0	0.999998	-	1	0	0	1	-
	Fatima Al-Zahraa	0	1	0	1	-	0	0.999	0	1.000002	-
	Al- Alwaiya Children's	0	0	1	1	-	0	0	1	1	-
Case II 2014	Ibn Al-Balady	1	0	0	1	-	1	0	0	1	-
	Fatima Al-Zahraa	0.389	0	0.642	0.88391	λ_1, λ_3	0.440	0	0.726	1.13134	λ_1, λ_3
	Al- Alwaiya Children's	0	0	1	1	-	0	0	1	1	-
Case II 2015	Ibn Al-Balady	1	0	0	1	-	1	0	0	1	-
	Fatima Al-Zahraa	0	0	1.326	0.71451	λ_3	0	0	1.855	1.39956	λ_3
	Al- Alwaiya Children's	0	0	1	1	-	0	0	1	1	-
Case III 2014	Ibn Al-Balady	1	0	0	1	-	1	0	0	1	-
	Fatima Al-Zahraa	0.532	0	0.174	0.79814	λ_1, λ_3	0.666	0	0.217	1.25291	λ_1, λ_3
	Al- Alwaiya Children's	0	0	1	1	-	0	0	1	1	-
Case III 2015	Ibn Al-Balady	1	0	0	1	-	1	0	0	1	-
	Fatima Al-Zahraa	0	0	1.326	0.71451	λ_3	0	0	1.855	1.39956	λ_3
	Al- Alwaiya Children's	0	0	1	1	-	0	0	1	1	-
Case IV 2014	Ibn Al-Balady	0	0.526	0.765	0.99323	λ_2, λ_3	0	0.529	0.770	1.00682	λ_2, λ_3
	Fatima Al-Zahraa	0	1	0	1	-	0	1	0	1	-
	Al- Alwaiya Children's	0	0	1	1	-	0	0	1	1	-
Case IV 2015	Ibn Al-Balady	0	0	1.877	0.87446	λ_3	0	0	2.147	1.14356	λ_3
	Fatima Al-Zahraa	0	0	2.421	0.85119	λ_3	0	0	2.844	1.17483	λ_3
	Al- Alwaiya Children's	0	0	1	1	-	0	0	1	1	-

In case III, select only two inputs and two outputs, to see the effect of number of variables in relative efficiency score. The results show there is no real change in relative efficiency score in case III compared with the case II, which shows the Fatima Al-Zahraa hospital is still inefficient, with efficient of other hospitals, except small change in value of efficiency score and reference sets, where, the efficiency score in case II of Fatima Al-Zahraa hospital of year 2014 (0.88391) is slightly higher

than efficiency score in case III (0.79814), while in year 2015, stay same in both cases (0.71451).
The output oriented case III as in input oriented, the amount of inefficiency of Fatima Al-Zahraa hospital increases if compared with amount of inefficiency in case (II).
In case IV, select only one input, with three output variables, the input oriented results show that Ibn Al- Balady hospital is inefficient, has relative efficiency score less than one (0.99323), with efficient Fatima Al-Zahraa and Al- Alwaiya Children's hospitals in year 2014, but the inefficiency in Ibn Al- Balady hospital is small if compared with inefficiency in year 2015 (0.87446). In output oriented case IV, the Ibn Al-balady hospital has relative efficiency score more than one (1.00682) in 2014, (1.14356) in 2015. The Fatima Al-Zahraa hospital also is inefficient (1.17483) in year 2015, but, the Ibn Al- balady hospital is more efficient than Fatima Al-Zahraa hospital, which in output oriented, the hospital be more efficient whenever the efficiency score closer to one.

II. LPI Module

LPI technique used to determine the change in productivity over consecutive time periods, first find the values of directional distance functions $(D_p(z_p, g), D_p(z_{p+1}, g),\ D_{p+1}(z_p, g), D_{p+1}(z_{p+1}, g))$ by applying models (3), (4), (5), and (6) respectively, these linear four maximization problems are determined by using Microsoft® Excel solver. Then the values of four maximization problems are subject to equations (1), (2), (3), to evaluate change in productivity (L), efficiency change (EFFCH) and technological change (TECH) respectively, as shown in table (3).

Table 3: Productivity progress for case (I, II, III and IV) in (2014-2015)

cases	Hospitals	(L)	(EFFCH)	(TECH)
Case (I)	Ibn Al- Balady	0.00299	0	0.00299
	Fatima Al-Zahraa	0	0	0
	Al-Alwaiya Children's	0.0132	0	0.0132
Case (II)	Ibn Al- Balady	0.00299	0	0.00299
	Fatima Al-Zahraa	-0.01445	-0.10489	0.09044
	Al-Alwaiya Children's	0.01319	0	0.01319
Case (III)	Ibn Al- Balady	0.00299	0	0.00299
	Fatima Al-Zahraa	0.01087	-0.05425	0.06512
	Al-Alwaiya Children's	0.02471	0	0.02471
Case (IV)	Ibn Al-Balady	-0.061	-0.06697	0.00598
	Fatima Al-Zahraa	-0.07621	-0.08039	0.00418
	Al- Alwaiya Children's	0.03874	0	0.03874

Preliminary estimates for (case I) show there is no change of productivity in 'Fatima Al-Zahraa' hospital. While the 'Ibn Al- Balady' hospital revealed the productivity progress (0.299 %) in positive, but it small progress level. The amount of progress in Al- Alwaiya Children's hospital (1.32%), is higher than in Ibn Al- Balady hospital. The efficiency change of all hospitals in case (I) is zero, this is because the hospitals are relatively efficient during each year periods (2014-2015). Therefore, in this case, the productivity variations are explained only by the technological change. Case (II) shows that, the 'Fatima Al-Zahraa' revealed the productivity progress (-1.445%) in negative, which means that there is decline in productivity in year 2015, while the two hospitals 'Ibn Al- Balady' and 'Al- Alwaiya Children's' hospitals have a growth in productivity, which revealed productivity change in positive (0.299 %, 1.32%) respectively, as in case (I) the 'efficiency change' of 'Fatima Al-Zahraa' in case (II), plays a major role in productivity progress than technological change, due to the score of efficiency change in negative (-10.489%) is higher than the score of technological change in positive (9.044). While the two other hospitals revealed no change in the efficiency as in case (I), because they are relatively efficient in both years (2014) and (2015). In case (III), the three hospitals revealed positive productivity progress. The Al-Alwaiya Children's hospital has highest positive productivity change (2.4708 %), then Fatima Al-Zahraa hospital (1.087 %), and Ibn Al- Balady hospital (0.299%). In this case, the three hospitals have growth in productivity, the efficiency change scores are equal to zero in 'Ibn Al- Balady' and Al-Alwaiya Children's hospitals, and 'Fatima Al-Zahraa' hospital has a small negative change (-5.425%). while the Technological change has the positive values in all hospitals (0.299%), (2.4708 %), and (6.512%) respectively. Finally, in case (IV), only ('Al- Alwaiya Children's') has positive productivity change (3.874%), indicating, it has productivity growth during year 2015, while, the two hospitals 'Fatima Al-Zahraa' and Ibn Al-Balady have the change in productivity in negative (-6.1%), (-7.621%) respectively, indicating, that there was decrease in productivity during year 2015.

From previous results indicate that the (Ibn Al- Balady) hospital has productivity growth in all cases unless in case (IV) has decline in productivity. The Fatima Al-Zahraa hospital has

productivity decline in two cases (II, IV) and has productivity growth in case (III) only, with no change in case (I). Finally the Al- Alwaiya Children's hospital has productivity growth in all cases during period (2014–2015).

5. Conclusion

From the results highlighted in previous sections, the following conclusions are drawn:

1. This research using (two techniques DEA and LPI), gives a comprehensive analysis of hospital efficiency, which determines if the hospital is efficient or not by DEA, determines the change of productivity over consequence time periods using LPI.
2. The study model can be developed in all hospital wards and healthcare centers, but each hospital should be supplied with peer systems.
3. Using (DEA) technique, the results show that Al- Alwaiya Children's hospital still efficient in four cases (combination of different inputs & outputs), while, other hospitals change their efficiency by changing the case.
4. Using (LPI) technique, the results show that there is a clear decline in efficiency of Fatima Al-Zahraa hospital over the period (2014-2015) in all cases, while in Al- Alwaiya Children's hospital there is no change in efficiency.
5. sing the Luenberger indicator with DEA gives insightful results of the change in productivity and causes of the change of either declined or increased, to achieve better indicators.

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