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Research Article

Evaluation of Water and Wastewater Companies of Sistan and Baluchestan Province Using Russell Modified Model Based on DEA

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Abstract: Undoubtedly, skilled and expert human work force is the biggest asset and the corner stone of progress in every Service Company and organization. Reinforcing and creating modern skills in work force in order to increase efficiency of the organization have always been in managers and experts' mind both in profit and nonprofit organization. Therefore, performance evaluation of the organizations is a good strategy to optimize the workforce. It means that the goal of performance evaluation must be improving and upgrading personnel's capabilities of an organization. So, the study of service companies and organizations has a great importance and many models and methods have been proposed to performance evaluation so far. One of the best criteria for performance evaluation is data envelopment analysis (DEA) model. These models use efficiency of decision making units (DMU) to obtain the amount of advances and retreats of those units in different periods of time. In this research, performance of 15 Water and Wastewater Companies (WWCs) of different cities in Sistan and Baluchestan province has been evaluated in two time periods led to March 2012 and 2013. These 15 cities have been selected randomly from 37 cities. First, input and output indicators were determined and by using Russell modified model, performance of the companies was evaluated in each time period, and then by using productivity index of Malmquist, productivity of companies was calculated in time, and consequently, the performance of WWCs of Sistan and Baluchestan province was evaluated.
Keywords: data envelopment analysis (DEA), Russell modified model, Malmquist productivity index, performance evaluation

INTRODUCTION

Performance measurement has always been important for researchers due to the importance of performance of a company or organization. Farrell [1] evaluated the performance of a firm using a method like performance evaluation in engineering. A case which had been studied by Farrell [1] had an input and an output. Farrell's study [1] included performance measurements of technical, allocating, and derivate of productive function. Farrell [1] used his model to measure the efficiency of agriculture in America in comparison to other countries. However, he was not successful in a method which covered various inputs and outputs.

Charnes et al. [2] extended the Farrell's idea [1] and proposed a model which could evaluate the performance with several inputs and outputs. This model was called Data Envelopment Analysis (DEA), and firstly was used in Rhodes's doctoral dissertation, under Cooper's consultation and by the title of Education Progress Evaluation of National School Students of America in 1976 in Carnegie University, and then proposed as an article named performance evaluation of decision making unit in 1978.

The aim of this model is evaluation and comparison of relative efficiency of organizational units such as schools, hospitals, banks, municipalities and … which have several similar inputs and outputs. It is clear that creating an efficient system and efficient use of the sources can stop wasting huge amount of both financial and spiritual sources, in a way that by a little increase in efficiency, large savings are achieved. Therefore, the study of efficiency level in WWCs of Sistan and Baluchestan province is so essential. To achieve this goal, first, performance of WWCs of Sistan and Baluchestan province must be evaluated and analyzed and then those cities which are not efficient being recognized.

There are many methods to evaluate efficiency in the researches. But compared to all methods, DEM is a better method to organizing; because it allows that the efficiency changes over the time and does not need any presupposition about efficiency border.

DEA is a method based on linear programming which was introduced by Charnes et al. [2]. In fact, they developed Farrell's approach [1] and propose a model based on the mathematics for measuring relative efficiency of productive firms and decision-making units with several congruent inputs and outputs. DEA is a nonparametric method which is broadly used in different sections of industry and economy because efficiency evaluation using this method does not need to identify production or cost function to estimate efficiency border.

In the competitive world today, organizations active in every circumstance constantly need performance improvement and must do their best to achieve performance upgrading. So, performance evaluation is always one of the controversial issues in the organization management.

Determining and describing appropriate indexes of performance evaluation of organizations are so important in achieving goals and perspectives of the organization. Poor Nosrat and Sharifi [3] evaluated performance of water and wastewater Companies (WWCs) of cities in Kermanshah province using EFQM model. In this model 14 cities were identified with 99 indexes and in five aspects, and they were selected and codified as the most important performance indexes and the percentage of importance (weight) of each aspects and indexes were determined. Khashaiy and Abadi [4] and Kimiyagari and Farhad [5] worked on evaluation of financial performance and ranking of WWCs in two independent research. Romano and Guerrini [6] did the measuring, comparison, and efficiency evaluation of WWCs using DEA. In this study, the annual financial reports of 43 WWCs were analyzed and the information was evaluated using DEA and nonparametric statistics methods.

Regarding the importance of the role of WWCs in providing and distributing healthy and good-quality drinking water and helping to upgrade healthy level of the society, and direct and constant connection of services of this companies with everyday life of the covered population of the cities, the main aims of these companies include providing appropriate and good-quality services, having customers' satisfaction, upgrading efficiency level, and decreasing dependency to the governmental aids. Performance evaluation systems, as a tool of evaluating the achievements of organization and identifying strengths and weaknesses for taking reformist actions to improve the processes, have a great importance.

The aim of this research is performance evaluation of WWCs of Sistan and Baluchestan province and identifying efficient and inefficient WWCs using Russell modified model which is a non-radial model in which each input and output get improved by an independent ratio and pays attention to all technical and synthetic inefficiencies.

Data Envelopment Analysis

Assume n, DMU and $DMU_j \left(j = 1,\ldots,n \right)$ has an m-input vector $X_j \left(j = 1,\ldots,n \right)$ and an s-output vector $Y_j \left(j = 1,\ldots,n \right)$ and also it is assumed that at least one components of input or output vectors are contrary to zero and positive which means:

$$X_j \geq 0,\ X_j \neq 0, Y_j \geq 0, Y_j \neq 0\ \ j = 1,\ldots,n\ .$$

Russell model

Russell's rate was proposed by Fare and Lovell [7]. This model decreases each input to θ_i ratio and increases each output to φ_r ratio.

$$R = Min\quad \frac{1}{m}\sum_{i=1}^{m}\theta_i + \frac{1}{s}\sum_{r=1}^{s}\frac{1}{\varphi_r}$$

$$s.t.\qquad \sum_{j=1}^{n}\lambda_j x_{ij} \leq \theta_i x_{io}\ ,\ \ i = 1,\ldots,m$$

$$\sum_{j=1}^{n}\lambda_j y_{rj} \geq \varphi_r y_{ro}\ ,\ \ r = 1,\ldots,s \qquad (1)$$

$$\theta_i \leq 1,\ \ i = 1,\ldots,m$$

$$\varphi_r \geq 1,\ \ r = 1,\ldots,s$$

$$\lambda_j \geq 0,\quad \mathrm{j} = 1,\ldots,\mathrm{n}$$

Non-linearity of the aim function makes some problems to solve it, so, regarding Russell model, another model was introduced as (2) in which the aim function is the average of output size.

Russell modified model

To evaluate decision-making unit, consider model (2). In this model, each input and output gets improved by an independent model.

$$
\begin{aligned}
Re = Min \quad & \frac{1}{m}\sum_{i=1}^{m}\theta_i \Big/ \frac{1}{s}\sum_{r=1}^{s}\varphi_r \\
s.t. \quad & \sum_{j=1}^{n}\lambda_j x_{ij} \le \theta_i x_{io}\ ,\ i=1,\ldots,m \\
& \sum_{j=1}^{n}\lambda_j y_{rj} \ge \varphi_r y_{ro}\ ,\ r=1,\ldots,s \qquad (2) \\
& \theta_i \le 1,\ i=1,\ldots,m \\
& \varphi_r \ge 1,\ r=1,\ldots,s \\
& \lambda_j \ge 0,\quad \mathrm{j}=1,\ldots,\mathrm{n}
\end{aligned}
$$

This model is famous as Russell model and was firstly proposed by Pastor et al. [8] to make the model (1) linear. In this model, the maximum of input decreasing and output increasing are obtained. Each input is contracted to θ_i^* and expanded to φ_r^*. By changing the variable $t = 1\Big/\frac{1}{s}\sum_{r=1}^{s}\varphi_r$ of the above model to a model of linear programming, it will be as follows:

$$
\begin{aligned}
Re = Min \quad & \frac{1}{m}\sum_{i=1}^{m}\theta_i \\
s.t. \quad & \sum_{j=1}^{n}\lambda_j x_{ij} \le \theta_i x_{io}\ ,\ i=1,\ldots,m \\
& \sum_{j=1}^{n}\lambda_j y_{rj} \ge \varphi_r y_{ro}\ ,\ r=1,\ldots,s \qquad (3) \\
& \frac{1}{s}\sum_{r=1}^{s}\varphi_r = 1 \\
& \theta_i \le t,\ i=1,\ldots,m \\
& \varphi_r \ge t,\ r=1,\ldots,s \\
& \lambda_j \ge 0,\quad \mathrm{j}=1,\ldots,\mathrm{n} \\
& t \ge 0
\end{aligned}
$$

If we remove the return condition to constant scale, then after having above process, Russell modified model of linear programming will be as (4).

$$
\begin{aligned}
Re = Min \quad & \frac{1}{m}\sum_{i=1}^{m}\theta_i \\
s.t. \quad & \sum_{j=1}^{n}\lambda_j x_{ij} \le \theta_i x_{io}\ ,\ i=1,\ldots,m
\end{aligned}
$$

$$\sum_{j=1}^{n}\lambda_j y_{rj} \geq \varphi_r y_{ro}\ ,\ r=1,\ldots,s \qquad (4)$$

$$\frac{1}{s}\sum_{r=1}^{s}\varphi_r = 1$$

$$\sum_{j=1}^{n}\lambda_j = t$$

$$\theta_i \leq t,\ i=1,\ldots,m$$

$$\varphi_r \geq t,\ r=1,\ldots,s$$

$$\lambda_j \geq 0,\quad j=1,\ldots,n$$

$$t \geq 0$$

Theorem. Re is true in below features

A) $0 < Re \leq 1$;

B) $Re = 1$ in and only if DMU_o pareto is efficient.

C) Re is consistent against unit change

D) Re is descending against inputs and ascending against outputs.

E) If $k > (<)1,\ Re(kX_o, Y_o) \leq (\geq)\frac{1}{k} Re(X_o, Y_o)$;

F) If $k < (>)1,\ Re(X_o, kY_o) \leq (\geq)k\ Re(X_o, Y_o)$;

G)If $k > (<)1,\ Re(kX_o, \frac{1}{k}Y_o) \leq (\geq)\frac{1}{k^2} Re(X_o, Y_o)$;

H) $Re < \theta$ (θ is radial efficiency in CCR input model);

I) $Re < \frac{1}{\varphi}$ ($\frac{1}{\varphi}$ is radial efficiency in CCR output model);

Malmquist productivity index

Efficiency was proposed by Malmquist [9] named Malmquist productivity as a quantity index of analyzing input decrease.

Malmquist index is introduced based on DEA and as one of the best tools for evaluation efficiency changes of decision-making units over time. This index evaluates efficiency changes of DMU between two or more time periods. Efficiency measurement can be helpful for comparison the performance of DMUs in the time unit. Efficiency changes is obtained by performance displacement of a DMU over the time.

We study Malmquist index based on Russell non-radial modified model. Assume that n, DMU we have under two period evaluation s and t;

Assume that $D^s\left(x_o^t, y_o^t\right)$ shows DMU_o efficiency in t period against other DMUs in s period. Four possibilities (s,s) , (t,s), (s,t) and (t,t) exist to evaluate Malmquist index. Therefore, four distances must be measured which means $D^s\left(x_o^s, y_o^s\right)$ ، $D^t\left(x_o^t, y_o^t\right)$ ،$D^t\left(x_o^s, y_o^s\right)$ and $D^s\left(x_o^t, y_o^t\right)$. Model (5) is to evaluate DMU_o for period (s,s) and also measures DMU_o efficiency for period (t,t).

$$D^h\left(x_o^h, y_o^h\right) = Min\quad \frac{1}{m}\sum_{i=1}^{m}\theta_i \Big/ \frac{1}{s}\sum_{r=1}^{s}\varphi_r$$

$$s.t.\qquad \sum_{j=1}^{n}\lambda_j x_{ij}^h \leq \theta_i x_{io}^h,\ i=1,\ldots,m$$

$$\sum_{j=1}^{n}\lambda_j y_{rj}^{h} \geq \varphi_r y_{ro}^{h},\ r=1,\ldots,s \qquad (5)$$
$$\theta_i \leq 1,\ i=1,\ldots,m$$
$$\varphi_r \geq 1,\ r=1,\ldots,s$$
$$\lambda_j \geq 0,\quad \mathrm{j}=1,\ldots,\mathrm{n},\ \mathrm{h=s,t}$$

Now, the measures of two periods (t,s), efficiency DMU_o is calculated as the optimal value of Russell modified model (6). Moreover, model (7) measures efficiency DMU_o for the other period (s,t).

$$D^t\left(x_o^s, y_o^s\right) = Min\ \ \frac{1}{m}\sum_{i=1}^{m}\theta_i \Big/ \frac{1}{s}\sum_{r=1}^{s}\varphi_r$$
$$s.t.\quad \sum_{j=1}^{n}\lambda_j x_{ij}^{t} \leq \theta_i x_{io}^{s},\ i=1,\ldots,m$$
$$\sum_{j=1}^{n}\lambda_j y_{rj}^{t} \geq \varphi_r y_{ro}^{s},\ r=1,\ldots,s \qquad (6)$$
$$\theta_i \leq 1,\ i=1,\ldots,m$$
$$\varphi_r \geq 1,\ r=1,\ldots,s$$
$$\lambda_j \geq 0,\quad \mathrm{j}=1,\ldots,\mathrm{n}$$

and

$$D^s\left(x_o^t, y_o^t\right) = Min\ \ \frac{1}{m}\sum_{i=1}^{m}\theta_i \Big/ \frac{1}{s}\sum_{r=1}^{s}\varphi_r$$
$$s.t.\quad \sum_{j=1}^{n}\lambda_j x_{ij}^{s} \leq \theta_i x_{io}^{t},\ i=1,\ldots,m$$
$$\sum_{j=1}^{n}\lambda_j y_{rj}^{s} \geq \varphi_r y_{ro}^{t},\ r=1,\ldots,s \qquad (7)$$
$$\theta_i \leq 1,\ i=1,\ldots,m$$
$$\varphi_r \geq 1,\ r=1,\ldots,s$$
$$\lambda_j \geq 0,\quad \mathrm{j}=1,\ldots,\mathrm{n}$$

Estimation of Malmquist index is defined as follows:

$$M_o = \left[\frac{D^s\left(x_o^t, y_o^t\right)}{D^s\left(x_o^s, y_o^s\right)}\frac{D^t\left(x_o^t, y_o^t\right)}{D^t\left(x_o^s, y_o^s\right)}\right]^{\frac{1}{2}} \qquad (8)$$

Therefore M_o stands for each decision making in three ranges of bigger than one, smaller than one, and equal to one. Bigger than one means efficiency increase (development of the unit under evaluation over the time), smaller than one means efficiency decrease (recession of the unit under evaluation over the time), and equal to one means the efficiency has not had any changes.

Evaluation WWCs

Performance evaluation of companies or organizations is a big challenge in modern world. Creating competitive situations in the business and services make the companies to increase their efficiency to live in this competitive situation. DEA is a method which has been paid attention to and applied in many researches to evaluate performance of companies and it consequently has led to a big improvement in practical field of DEA and its application. One of the service companies is WWCs which is now active in many cities of the country and especially in Sistan and Baluchestan province. Since WWCs are directly related to the health of the society, their performance evaluation will be so important in improving quality of services provided for people.

Among 37 cities of the province, 15 different cities were randomly selected as statistical sample and to efficiency evaluation of WWCs of Sistan and Baluchestan.

In this chapter, first we discuss a model to evaluate the selected model, and then we calculate the efficiency of 15 companies using Russell modified model for two periods ended to March 2012 and 2013, and finally we introduce efficient and inefficient models. In the following, we use Malmquist index and analyze the obtained result. Moreover, we investigate the performance of WWCs of the province from the company managers' and experts' point of view by preparing a qualitative questionnaire and changing qualitative data to fuzzy and de-fuzzy data.

Structure of WWCs

One of the main goals of WWCs is providing constant drinking water for their sphere of activity, and their important sources include their employed work force, different equipment of powerhouses, transmission line and distribution of water, and etc. In this article we just study the efficiency of human sources due to limitation of data which was given to us by the company.

WWCs are directly connected to the health of society, so having experts is so important in this field. This value is determined in terms of both strategic aspect and spent cost to recruit them. We consider the number of work force as an input of the model and four factors as main outputs which is related to service provided to clients which is a calculation of criteria for two outputs of the number of WWCs clients (because the amount of services given to the clients are balanced with the number of clients) and the calculation criteria for the other two outputs are the amount of energy delivery (water) and sewage disposal per cubic meter. Figure 1 shows input and output indexes related to deputy planning and human resources.

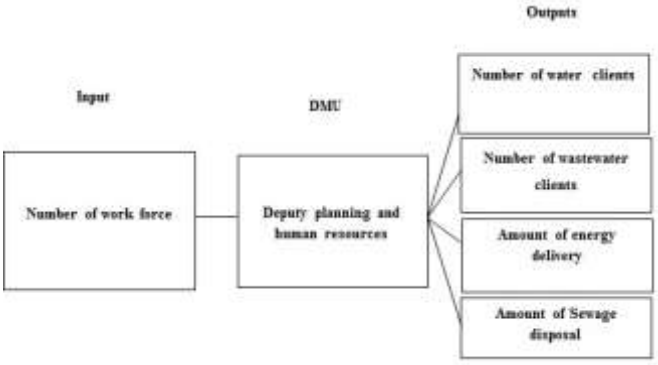

Fig- 1: Input and output indexes related to deputy planning and human resources

Sewage disposal in a modern way is one of the requirements of every human and civil society, but unfortunately, WWCs of the province do not give ant services to their clients in this regard, and this will lead to a decrease in efficiency and health problems in the society. So we eliminate these two indexes from output indexes. Figure 2 shows inputs and outputs used in this research.

Fig- 2: Final input and output indexes used in the model

With regard to Figure 2, we observe that the model investigate two output indexes (the number of water clients and delivering energy to the clients) and an input index (employed work force) related to deputy planning and human resources.

To evaluate performance of companies, we have statistical data related to two financial years ended to March 2012 and 2013.

RESULTS

The table of primary data (Table 1) shows input and output data of 15 WWCs of cities in Sistan and Baluchestan province in a financial year ended in March 2012.

Table 1: Primary data for 2012 and their efficiency

DMU	Input	Outputs		Efficiency
Aspich	3	5539	1380787	1
Adimi	2	1629	135061	0.2202
Iranshahr	37	27189	7649856	0.4220
Bonjar	2	1273	223436	0.2849
Chabahar	27	10381	2819545	0.2171
Khash	29	13561	3663597	0.2634
Zaboli	2	2071	386151	0.4750
Zahedan	325	117175	29386648	0.1959
Zahak	7	3665	833817	0.2706
Saravan	27	15408	3860430	0.3099
Sarbaz	2	553	101167	0.1268
Konarak	18	3093	3173358	0.1497
Mirjave	7	2965	605399	0.2066
Nikshahr	16	2983	1131084	0.1218
Hirmand	4	1771	337461	0.2078

Notable points in Table 1 are, first, remarkable differences in the number of inputs of WWCs of Zahedan in comparison to other companies in different cities of the province. Second, as an example, the client number of WWCs of Konarak which has 18 employees is just 3093 clients while WWCs of Aspich has 5539 clients and 3 employees. In the following, we calculate the efficiency of each unit under evaluation using Russell modified model (3) and show the result in Table 1.

Regarding Table 1, we observe that in the financial year ended in March 2012, Aspich company has efficiency 1 with input of 3 employees and output of 5539 clients, while, for example, Sarbaz company is inefficient with an input of 2 employees and an output of 553 clients. Therefore, Aspich Company with lesser inputs in comparison to other companies has the maximum outputs and gives the maximum services to the citizens. The efficiency of other companies under investigation is less than 1 and so, inefficient.

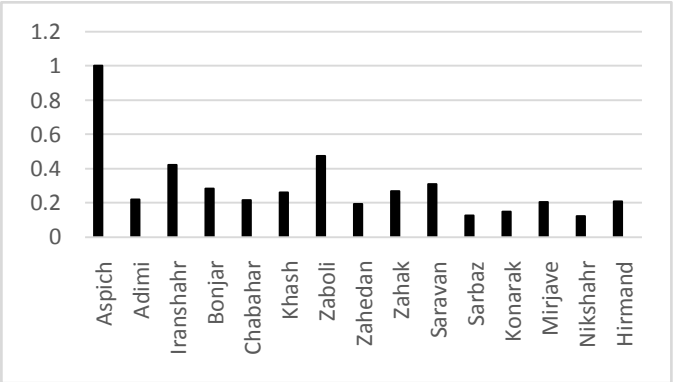

Fig-3: Efficiency resulted of Russell modified model for 15 companies in 2012

For a better understanding and imagination, we show the results of Table 1 in the column Figure 3.

The vertical axis of Figure 3 shows efficiency resulted from Russell modified model for 15 WWCs in the financial year ended in March 2012 and the horizontal axis shows the name of 15 cities which we studied their WWCs.

Table 2 shows input and output data related to the same 15 WWCs of cities in the financial year ended in March 2013.

Table 2: Primary data for 2013, their efficiency and productivity

DMU	Input	Outputs		Efficiency	Productivity
Aspich	3	6133	1293066	1	1
Adimi	3	1642	152614	0.1638	0.7297
Iranshahr	29	28448	8102364	0.5515	1.3424
Bonjar	2	1311	234350	0.2942	1.0403
Chabahar	29	12100	4744002	0.2654	1.2628
Khash	25	13561	3581351	0.2951	1.1482
Zaboli	2	2188	422178	0.5114	1.0820
Zahedan	298	122734	32307614	0.2237	1.1685
Zahak	6	3737	738751	0.2948	1.1059
Saravan	23	16508	3686723	0.3612	1.1884
Sarbaz	2	586	90189	0.1209	0.9584
Konarak	19	3253	3103295	0.1372	0.9831
Mirjave	7	3049	663630	0.2164	1.0628
Nikshahr	14	3200	1106898	0.1389	1.1833
Hirmand	4	1821	342115	0.2099	1.0203

By paying a little attention in Table 1 and Table 2, it is observed that WWCs of the cities Adimi, Chabahar, and Konarak have an increase in their work forces and WWCs of cities Iranshahr, Khash, Zahedan, Zehak, Saravan, and Nikshahr have a decrease in work forces, and WWCs of cities Aspich, Bonjar, Zaboli, Sarbaz, Mirjave, and Hirmand have not had any changes in the number of work forces. The number of clients in WWCs of Adimi and Zehak had a decrease and except WWCs of Khash which has not had any changes in the number of the clients, the client number of other companies had an increase.

Using Russell modified model (3), we calculate each unit under evaluation and show the results in Table 2.

Based on the obtained results of Table 2, WWCs of Aspich again has had the efficiency one in this period of time and WWCs of Iranshahr, Bonjar, Chabahar, Khash, Zaboli, Zahedan, Zehak, Saravan, Mirjave, Nikshahr, and Hirmand had an efficiency increase in 2013 in comparison to 2012, and other companies experienced decrease. For a better understanding, we show the obtained result of Table 2 in the Figure 4.

The vertical axis of Figure 4 is related to the efficiency obtained from Russell modified model in the financial year ended in 2013 in 15 WWCs of the province, and in the horizontal axis, you can see the name of 15 cities of which their WWCs were analyzed.

Using the relation (7), the productivity of companies is calculated in two time periods and is shown in the last column of Table 2.

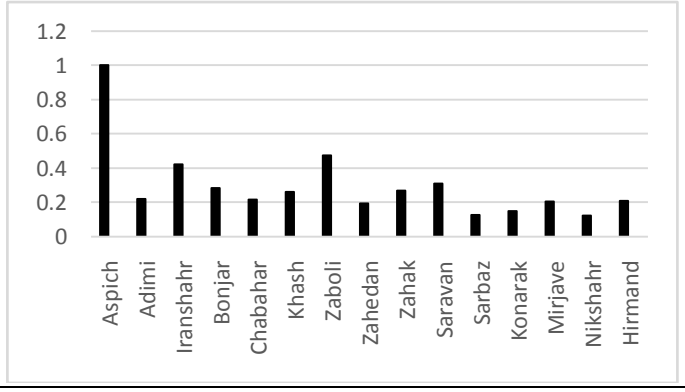

Fig-4: Results obtained from efficiency calculation using Russell modified model in 2013

Regarding the features of Malmquist index, if the amount of index is bigger than one, then unit under evaluation has an efficiency increase which means it has a progress over the time. And, if the amount of index is less than one, then the unit has an efficiency decrease which means it has a recession. And if the efficiency amount is one, then the efficiency of that unit does not have any progress or recession over the time.

From Table 2, we understand that the numerical amount of efficiency index of WWCs of Iranshahr, Chabahar, Khash, Zaboli, Zahedan, Saravan, Nikshahr, Mirjave, Bonjar, and Hirmand is bigger than one, so these companies have an efficiency increase in two time periods in 2012 and 2013, and numerical amount of efficiency index of WWCs of Adimi, Sarbaz, and Konarak is smaller than one, therefore these companies had an efficiency decrease in two periods of 2012 to 2013. Numerical amount of efficiency index of WWCs of Aspich is one in the period 2012 to 2013 and based on the efficiency index, the efficiency of this company has remained stable over the time.

By comparison of Table 1 and Table 2, it is concluded that all cities which have had performance increase, have experienced an efficiency increase from 2012 to 2013, and all cities which have had a performance decrease, have experienced an efficiency decrease from 2012 to 2013. The productivity result obtained from Table 2 is shown in Figure 5.

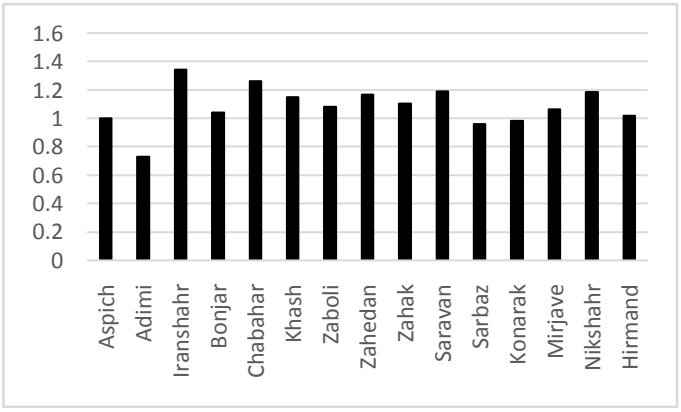

Fig-5: performance representation of 15 WWCs in periods 2012 and 2013

The vertical axis of Figure 5 is related to the performance obtained from Malmquist index of 15 WWCs which their names can be seen in the horizontal axis.

Generally, and with regard to Figure 5, ranking of 15 WWCs of cities in Sistan and Baluchestan province is as follows.

Iranshahr>Chabahar>Saravan>Nikshahr>Zahedan>Khash>Zahak>Zaboli>Mirjave>Bonjar>Hirmand>Aspich> Konarak>Sarbaz>Adimi

Evaluation WWCs by Company Managers

In this study, a questionnaire planned to evaluate performance evaluation of company from managers and experts' point of view, and it was given to 20 managers and experts of the mentioned company, and they were asked to answer carefully. Since the answers in the questionnaire were qualitative five options as very good, good, moderate, weak, and very weak, a triangular fuzzy number is given to each option to convert these qualitative numbers to certain quantities which can be seen in the Table 3.

Table 3: Representation of qualitative numbers as triangular fuzzy numbers

Options	Triangular fuzzy numbers
Very good	$(0.05, 0.2, 0.57)$
Good	$(0.1, 0.5, 0.6)$
Moderate	$(0.1, 0.36, 0.6)$
Weak	$(0, 0.1, 0.3)$
Very weak	$(0, 0.05, 0.22)$

Figure 6 shows fuzzy numbers shown in the Table 3.

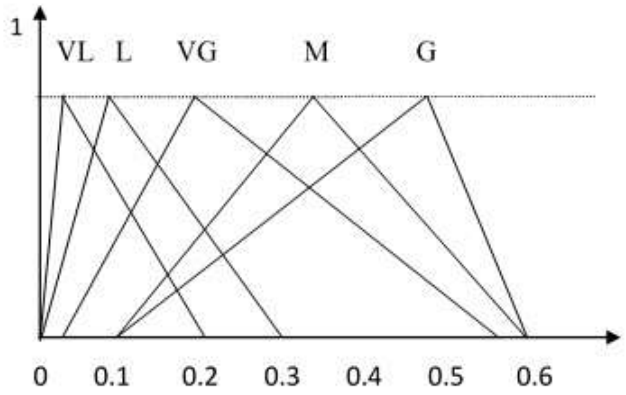

Fig- 6: Representation of fuzzy numbers

Using relation (9), the average of triangular fuzzy number of Table 3 is obtained as $A_{ave} = (0.04, 0.24, 0.45)$.

$$A_{ave} = \left(\frac{1}{n}\sum_{i=1}^{n}\alpha_i , \frac{1}{n}\sum_{i=1}^{n}m_i , \frac{1}{n}\sum_{i=1}^{n}\beta_i \right) \qquad (9)$$

De-fuzzing is finding the best fuzzy representative. In this stage, we use the relation (10) to de-fuzzing of triangular fuzzy numbers and convert number A_{ave} to certain number 0.353 .

$$\mu_T(A) = \frac{m+\beta}{2(1+\beta)} + \frac{m}{2(1+\alpha)} \qquad (10)$$

This number shows the amount of WWCs managers and experts' evaluation of Sistan and Baluchestan province of performance of these companies. The important and essential role of WWCs is completely tangible in the quality of everyday life of city residences. Regarding the experts and managers' low rate evaluation of company performance and results obtained from Russell modified model, it is clear that these companies should increase their efficiency by reinforcing human resources part, and recruiting educated people and experts.

CONCLUSION

In the modern societies today, with increasing competition between the organizations and companies to survive, they always try to improve their performance. One of the important service companies which have an important role in people's everyday life is WWCs which is directly connected to the health of society. One of the aims of this research was performance evaluation of WWCs of some cities in Sistan and Baluchestan. One of the important performance evaluations of the companies is using DEA models. In this research Russell modified model was used to performance evaluation of companies, and determining efficient and inefficient companies. After calculation of efficiency, company performance was calculated over the time using Malmquist index to improve the performance and services of these companies to the clients. So, the companies which had efficiency increase or decrease, or their efficiency did not change over the time were identified.

In this research the information of 15 cities of 37 cities of the province related to two periods of time ended in March 2012 and 2013 was studied. We faced with some limitations in selecting and identifying effective input and output indexes in the performance because WWCs of the province did not give us enough information to evaluate their performance. We evaluated the performance of these companies after selecting input and output indexes using Russell modified model which is one of the non-radial models of DEA. This model has the potentiality of precise and complete performance evaluation of WWCs of Sistan and Baluchestan. The result obtained from efficiency calculation using Russell modified model are shown in Table 2. Moreover, for a better understanding, the result of efficiency calculation is shown in Figure 3 and Figure 4. Finally, the performance of WWCs of Sistan and Baluchestan was evaluated in two periods of time ended in March 2012 and 2013 using Malmquist index; the results of efficiency evaluation of 15 WWCs

of different cities of the province are shown in Table 2; and it is observed that WWCs of Iranshahr, Chabahar, Saravan, Nikshahr, Zahedan, Khash, Zaboli, Zehak, Mirjave, Bonjar, and Hirmand had an efficiency increase in two periods of time 2012 to 2013 and WWCs of Adimi, Sarbaz, and Konarak had a decrease. Efficiency of WWCs of Aspich was stable over time.

With regard to the breadth and vastness of Sistan and Baluchestan province, some mountain town, and long distance of province city to the center, population distribution and split length of water and wastewater can be added to the used model as environmental variables to have a better result. Moreover, the spent cost to give services to the clients can be introduced as an input index, but since these companies did not give us any information in this regard, it was not possible to use these indexes in the research.

Regarding sensitive works of these offices, maybe it is necessary to give more power to the managers so that they could employ more elite work force or layoff to increase their efficiency.

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