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An empirical study to measure the relative efficiency and strategic planning using BSC-DEA and DEMATEL

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A B S T R A C T

Performance evaluation is one of manager's main concerns in today competitive world, which covers all aspects and dimensions of organization and it is adequately flexible and measurable. So, the necessity of performance evaluation application for organizations where their intangible assets are higher than tangible ones, such as educational institutions, is more obviously observed. Balanced scorecard (BSC) is discussed by the aim of promoting manager's decision making and directing their attention toward extensive operational vision of organization compared to traditional measurement systems, which only include the financial measures. However, BSC is a qualitative approach and has some disadvantages and its integration by other quantitative techniques such as data envelopment analysis makes it more efficient. The proposed model of this paper uses DEMATEL technique as part of BSC-DEA model to empower strategic planning. The proposed model of this paper is applied for 10 zone university branches of Islamic Azad universities to provide an appropriate road map.

1. Introduction

Performance measurement has been an interesting area of research for the past few years and there have been tremendous effort to propose efficient methodologies to provide ranking non-for-profit organizations such as educational colleagues, governmental hospitals, etc. (Neely & Platts, 1995). Identification of different performance evaluation models and correct application of these methods in organization is one of the most important problems in performance evaluation field, incorrect selection of a method can cause the undesirable situation become desirable and vice versa.

Balanced score card (BSC) is one of the most famous performance evaluation models, which was represented by Kaplan and Norton in 1992 (Kaplan& Norton,1992) and thereafter was chosen as an issue of many studies. Data envelopment analysis (DEA) is a nonparametric technique for

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performance evaluation of decision making units introduced by Charnes et al. (Charnes et al., 1978). Many researchers in DEA theoretical development have tried in different fields such as production, retailing, banking, etc. (Cook & Seiford, 2009). In spite of BSC and DEA propagation, a few studies have tried to incorporate these two approaches for performance evaluation. In addition to literature review in BSC and DEA incorporation, this study aims to develop an applied and comprehensive model in actual operational environment, which represents a new perspective for achievement of complementary information and management discussed details. By this aim, the given model was tested in the tenth zone university branches of Islamic Azad University. Obtained results produce detailed information for identification of the strengths and weaknesses of each university units appropriate for organization strategic objectives. Section 2 discusses the previous studies that have combined DEA and BSC. Section 3 includes the proposed model and main results. Section 4 discuses the results and finally, section 5 concludes the use of proposed model.

2. Literature review

2.1. Data envelopment analysis (DEA)

DEA was introduced by Charnes et al. (1978), which is a nonparametric technique for measuring the relative efficiency of decision making units serving similar duties and following similar objectives and priorities such as bank branches or ministry organizational units. One of the advantages of DEA is that it lets any DMU compares itself with another DMU. Because of its simple application, DEA has been focused by researchers in business and academic researches (Li et al., 2012; Luo et al., 2012). DEA has been used for evaluation of non-financial units during two past decades (Manthos & Papanikolaou, 2009). Studies of Cooper et al. (1994) and Cook and Zhu (2005) represent outstanding review of DEA models.

2.2 Balanced scorecard (BSC)

BSC is the most famous and prevalent model for performance evaluation in recent years. 64% of American firms applied BSC for their performance evaluation up to 2005 (JalaliNaini et al., 2011). BSC is a conceptual framework for transforming the organizational strategic objectives to a set of measurable and tangible performance measures described in four perspectives of customers, internal processes, growth and learning and financial. These measures are concentrated in some questions: how the stockholders' idea can be attracted for achieving financial success (financial)? How should be viewed from customer perspective for achieving organizational objectives (customer)? How should business processes operate for satisfying customers and stockholders (internal processes)? How can the organization produce, give rise and maintain the capacity of value creation in it (growth and learning)?

BSC indicates the organizational mission and vision in a set of cause-effect relationships in the four discussed perspectives (Achterberg et al., 2003; Nissen, 2006) and assumes organization as a unified and integrated body (Blokdijk, 2008). These excellent features of BSC lead to its application in different service and industrial sections (Xu & Yeh, 2012).

According to Makhijani and Creelman (2008) BSC consists of four interrelated components: a) Strategy map which explain and identify the relation among the strategic objectives after identification of strategic objectives. b) Performance measures which indicate the progressive extent toward strategic objectives. c) Quantitative objectives which are identified for any measure. d) Selection and implementation of strategic innovations in order to connect the performance to quantitative objectives and so achievement of strategic objectives. BSC innovators believe that successful implementation of organizational strategic depends on the issue that organizational individual perceive and realize the strategies. Note that this issue requires complicated process creation, which cause organizational intangible assets and investments convert to tangible and visible outputs. To do so, BSC innovators introduced strategy map as an instrument which can represent the

link between strategy structures of the organization by identification and exploration of organization key objectives and conceptualization of cause-effect relations among them (Kaplan & Norton, 2000). The main function of map is that it can perfectly indicate how the objectives can have transaction with each other for the strategy implementation (Makhijani & Creelman, 2008). There are several advantages on BSC: 1) Just a few performance indexes or measures need to be checked at any one time, 2) Emphasize on relation between financial and non-financial fields, 3) Planning causal loop diagrams for improving strategic plans, 4) Improving information management in organization (JalaliNaini et.al, 2011). BSC, however, has some limitations: 1) One way causal relations are very simple and their use is not sufficient, 2) Time dimension is not considered in cause-effect relations, 3) BSC does not incorporate a mechanism for selection of the best performance measures. 4) BSC is not that much dynamic for simultaneous control (JalaliNaini et.al, 2011). 5) BSC doesn't identify how the relations among cards measures are produced, 6) It is incapable of inefficiency identification in the use of resources, 7) In practice, identification of objective features for each of performance indexes is sufficient without measuring the discussed operations, 8) It can not specify an objective weighting (Amado et al., 2012). BSC is a management model, which requires quantitative or logic based models for being implemented such as DEA, furthermore it can give organizational reason to concepts such as DEA which does not have the perception of environment analysis by the use of a structured model such as BSC.

2.3 The integration of DEA and BSC

Rouse et al. (2002) were the first who concentrated on the existing potential in integration of DEA in performance evaluation framework of BSC. Richard (2003) used DEA in four perspectives of BSC. Eilat et al. (2006) applied the integration method of DEA-BSC for investigation of R&D projects. The suggested integration method is implemented in 7steps. Their aim was to reach balanced, efficient and effective portfolios. According to their method, first, it represents a method for quantification of BSC concept, second, it introduces a reciprocal hierarchical structure to cards perspectives by DEA. One other study has investigated the efficiency of changed performance by applying four kinds of selective performance indicators They discovered that investigation based on DEA model have similar results to traditional financial indexes analysis, while investigation based on BSC indicated different findings (Chen et al., 2008).

Asosheh et al. (2010) applied the integrated model of DEA-BSC in investigating the information technology projects of Iran technology and research science ministry. They discussed more about different models of DEA and their most appropriate one for IT projects by ordinal and cardinal information. Similar to earlier studies, DEA is used as the main core of the model in two other studies (Chen & Chen, 2007; Wang, 2006). Valderrama et al. (2009), investigated the relations among BSC in R&D plans and by different multiple models of DEA in 90 pharmaceutical-chemical companies. They used five different DEA models (differences in input and output) in the first level to investigate hypothetical cause-effect relations among BSC perspectives and analyzed the correlation coefficient among the findings of five models by Pierson correlation coefficient and factor analysis in the next step. The diverse models of efficiency in fact enable the researcher to analyze the hypothetical cause-effect relations among BSC perspectives.

In addition to Valderrama's work, another study applied two discussed approaches by the aim of performance evaluation of multi nation companies in two different business fields. Authors claimed that they had used multiple integrated models, which were based on the principals of network DEA, that is, the outputs of aperspective were considered as the inputs of the next perspective. They did not assume that the reciprocal weights of an index are constant, that is, an index, whether input or output is impacted by various operations and had different weights in any perspective.

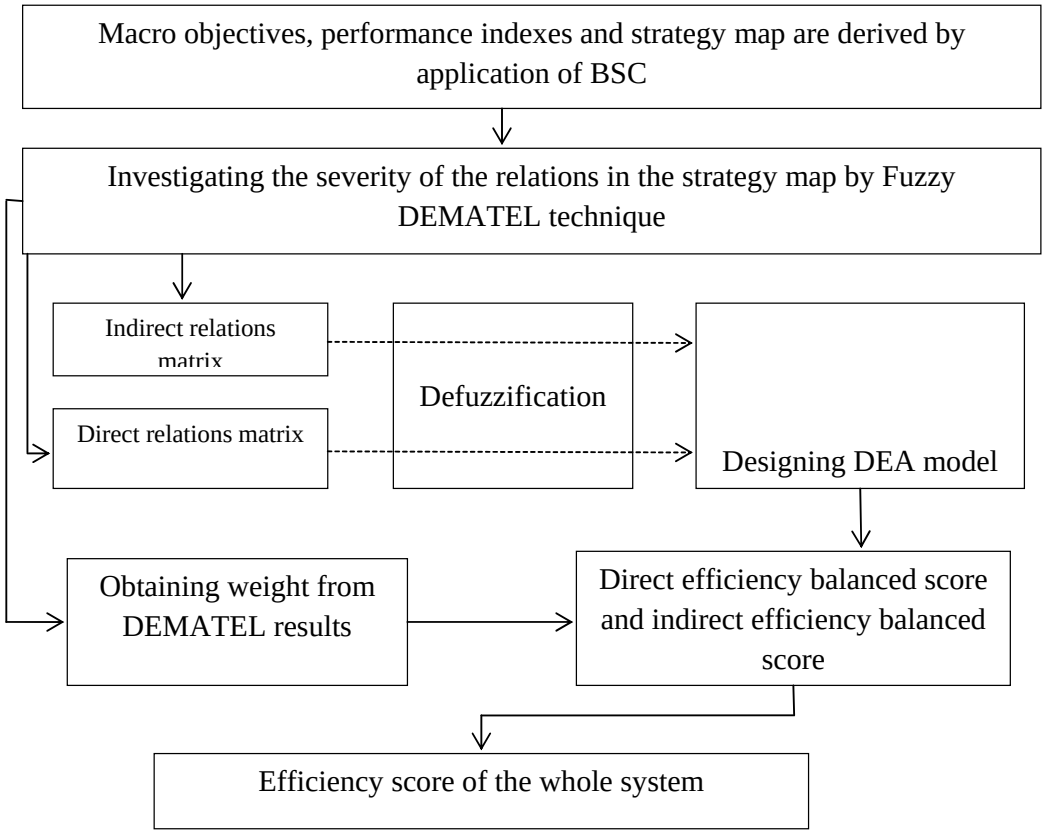

Fig. 1. Conceptual model

Unlike earlier works, which are always descriptive or ranking, they emphasized that an applied model was represented which had the ability to identify opportunities for helping any of DMUs in their performance improvement. They used four DEA models (each for any BSC perspective) and pointed out that any of DMUs could obtain structured information in relation to its performance by this conceptual framework an identify its weaknesses, so the whole organization can recognize the strengths of its performance and concentrate on them (Amado et al., 2012). Valderrama et al. (2009) emphasized on the existence of relations among BSC perspectives by its multiple models while, Amado et al. (2012), in addition to developing a new model for integration, avoided implementation of network DEA model. As noted earlier, our model is based on strategy map and the strategic objectives have formed the map components. The objectives have cause-effect relations in any perspective (Valderrama et al., 2009; Jassbi et al., 2011; Seyed-hosseini et al., 2011). Considering these relations in investigation model require network DEA.

It is obvious that implementing and programming network DEA is so difficult. However, the precision of network models could be applied in achieving the information layers of a detailed organization (in compare to earlier works) and not to be involved in network solution? How can a model be represented to divide the network model to simple linear models? To solve these problems in DEA and BSC integration, we have applied the strong DEMATEL technique in the strategy map in order to divide cause-effect relations network to simple models to regard network precision without being involved in its solution and to achieve more detailed information, each objective plays a role as a DMU. Therefore, management identifies the strengths and weaknesses of any unit in each of organizational strategic objectives and this is same as a perfect and accurate dissection and of course in relation to organizational objectives.

3. Proposed performance evaluation framework- a case study

We have presented a suggested model for integration of BSC and DEA in this section. For testing the model, we used the information of the tenth zone university branches of Islamic Azad University. In educational-cultural organizations such as universities or supreme instruction institutes, which considered the qualitative and quantitative dimensions in growth and development, unit ranking is an important issue from their performance evaluation view. This issue will be more important in relation to Islamic Azad University in Iran as the largest supreme instruction institute of Iran and the zone. It should be noted that the tenth zone of Islamic Azad University by the geographical position of northeast and center of Iran and by covering two Golestan and Semnan provinces has 11 university branches and their information are analyzed as an almost congruent society.

3.1. Macro objectives, performance indexes and strategy map are derived by application of BSC

For map designing in present study, the strategy map can be designed after discovering strategies and their effective relations with scorecard perspectives. This step requires experience and very deep insight of organization, which is based on mission, vision and strategies of the organization and is derived from organization strategic documents and by organizational manager's ideas (Fig. 2). For measuring of each objective we identified performance indexes for them, we considered related researches and organizational manager's ideas (Table 2).

3.2. Investigating the severity of the relations in the strategy map by Fuzzy DEMATEL technique

Investigating the cause-effect relations among objectives by DEMATEL will help us in achieving several linear relations among objectives in the strategy map and the extent of influencing and being influence by each one has an uncertain and qualitative estate, Fuzzy logic could be applied for measuring this phenomenon. So, investigating these influences was stated in the form of linguistic variables. Linguistic variables in some complex or ambiguous situations reasonably described by temporary quantitative expressions are so useful (Zadeh, 1975). These linguistic variables can be represented by Fuzzy numbers. We used trapezoidal Fuzzy numbers in this paper. Working with trapezoidal numbers is much harder than triangular numbers but has more accuracy. The steps of trapezoidal Fuzzy DEMATEL implementation (Hiete et al., 2011):

1. Investigating factors are specified according to experts' committee ideas and research background.
2. The influences of each factor on the whole system are specified according to experts's ideas and the direct relation matrix is formed. Fuzzy numbers are in fact shown by four(trapezoidal) $n \times n$ matrixes. To do so, discussed linguistic variables in table1 are used.

Table 1
The fuzzy linguistic variables

Linguistic values	Linguistic variables
(0.8,0.95,1,1)	Very high influence(VH)
(0.55,0.7,0.8,0.95)	high influence (H)
(0.3,0.45,0.55,0.7)	medium influence(M)
(0.05,0.2,0.3,0.45)	low influence (L)
(0,0,.05,.02)	Very low influence(VL)
(0,0,0,0)	No influence(NO)

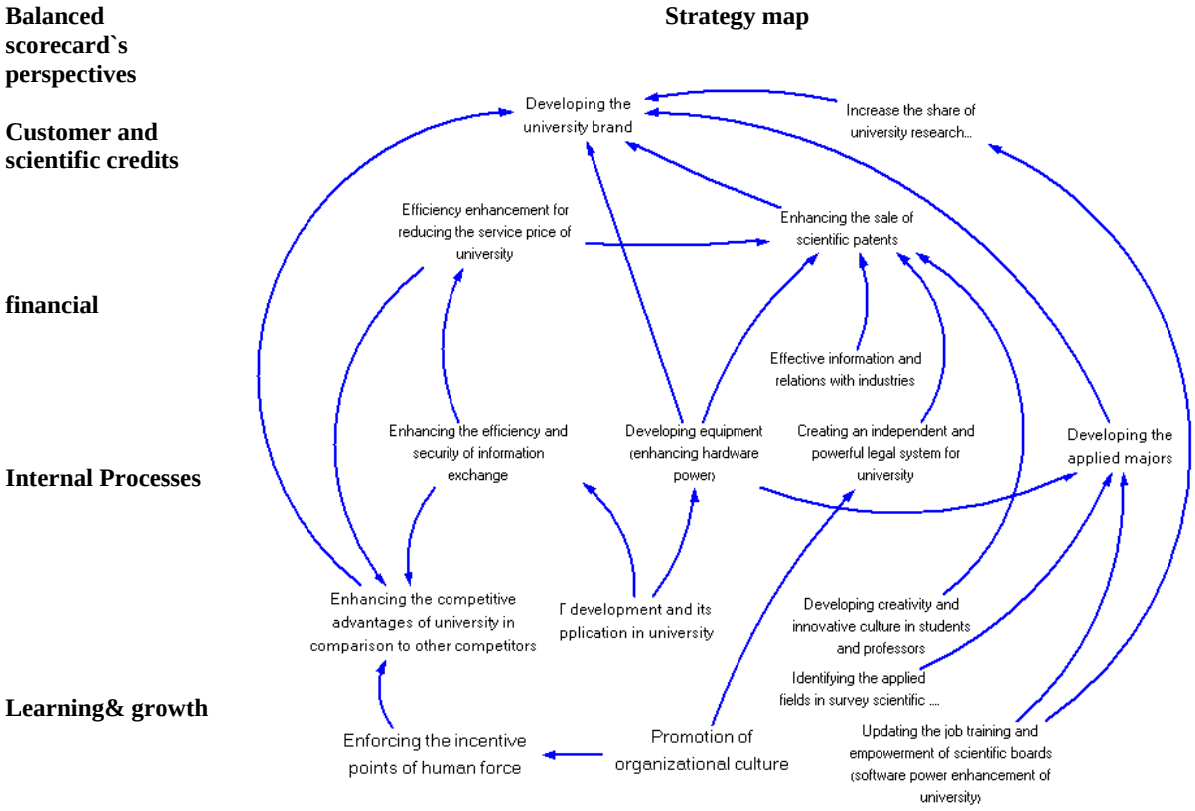

Fig. 2. Strategy map

Achieving normalized matrix

$$\widetilde{\mathrm{N}}_{\mathrm{ij}} = \frac{\widetilde{\mathrm{M}}_{\mathrm{ij}}}{\max[\max_{\mathrm{i}=1,\ldots,\mathrm{n}}(\sum_{\mathrm{j}=1}^{\mathrm{n}} \mathrm{D}_{\mathrm{i,j}}, \max_{\mathrm{j}=1,\ldots,\mathrm{n}} \sum_{\mathrm{i}=1}^{\mathrm{n}} \mathrm{D}_{\mathrm{i,j}})]} \quad (1)$$

It is supposed that, there is at least one i^* row where$1 \le i^* \le n$, that $1 > \sum_{j=1}^{n} D_{i^* j}$ or, there is at least one j^* column that$1 \le j^* \le n$, such that $1 > \sum_{i=1}^{n} D_{i j^*}$.

3. Obtaining total relations matrix T: I is the $n \times n$ identity matrix and the element $\mathrm{T} = [\mathrm{t_{ij}}]$ indicates the direct and indirect influences (total influence) of factors ion j.

$$T = \lim_{k\to\infty}\left(\widetilde{N} + \widetilde{N}^2 + \cdots + \widetilde{N}^k\right) = \widetilde{N}(I - \widetilde{N})^{-1} \quad (2)$$

4. Obtaining the H indirect relations matrix:

$$H = \lim_{\mathrm{k}\to\infty}\left(\widetilde{\mathrm{N}} + \widetilde{\mathrm{N}}^2 + \cdots + \widetilde{\mathrm{N}}^{\mathrm{k}}\right) = \widetilde{\mathrm{N}}^2(\mathrm{I} - \widetilde{\mathrm{N}})^{-1} \quad (3)$$

5. Obtaining HD direct relations matrix:

$$HD = T_{ij} \_ H_{ij} \quad (4)$$

$$\mathrm{r_i} = \sum_{1\le \mathrm{i} \le \mathrm{n}} \mathrm{t_{ij}}, \quad (5)$$

$$C_j = \sum_{1\le i\le n} t_{ij} \quad (6)$$

6. Calculating the row summation and column summation of H and HD matrixes: for obtaining better output, r_i and $\mathrm{c_j}$ should be obtained. The ith row summation in direct/indirect relations

matrix is indicator of all direct/indirect influences of factor i on all other factors, so r_i is called influencing degree. Similarly, c_j is the column summation and is called the being influenced degree of the factor j by the other factors.

7. We show the diagram of factor influences based on $r_i - C_i$ and $r_i + C_i$. Effects by the coordinates$(r_i + C_i, r_i - C_i)$ are designed and the complicated relations among factors are easily observable and analyzable.

8. 3.4. Defuzzification

9. Defuzzification is the inverse of Fuzzification. Center Of Gravity(COG) method (the most popular method in defuzzify literature) was used for specifying crispvalues (Timothy, 2005).

$$Z^* = \frac{\int \mu(z).zdz}{\int \mu(z).dz} \tag{7}$$

3.3. Designing DEA model

10. Each objective in the strategy map is regarded as a DMU. Several indexes were specified for each objective and these indexes play the role of input/output. Therefore, there were three kinds of objectives/DMU. The first one gets its inputs from the environment and gives the outputs to the other objectives/DMUs. The second one obtains its inputs from other objectives/DMUs (with which is in relation) and deliver its outputs to other objectives/DMUs and the third one obtains the inputs from other objectives/DMUs and delivers its outputs to the environment. Opposite input/output to the environment was considered as 1 for all DMUs which are in relation with the environment (obtain input from the environment or deliver the output to the environment) without any disturbance to the whole. Therefore, in the suggested model, the outputs of each objective/DMU are its indexes and their inputs are indexes, which influence on the considered objective/DMU from other objectives. For example, the eighth objective is influenced by the fifth objective, so, the indexes of the fifth objective constitute eighth objective`s inputs and the performance indexes of the eighth objective constitute its outputs or the second objective (Updating the job training and empowerment of scientific boards (software power enhancement of university)) obtain its input from the environment (we consider 1 for the whole university branches) and its indexes from its outputs. Output orientation CCR model was used for obtaining efficiency score. Super radial efficiency model was applied for creating differences in efficiency scores of DMUs (Anderson& Peterson, 1993).

3.4. Direct efficiency balanced score and indirect efficiency balanced score

As mentioned before, each objective is considered as a DMU. By considering the strategy map and resulting indirect and direct weights matrix of DEMATEL, each objective might have direct or indirect influence on other objectives, for example, the first objective (creation and reinforcement of human force motivation) influences directly on the fourth objective (increase in competitive advantages in university) and indirectly on the fifteenth objective (developing university brand). If we assume that the column matrix Ed_{i1}, $i = 1, \dots, 11$ is the efficiency score matrix of the first objective for eleven university branches and EL_{i1}^{d} is the direct efficiency balanced score relative to the first objective and Ed_{i1}^{Id} is the indirect efficiency balanced score relative to the first objective, then we have:

EL_{i1}^{d}=Ed_{i1} × (DEMATEL direct weight of the 1th objective to the 4th objective) (8)

Ed_{i1}^{Id}= Ed_{i1} × (DEMATEL indirect weight of the 1th objective to the 15th objective) (9)

Table 2
Performance indexes for strategic objectives

perspectives	strategic objectives	Performance indexes
Learning& growth	S1. Enforcing the incentive points of human force	The extent of courage and awards in organization (Wu et al., 2011). Satisfaction audit of employees and professors (Tseng, 2010). The number of expert force left in organization.
	S2. Updating the job training and empowerment of scientific boards (software power enhancement of university)	Educational opportunities abroad The promotion percentage in faculty member
	S3. Promotion of organizational culture	The extent of dependency spirit in employees (pluralism). The extent of uncertainty in organization.
	S4. Enhancing the competitive advantages of university in comparison to other competitors	The flexibility of service delivering system in the university (Wu et al., 2011). The number of student complaint to meritorious reference for the unit (central organization, governor and ...) (Tseng, 2010).
	S5. IT development and its application in university	The number of bespoke educational terms from students and faculty members side (Wu et al., 2011). The number of updated computers. The Number of servers.
	S6. Identifying the applied fields in survey scientific communities of the country.	This objective is totally qualitative and is not now measurable because of not having pure process
	S7. Developing creativity and innovative culture in students and professors	The number of bespoke educational terms from students and faculty members side (Wu et al., 2011). The amount of paid awards (Wu et al., 2011). The percentage of new ideas transferrable to delivered product to the growth centers.
Internal Processes	S8. Enhancing the efficiency and security of information exchange	Application of standard administrative methods in university (Wu et al., 2011). The time of service delivery(Tseng, 2010) The Success of implementing the official systems without any paper.
	S9. Developing equipment (enhancing hardware power)	The monetary value of assets Civil space (square meter)
	S10. Creating an independent and powerful legal system for university	The number of independent and empowered legal centers in university
	S11. Developing the applied majors	The rate of given new and functional service/educational package in every year (Tseng, 2010).
	S12. Effective information and relations with industries	The number of agreements, contracts with external organizations. Development of new customers (Wu et al., 2011) (customers of research production)*
financial	S13. Efficiency enhancement for reducing the service price of university	The service cost (equipment productivity) (Tseng, 2010).
	S14. Enhancing the sale of scientific patents	The number of sold scientific patents.
Customer and scientific credits	S15. Developing the university brand	Industry satisfaction (Wu et al., 2011; Tseng, 2010)*. Student satisfaction (Wu et al., 2011; Tseng, 2010)*. Customer loyalty (Wu et al., 2011).* Student loyalty (Wu et al., 2011).* University rank in science administration ranking (in Azad university ranking) Revenues
	S16. Increase the share of university research activities in scientific& research communities of the country.	Research scores (the number of ISI articles, the number of Inventions, Exploration, published books and…)

*The information of these indicators are not available, so they were omitted from total analysis

Similarly, the direct and indirect efficiency balanced score of each branch can be obtained for each objective. For example, the direct weight of the first objective (0.195) is multiplied by the efficiency score of this objective (for 11 university branches) and the direct efficiency balanced score is obtained and the indirect weight of this objective (0.027) is multiplied by the efficiency balanced score of this objective and the indirect efficiency balanced score is obtained (Fig. 2).

Table 3
Defuzzify indirect relations matrix

objectives	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.027	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.075	0
3	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0.048	0	0	0	0	0	0	0	0	0.032	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.032	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.032	0
8	0	0	0	0.027	0	0	0	0	0	0	0	0	0	0.01	0.027	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.075	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.032	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.059	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.044	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4
Defuzzify direct relations matrix

objectives	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0	0	0	0.195	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0.195	0	0	0	0	0.195
3	0.195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0
5	0	0	0	0	0	0	0	0.253	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0.253	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0	0
8	0	0	0	0.195	0	0	0	0	0	0	0	0	0.13	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0.195	0	0	0.195	0.065	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0.253	0	0
13	0	0	0	0.195	0	0	0	0	0	0	0	0	0	0.065	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.253	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.253	0

If the total matrix of direct efficiency balanced score is indicated byEL^d, then we have:

$$EL^d = \left[EL^d_{i1}, EL^d_{i2}, \dots, EL^d_{i16}\right] i = 1, \dots, 16 \tag{10}$$

which is a matrix composed of eleven rows (the number of university branches) and 16 columns (the number of objectives), similarly, EL^{Id} is the total matrix of indirect efficiency balanced score.

$$EL^{Id} = \left[EL^{Id}_{i1}, EL^{Id}_{i2}, \dots, EL^{Id}_{i16}\right] \tag{11}$$

$$0.195 \times \begin{pmatrix} 93.9 \\ 114 \\ 132.10 \\ 73.70 \\ 99.4 \\ 112.60 \\ 79.30 \\ 108.5 \\ 87.3 \\ 225 \\ 84.3 \end{pmatrix} = \begin{pmatrix} 18.311 \\ 22.230 \\ 25.760 \\ 14.372 \\ 19.383 \\ 21.957 \\ 15.464 \\ 21.158 \\ 17.024 \\ 43.875 \\ 16.4396 \end{pmatrix} \qquad 0.027 \times \begin{pmatrix} 93.9 \\ 114 \\ 132.10 \\ 73.70 \\ 99.4 \\ 112.60 \\ 79.30 \\ 108.5 \\ 87.3 \\ 225 \\ 84.3 \end{pmatrix} = \begin{pmatrix} 2.535 \\ 3.078 \\ 3.567 \\ 1.99 \\ 2.684 \\ 3.04 \\ 2.141 \\ 2.93 \\ 2.357 \\ 6.075 \\ 2.276 \end{pmatrix}$$

Fig. 2. Obtaining efficiency balanced score in relation to the 1thobjective (the left on is direct the right one is indirect)Attention: some objectives might influence directly or indirectly on more than one objective, so for obtaining the efficiency score, their sum should be obtained.

The efficiency score equals:

$$EL_{11\times16} = EL^{d} + EL^{Id} \quad (12)$$

In which el_{13} indicates the first university efficiency score relative to the third objective.

3.5. Obtaining weight from DEMATEL results

The suggested method of Dalalah et al. (2011) is applied in this study for obtaining the weight of each objective. If r_i is called row summation and c_i is called column summations in the matrix of total defuzzify relation, and then we have:

$$W_i = \sqrt{\{(r_i + c_i)^2 + (r_i - c_i)^2\}} \quad (13)$$

$W = (0.418, 0.657, 0.340, 1.015, 0.480, 0.387, 0.229, 0.656, 0.749, 0.229, 0.911, 0.425, 0.486, 1.147, 1.742, 0.439)^T$

3.6. Efficiency score of the whole system (each university branch)

It is better to multiply the resulted efficiency score from the previous level in the obtained weight for achieving the efficiency score of the whole system, if the resulted weighted matrix is called $W_{16\times1}$ (from 13th equation) then, we have:

$$E_{11\times1} = EL_{11\times16} \times W_{16\times1} \quad (14)$$

The total efficiency score is also measurable from summation of the scores owning to 16 objectives for each university.

4. Discussion

According to Table7, the findings indicate that Shahrod, Azadshahr, Gorgan and Garmsar units are placed in the highest ranks and Minodasht unit has achieved the last position. According to Table 6, the score of each university unit is recognizable relative to each objective. So each unit can be analyzed proportionate according to each objective. For example, Garmsar unit has achieved the highest score in reinforcing human force motivation (the first objective) and promotion of organizational culture (the third objective). Azadshahr unit has achieved the highest score in faculty member's empowerment (the second objective). In network capacity and IT development (the fifth objective), Shahrod is placed in the first position by obscene difference and had also the highest score in innovation and creativity culture development by score 11.129.

Similarly, detail information for each objective can be considered, since the 1th to 7th objectives cover the Learning& growthperspective, the 8th to 12th objectives cover the internal processes perspective, the 13th and 14th objectives cover the financial perspective and the 15th and 16th objectives cover the customer perspective of balanced scorecard by summation of the symmetrical score of each perspective's objectives, the scores of each university unit is indicated proportionate to each BSC perspective(Table8). In financial perspective, for example, Garmsarand Semnan units without any competitor dedicated orderly the first and second positions to themselves and this score difference is achieved from the 14th objective, "Increase in the number of scientific patents". Because the score of these two units in this objective has a very obscene difference rather than other units (see the Table6). In this way, managers can analyze the required information for each branch confronting to each BSC perspective.

5. Conclusion

In this paper, we have presented a hybrid BSC-DEA method to measure the relative importance of different university units. The proposed model of this paper used DEMATEL technique as part of BSC-DEA model to empower strategic planning. We have applied the method for 10 zone university

branches of Islamic Azad universities to provide an appropriate road map. The results of our survey indicated that different branches were efficient differently and some units were efficient in terms of human resources while other units were efficient in other BSC perspectives.

Table 5

Efficiency score ($EL_{11\times16}$)

	Azad shahr	Banda rgaz	Damghan	Semnan	Shahrod	Aliabad	Gorgan	Gonbad	Mahdi shar	Garmsar	Mino dasht
1	20.846	25.308	29.326	16.361	22.067	24.997	17.605	24.087	19.381	49.950	18.715
2	657.51	4.464	19.437	40.8735	9.207	69.75	47.8485	0	1.302	24.738	2.2785
3	16.497	15.510	17.249	23.242	21.244	21.009	22.490	16.756	17.743	35.250	20.492
4	34.216	15.47	16.484	35.1	50.713	11.453	10.348	11.102	9.919	13.481	18.694
5	11.322	11.089	23.310	22.211	55.944	30.636	27.972	13.653	5.561	28.105	5.561
6	0	0	0	0	0	0	0	0	0	0	0
7	7.160	1.863	8.780	10.530	48.600	14.580	29.452	9.412	0.373	13.624	0.373
8	35.477	90.948	32.909	7.002	4.863	22.251	82.974	31.937	129.537	11.009	45.007
9	18.073	17.543	38.637	30.369	65.19	40.28	30.369	3.445	0.636	70.119	2.756
10	16.2	0	16.2	16.2	16.2	0	16.2	0	0	16.2	0
11	131.469	19.305	6.253	20.930	575.718	196.645	344.533	31.499	2.795	131.469	19.305
12	7.207	4.805	16.786	14.414	19.188	2.402	9.610	14.414	7.207	50.700	0.000
13	5.229	32.254	6.597	13.771	9.029	5.685	102.478	16.963	37.088	10.275	32.558
14	0.000	0.000	5.060	158.555	24.845	0.000	0.000	0.000	0.000	204.323	0.000
15	12.40	3.90	8.10	15.90	20.50	9.30	18.80	30.70	100	13.90	19
16	4.984	5.136	48.880	9.791	56.495	61.585	13.283	0.000	0.000	33.927	36.776

Table 6
Score of each university relative to each objective (section 3.7)

	Azad shahr	Bandargaz	Damghan	Semnan	Shahrod	Aliabad	Gorgan	Gonbad	Mahdishar	Garmsar	Minodasht
1	8.714	10.579	12.258	6.839	9.224	10.449	7.359	10.068	8.101	20.879	7.823
2	431.984	2.933	12.770	26.854	6.049	45.826	31.436	0.000	0.855	16.253	1.497
3	5.609	5.273	5.865	7.902	7.223	7.143	7.647	5.697	6.033	11.985	6.967
4	34.729	15.702	16.731	35.627	51.474	11.625	10.503	11.269	10.068	13.683	18.974
5	5.435	5.323	11.189	10.661	26.853	14.705	13.427	6.553	2.669	13.490	2.669
7	1.640	0.427	2.011	2.411	11.129	3.339	6.745	2.155	0.085	3.120	0.085
8	23.273	59.662	21.588	4.593	3.190	14.597	54.431	20.951	84.976	7.222	29.525
9	13.537	13.140	28.939	22.746	48.827	30.170	22.746	2.580	0.476	52.519	2.064
10	3.710	0.000	3.710	3.710	3.710	0.000	3.710	0.000	0.000	3.710	0.000
11	119.768	17.587	5.696	19.067	524.479	179.144	313.870	28.696	2.546	119.768	17.587
12	3.063	2.042	7.134	6.126	8.155	1.021	4.084	6.126	3.063	21.548	0.000
13	2.541	15.675	3.206	6.693	4.388	2.763	49.804	8.244	18.025	4.994	15.823
14	0.000	0.000	5.804	181.863	28.497	0.000	0.000	0.000	0.000	234.358	0.000
15	21.601	6.794	14.110	27.698	35.711	16.201	32.750	53.479	174.200	24.214	33.098
16	2.188	2.255	21.458	4.298	24.801	27.036	5.831	0.000	0.000	14.894	16.145

Table 7
Ranking the tenth zone university branches of Islamic Azad University based on total efficiency score

The name of university branches	total efficiency score	Level in ranking
Azadshahr	677.791	2
Bandargaz	157.391	9
Damghan	172.470	8
Semnan	367.088	5
Shahrod	793.711	1
Aliabad	364.017	6
Gorgan	564.342	3
Gonbad	155.819	10
Mahdishahr	311.098	7
Garmsar	562.637	4
Minodasht	152.258	11

Table 8
The rank of each university units proportionate to each perspective of balanced score card

	Perspectives			
Branches	Learning& growth	Internal Processes	Financial	Customer and scientific credits
Azadshahr	1	5	11	10
Bandargaz	8	6	7	11
Damghan	7	8	8	8
Semnan	4	10	2	9
Shahrod	2	1	4	2
Aliabad	3	3	10	5
Gorgan	6	2	3	7
Gonbad	10	8	9	3
Mahdishahr	11	7	5	1
Garmsar	5	4	1	6
Minodasht	9	11	6	4

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