Development of Using Balanced Scorecard in Universities to Improve Performance: a Fuzzy DEMATEL-Shapley Value Goal Programming Approach

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ABSTRACT

Universities play a magnificent role in the sustainable development and international scientific production of their country. The Purpose of this paper is to expand using the Balanced Scorecard in universities to improve performance of universities in learning and educating. The Balanced Scorecard (BSC) is an extensively adopted performance management framework in variety of organizations and was introduced in the early 1990s. The Balanced Scorecard is a pure measurement system and has been proposed as the basis of a Strategic Management System. We describe the Balanced Scorecard as a meticulously picked out set of measures derived from an organization's strategy. Achieving all the objectives in the real world is very difficult and in many cases impossible; therefore, researchers proposed goal programming as a solution. This paper intends to treat this problem by using an integrated approach based on fuzzy DEMATEL and Shapley value for determining the priority of objectives and goal programming is aimed to reduce deviation from goals.

Keywords

University, BSC, Fuzzy DEMATEL, Shapley value, Goal programming

1. INTRODUCTION

Universities have a magnificent role in sustainable development and international scientific production of their country. The contribution of universities to sustainable development is increasingly being expressed through various publications. To reach this goal, various strategies and declarations have been adopted at international, regional and university level [1]. Universities are establishing institutional arrangements such as Technology Transfer Offices (TTOs), incubators, entrepreneurship centers, and internal seed funds to increase the commercialization of researches [2]. Many countries and universities have emphasized on transforming ideas to products, as an applicable tool, to achieve the sustainable development and increase the commercialization of researches. Achieving this objective requires applying an efficient and capable system such as the Balanced Scorecards that divided the objectives to four perspectives and measures organization performance in every perspective. The Balanced Scorecard system is an extensively adopted performance management framework in many organizations and was first introduced in the early 1990s [3]. The Balanced Scorecard is a pure measurement system and has been proposed as the basis for a Strategic Management System. We describe the Balanced Scorecard as a meticulously picked out set of measures derived from an organization's strategy [4]. By implementing Balanced Scorecard system, organizations attempt to translate their vision into operational goals, communicate their vision and link it to individual performance, plan their businesses, and receive feedbacks and learn from their underlying operational activities. Then they use the following to adapt their strategy correspondingly [5]. Decision-making Trial and Evaluation Laboratory (DEMATEL) [6,7] is a technique of drawing the complicated relationships of cause and effect among all perspectives and their contributing parts in the Balanced Scorecard system. DEMATEL can express the cause and effect relationship of criteria clearly when measuring a problem. Human judgments for deciding the relationship between subsystems are commonly given by crisp values for establishing a structural model. However, in many occasions, crisp values are unable to reflect the ambiguity in the real world sufficiently. The fact that human judgments with preferences are often vague and hard to estimate by exact numerical values has created the need for fuzzy logic for managing problems with ambiguity and imprecision [8]. In this paper, we first use DEMATEL to calculate the cause and effect relationships between four perspectives and then use the relations to calculate Shapley value. In cooperative games with crossable advantageousness, the Shapley value is certainly one of the most accepted solutions and is usually characterized by four axioms: efficiency, dummy player, symmetry and additivity. The Shapley value is the expected amount contributed by a player to a coalition [9]. This method is based on the potential fairness of the distribution of the total benefit achievable by the coalition [10]. This paper, use Shapley values as the priorities of the objectives for goal programming method. Achieving all the objectives in the real world is rigorous in many cases impossible; therefore researcher proposed goal programming as a solution. Goal programming is a special application of the linear programming (LP) model that considers multiple goals [11]. Hence, they supplemented that while LP tries to optimize, goal programming attempts to satisfy the goals to come closer to the targets.

The rest of the paper is organized as follows. In Section 2, we introduce the fuzzy DEMATEL and the procedure of calculating fuzzy DEMATEL. In section 3, we introduce the process of calculating Shapley values. Section 4 presents the goal programming approach and the process of formulating goal programming. In section 5, we follow the presented approach through a real case of Industrial University of Science and Technology University. Finally, the conclusion is presented in section 6.

2. FUZZY DEMATEL AS AN APPROACH FOR ACQUIRING CAUSE AND EFFECT RELATIONSHIPS

The Decision Making Trial and Evaluation Laboratory (DEMATEL) method was developed by the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva between 1972 and 1976. It was used for researching and solving the complicated and intertwined problems [12]. Due to the human judgment, the boards of executives assign their preferences to any relationships among the selected strategic objectives with actually crisp values. However, these crisp values are inadequate in the real world. As these human judgments with preferences in the process of decision making in general are often unclear and difficult to estimate by exact numerical values, the need for fuzzy logic emerged. In this section, we first introduce the process of deploying fuzzy DEMATEL algorithms for acquiring cause and effect relationships.

2.1. Stepwise Procedure of the Proposed Methodology

The DEMATEL method is a highly applicable way to form an evaluation structural model to improve decision making. To make the DEMATEL method for group decision making in a fuzzy environment more practical, the stepwise procedure of our proposed methodology is explained as follows.

Step 1: distinguishing the decision goal and forming a committee.

Decision making is the process of clarifying the decision goals, collecting relevant information, producing the broadest possible range of alternatives, evaluating the alternatives, selecting the optimal alternative, and monitoring the results to ensure that the decision goals are achieved [13,14]. Thus, the first step is to recognize the decision goal. Also, it is essential to form a committee to gather group knowledge for problem solving.

Step 2: Developing evaluation criteria and designing the fuzzy linguistic scale.

It is necessary to establish sets of criteria for evaluation. However, evaluation criteria have the nature of causal relationships and usually consist of many complicated aspects. DEMATEL method is essential to gain a structural model dividing criteria into cause group and effect group. To face up the ambiguities of human assessments, the linguistic variable "influence" is used with five linguistic terms [15]: very high influence, high influence, low influence, very low influence, no influence. They are expressed in positive triangular fuzzy numbers (l_{ij}, m_{ij}, u_{ij}) as shown in Table 1.

Step 3: Acquiring and aggregating the assessments of decision makers.

Table 1. The correspondence of linguistic terms and linguistic values.

Linguistic Terms	Linguistic Value
Very High Influence (VH)	(0.75, 1.0, 1.0)
High Influence (H)	(0.5, 0.75, 1.0)
Low Influence (L)	(0.25, 0.5, 0.75)
Very Low Influence (VL)	(0, 0.25, 0.5)
No Influence (No)	(0, 0, 0.25)

To measure the relationship between criteria O = {O_i | i = 1, 2,…,n}, a decision group of P experts make sets of pairwise comparisons matrices (Z_1,Z_2,…,Z_P) in terms of influences and directions between criteria. To aggregate the result of these assessments, we can use Equation 1, which is based on the representation of the addition operation. Then, the initial direct- relation matrix Z = $[Z_{ij}]_{n\times n}$ can be obtained, in which $\tilde{Z}_{ij}$ is denoted as the degree to which the criterion i affects the criterion j.

$$\tilde{Z} = \frac{\left(\tilde{z}^1 \oplus \tilde{z}^2 \oplus \cdots \oplus \tilde{z}^p\right)}{p} \tag{1}$$

Step 4: Establishing and analyzing the structural model. Fuzzy matrix $\tilde{Z}$ is produced which is called initial direct-relation fuzzy matrix (Equation 2).

$$\tilde{z} = \begin{bmatrix} 0 & \tilde{z}_{12} & \cdots & \tilde{z}_{1n} \\ \tilde{z}_{21} & 0 & \cdots & \tilde{z}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{z}_{n1} & \tilde{z}_{n2} & \cdots & 0 \end{bmatrix} \tag{2}$$

In this matrix $\tilde{z}_{ij} = (l_{ij}, m_{ij}, u_{ij})$ are triangular fuzzy numbers and $\tilde{z}_{ij}$ $(i=1,2,\ldots,n)$ will be regarded as triangular fuzzy number (0, 0, 0). Then, by normalizing initial direct-relation fuzzy matrix, we obtain normalized direct-relation fuzzy matrix $\tilde{X}$ by using Equation 3.

$$\tilde{x} = \begin{vmatrix} 0 & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & 0 & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{x}_{n1} & \tilde{x}_{n2} & \cdots & 0 \end{vmatrix} \tag{3}$$

Where

$$\tilde{x}_{ij} = \frac{\tilde{z}_{ij}}{r} = \left(\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r}\right) \tag{4}$$

And

$$r = \max_{l \le i \le n}\left(\sum_{j=1}^{n} u_{ij}\right) \tag{5}$$

It is supposed at least one i such that $\sum_{j=1}^{n} u_{ij} < r$. After computing the above matrices, the total-relation fuzzy matrix $\tilde{T}$ is calculated. Total-relation fuzzy matrix is defined as follows [16]:

$$\tilde{T} = \lim_{k \to \infty}\left(\tilde{x}^1 + \tilde{x}^2 + \cdots + \tilde{x}^k\right) \tag{6}$$

Then

$$\tilde{T} = \begin{bmatrix} \tilde{t}_{11} & \tilde{t}_{12} & \cdots & \tilde{t}_{1n} \\ \tilde{t}_{21} & \tilde{t}_{21} & \cdots & \tilde{t}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{t}_{n1} & \tilde{t}_{n2} & \cdots & \tilde{t}_{nn} \end{bmatrix} \tag{7}$$

In which $\tilde{t}_{ij} = \left(l''_{ij}, m''_{ij}, u''_{ij}\right)$ and

Matrix

$$\left[l''_{ij}\right] = x_l \times \left(1 - x_l\right)^{-1} \tag{8}$$

Matrix

$$\left[m''_{ij}\right] = x_m \times \left(1 - x_m\right)^{-1} \tag{9}$$

Matrix

$$\left[u''_{ij}\right] = x_u \times \left(1 - x_u\right)^{-1} \tag{10}$$

$$crisp(\tilde{N}) = \frac{(l + 2m + u)}{4} \tag{11}$$

By generating matrix $\tilde{T}$, $\tilde{D}_i + \tilde{R}_i$ and $\tilde{D}_i - \tilde{R}_i$ are calculated in which $\tilde{D}_i$ and $\tilde{R}_i$ are the sum of the rows and the sum of columns of $\tilde{T}$ respectively. To complete the procedure, all calculated $\tilde{D}_i + \tilde{R}_i$ and $\tilde{D}_i - \tilde{R}_i$ are defuzzified through appropriate defuzzification method. Then, there would be two sets of numbers: $\left(\tilde{D}_i + \tilde{R}_i\right)^{def}$ which reveals how important the strategic objectives are, and $\left(\tilde{D}_i - \tilde{R}_i\right)^{def}$ which shows which strategic objective is cause and which one is effect. Generally, if the value $\left(\tilde{D}_i + \tilde{R}_i\right)^{def}$ is positive, the objectives belong to the cause group, and if the value $\left(\tilde{D}_i - \tilde{R}_i\right)^{def}$ is negative, the objectives belong to the effect group.

3. SHAPLEY VALUE

The Shapley value is the expected amount contributed by a player to a coalition [9]. This method is based on the potential fairness of the distribution of the total benefit achievable by the coalition [10,17].

Considering a TU game (N, υ); N={1,...,n} is the set of players, and $\upsilon = 2^n \to R$ is a characteristic function satisfying υ(ϕ)=0 ; where ϕ is the empty set and it is super-addictive, i.e., for any $S_1 \subseteq N$ and $S_2 \subseteq N$ with $S_1 \cap S_2 = \phi$,we have $\upsilon(S_1+S_2) \ge \upsilon(S_1)+\upsilon(S_2)$. For a coalition $S \subseteq N$; υ(S) represents the total payoff that partners in coalition S can jointly obtain if this coalition is formed. We use the results of DEMATEL method for calculating υ(S). If all partners in coalition S belong to cause or effect group, we plus the importance $\left(\left(\tilde{D}_i+\tilde{R}_i\right)^{def}\right)$ of partners, and if the partners belong to cause and effect, we multiple the importance of cause partners to effect partners (equation (13),(14)&(15)). The Shapley value ($\phi_i[\upsilon]$) of every subcontractor $SC_i \in S$ in the TU game (N, υ) is:

$$\varphi_i(\upsilon) = \sum_{\substack{S\subset N \\ i\in T}} \frac{(m-1)!(n-m)!}{n!}[\upsilon(s)-\upsilon(s-\{i\})] \qquad (12)$$

$$u(S) = (\sum_{w=1}^{k} C_w) * (\sum_{v=1}^{l} E_v) \qquad (13)$$

$$u(S) = (\sum_{w=1}^{k} C_w) \qquad (14)$$

$$u(S) = (\sum_{v=1}^{l} E_v) \qquad (15)$$

W refers to members who they belong to cause group (calculated by fuzzy DEMATEL) and they are present in coalition S. V refers to members who belong to effect group (calculated by fuzzy DEMATEL) and they are present in coalition S. C_w refers to the importance of members (calculated by fuzzy DEMATEL) who belong to cause group. E_v refers to the importance of members (calculated by fuzzy DEMATEL) who belong to effect group. m is the number of members in coalition S, n is the number of all the members in grand coalition N, S -{i} the coalition, not including SC_i members. If a subcontractor, SC_i cooperates with the coalition, which consists of members S -{i}, (s)he receives the amount u(S)-u(S-{i}) ,the marginal amount which (s)he contributes to the coalition, as payoff. Then, the Shapley value $f_i[u]$ is the expected payoff to subcontractor SC_i under the randomization scheme, $\frac{(m-1)!(n-m)!}{n!}$ is the probability of subcontractor SC_i joining coalition S-{i} [18].

4. GOAL PROGRAMMING

Achieving all the objectives in the real world is rigorous and in many cases impossible; therefore, researchers proposed goal programming as a solution. Goal programming (GP) Models were originally introduced by Charnes and Cooper in early 1961 for a linear model [19]. This approach allows simultaneous solutions of a system of complex objectives. The solution of the problem requires the establishment relationships among these multiple objective. One way to deal with multiple criteria is to choose one criterion as the primary and the others as secondary. The primary criterion is then used as the optimization objective function, while the secondary criteria are assigned acceptable minimum or maximum values depending on whether the criterion is maximum or minimum and are treated as problem constraints. In this approach, the decision maker is asked to specify a realistic goal or target value that is the most desirable value for that function, instead of trying to optimize each objective function, [20]. When a set of criteria has been concluded and determined, it is necessary to discern between goals and hard constraints. Hard constraints are in variable space and are conditions that must be satisfied in order for the solution to be implementable . Any condition rejecting this requirement should be included as a goal and not a hard constraint. The modeler is cautioned not to use many hard constraints since this could cause infeasibility. Also it may exclude solutions that may be of practical interest to the decision maker [21].

4.1. Formulating Goal Programming

Goal functions have two deviation variables that imply distance from goal and they may be desirable or unwanted. In goal programming approach, the goal is to minimize the deviations based on order of determined priorities by decision makers. In this approach, we consider decision variable between zero and one for acquiring how much we have to focus on that decision variable. We show goal programming equation as follows:

$$\text{Minimize } z = \sum_{i=1}^{m} p_i(d^-_i - d^+_i) \qquad (16)$$

Subject to:

$$\sum_{j=1}^{n} c_{ij}x_j + d^-_i - d^+_i = b_i,\ i = 1,2,\ldots,m$$

$$0 \le x_j \le 1 \qquad \text{For} \quad j = 1,2,\ldots,n$$

$$d^-_i . d^+_i = 0,\ d^+_i \ge 0,\ d^-_i \ge 0$$

Pi refers to priority of the i[th] goal. d^-_i , d^+_i refer to deviation variables of the i[th] goal. C_{ij} refers to coefficient of the j[th] decision variables in the i[th] objective function and X_j refers to the j[th] decision variables in the objective function.

5. CASE STUDY: IRAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

Iran University of Science and Technology (IUST) was originally founded in 1929 as the first Iranian institution to train engineers. The institute educates engineering students in different fields, who are well employed after graduation by industries and companies mostly involved in industrialization and development processes in the country.

IUST has now granted degrees to over 32,000 students. Currently, the main branch, as well as its two branches in the cities of Arak and Behshahr, benefit from more than 380 members of the academic board. More than 9,900 students are currently enrolled on the main campus, in specialized fields of engineering and sciences, from which 3030 are in Masters Programs, and 670 are Ph.D. students. IUST's fourteen schools and departments located on the main campus, northeast of Tehran, extend to 42 acres, and encompass numerous degree programs, laboratories, a main library, residential halls, mosque, administrative buildings, sport arenas, and especially a beautiful scenery where students can pursue their education in a comforting environment.

The authors for the first step of fuzzy DEMATEL approach, realized and determined several criteria for every perspective of BSC based on strategic planning through excessive sessions with managers of the university and by conducting brainstorming techniques in the sessions. The result is shown in table 1. In the next step, subject to the fuzzy linguistic scale, every manager was asked to make pair wise relationships between each pair of criteria in every perspective. By using equation (1) we calculated the average of all assessment matrices of every manager and therefore we reached initial-direct fuzzy matrix $\tilde{z}$ as shown in Table 2.

TThen, using equation (4), the normalized direct-relation fuzzy matrix $\tilde{x}$ was produced. The results of our case study are depicted in Table 3.

Following (8), (9) & (10) equations, we achieved the total-relation fuzzy matrix which was the last step for transforming crisp data into the fuzzy environments. The matrix is depicted in Table 4. To access the casual relationships among strategic objectives, we then calculated $(D_i + R_i)$ and $(D_i - R_i)$. The results are shown in Table 5.

To finalize the procedure, all calculated $D_i + R_i$ and

Table 2. The Initial direct-relation fuzzy matrix $\tilde{z}$.

	F1	F2	F3	F4
F1	(0.00,0.00,0.00)	(0.33,0.58,0.83)	(0.29,0.54,0.79)	(0.29,0.54,0.79)
F2	(0.38,0.63,0.88)	(0.00,0.00,0.00)	(0.00,0.08,0.29)	(0.04,0.21,0.42)
F3	(0.21,0.42,0.67)	(0.00,0.13,0.38)	(0.00,0.00,0.00)	(0.00,0.13,0.33)
F4	(0.29,0.54,0.79)	(0.29,0.54,0.79)	(0.00,0.04,0.25)	(0.00,0.00,0.00)

Table 3. The normalized initial direction-relation fuzzy ma trix $\tilde{x}$.

x	F1	F2	F3	F4
F1	(0.00,0.00,0.00)	(0.14,0.24,0.34)	(0.12,0.22,0.33)	(0.12,0.22,0.33)
F2	(0.16,0.26,0.36)	(0.00,0.00,0.00)	(0.00,0.03,0.12)	(0.02,0.09,0.17)
F3	(0.09,0.17,0.28)	(0.00,0.05,0.16)	(0.00,0.00,0.00)	(0.00,0.05,0.14)
F4	(0.12,0.22,0.33)	(0.12,0.22,0.33)	(0.00,0.02,0.10)	(0.00,0.00,0.00)

Table 4. The total-relation fuzzy matrix $\tilde{T}$.

t	F1	F2	F3	F4
F1	(0.05,0.22,0.97)	(0.16,0.38,1.13)	(0.13,0.29,0.88)	(0.13,0.32,0.96)
F2	(0.17,0.36,1.00)	(0.03,0.13,0.66)	(0.02,0.12,0.60)	(0.04,0.18,0.70)
F3	(0.09,0.25,0.84)	(0.01,0.14,0.71)	(0.01,0.06,0.42)	(0.01,0.12,0.59)
F4	(0.15,0.36,1.06)	(0.14,0.34,0.99)	(0.02,0.11,0.63)	(0.02,0.12,0.60)

Table 5. The values of $(D_i + R_i), (D_i - R_i), (D_i + R_i)^{def}, (D_i - R_i)^{def}$.

criteria	$(D_i + R_i)$	$(D_i - R_i)$	$(D_i + R_i)^{def}$	$(D_i - R_i)^{def}$
F1	(0.92,2.40,7.80)	(-3.39,0.04,3.48)	3.38	0.04
F2	(0.60,1.79,6.44)	(-0.21,2.61,-3.24)	2.66	-0.26
F3	(0.30,1.16,5.10)	(-0.01,2.39,-2.41)	1.93	-0.01
F4	(0.53,1.67,6.13)	(-2.53,0.18,3.08)	2.50	0.23

$D_i - R_i$ were defuzzified through a defuzzification method using (11) equation. Then, we had two sets of numbers: $(D_i + R_i)^{def}$ which showed the importance of all strategic objectives by aggregation of all managers' preferences and $(D_i - R_i)^{def}$ which assigned strategic objectives into cause and effect groups. As shown in Table 5, the strategic objectives were divided into two groups: the cause group which Involved F2 and F3 and effect group which involved the rest of the objectives.

Having the results of fuzzy DEMATEL and using (12), (13), (14), (15) equations, we acquired Shapley value for every perspective of BSC system and used these Shapley values as priorities of objective functions for goal programming. The procedure of calculating Shapley value is shown on Table 6 and the results of calculating Shapley values in Table 7.

Table 6. Procedures of calculating Shapley value on the importance of f1.

S	$\upsilon(s)$	$\upsilon(s-\{i\})$	$\upsilon(s)-\upsilon(s-\{i\})$
{f1}	3.38	0	3.38
{f1,f2}	8.98	2.66	6.32
{f1,f3}	6.53	1.93	4.6
{f1,f4}	5.88	2.50	3.38
{f1,f2,f3}	15.5	4.59	10.91
{f1,f3,f4}	11.36	4.83	6.53
{f1,f2,f4}	15.62	6.64	8.98
{f1,f2,f3,f4}	26.97	11.47	15.5

Table 7. Calculated Shapley value and normalized Shapley value.

Criteria	Shapley value	Normalized Shapley value
F1	8.11	0.30
F2	7.71	0.29
F3	5.34	0.20
F4	5.80	0.22

For formulating goal programming, we considered every perspective as a goal and the criteria in every perspective as the decision variable for objective function. The result of this step is shown in Table 8. We asked the determined committee to assign a technical coefficient for the decision variables as importance of the criteria between zero to ten. Then, we calculated the average of the assessment and the numbers assisted the authors to formulate goal programming. The results of the assessment are shown in Table 9.

We intend to attain 100 percent of every perspective. In other words, we want to minimize the deviation from every goal in order to obtain their priorities in every objective function. The university has achieved some percent in every perspective; therefore, we consider it in the objective function.

Minimize

$$Z = 0.3 * d_1^- + 0.29 d_2^- + 0.2 * d_3^- + 0.22 * d_4^- \tag{17}$$

Subject to:

$$86.4 + 8.33 * F_1 + 6.88 * F_2 + 7.13 * F_3 + 5.66 * F_4 = 100$$

$$78.4 + 7.44 * C_1 + 6.94 * C_2 + 8.3 * C_3 + 7.6 * C_4 = 100$$

$$68.7 + 6.8 * I_1 + 7.3 * I_2 + 6.48 * I_3 + 5.1 * I_4 = 100$$

$$71.8 + 6.2 * L_1 + 7.5 * L_2 + 9.13 * L_3 + 7.5 * L_4 = 100$$

$F_1 - F_2 \geq 0$: This constraint implies that criterion F_1 (budget) is always more than criterion F_2 (Science and technology production), because we are unable to product something more than our accessible budget.

$F_1 - C_3 \geq 0$: This constraint implies that we are unable to provide high quality learning system more than our accessible budget. $F_1 - I_1 \geq 0$: This constraint implies that we are unable to grade service quality more than our accessible budget.

$F_1 - I_3 \geq 0$: This constraint implies that we are unable to provide facility more than our accessible budget.

$F_1 - L_4 \geq 0$: This constraint implies that we are unable to provide technologies and apply them more than our accessible budget.

$0 \leq F_i \leq 1$, $0 \leq C_i \leq 1$, $0 \leq I_i \leq 1$, $0 \leq L_i \leq 1$ For i=1,2,3,4

$d^-_i \geq 0, d^+_i \geq 0$ For i=1,2,3,4

The raw data for goal programming are depicted in Table 8 and the data of calculated goal programming are depicted in Table 10.

As shown in Table 10, in financial perspective, we have to focus on budget (F1) and revenue from selling technology (F4) completely (100%) and also focus on science and technology production (F2) partially (37%) and don't need to focus on price control (F3).

In customer perspective, we have to focus on university brand (C2) and providing high quality learning system (C3) completely (100%) and also focus on students satisfaction (C1) partially (27%) and don't need to focus on preferment in the international position of university (C4).

In internal processes perspective, we have to focus on offices related to industry (I4), gradation of service quality (I1), and extension of research and development center (I2) completely (100%) and focus on providing facilities (I3) partially (89%).

In learning and growing perspective, we have to focus on offices related to industry (I4), innovation (L1), employee empowerment (L2), faculties training (L3), and applying

Table 8. Perspectives of balance scorecard and their criteria.

Perspectives	Decision variables			
Financial perspective (F)	Budget (F1)	Science and technology production (F2)	Price control (F3)	Revenue from selling technology(F4)
Customer perspective (C)	Students satisfaction (C1)	University brand (C2)	Providing high quality learning system (C3)	Preferment in the international position of university (C4)
Internal processes perspective (I)	Gradation of service quality (I1)	Extension of research and development center (I2)	Providing facilities (I3)	Offices related to industry (I4)
Learning and growth perspective (L)	Innovation (L1)	Employee empowerment (L2)	faculties training (L3)	Applying new technology (L4)

Table 9. Technical coefficients of decision variables.

Perspectives	Decision variable	Technical coefficient
Financial perspective (F)	Budget (F1)	8.33
	Science and technology production (F2)	6.88
	Price control (F3)	7.13
	Revenue from selling technology(F4)	5.66
Customer perspective (C)	Students satisfaction (C1)	7.44
	University brand (C2)	6.94
	Providing high quality learning system (C3)	8.3
	Preferment in the international position of university (C4)	7.6
Internal processes perspective (I)	Gradation of service quality (I1)	6.8
	Extension of research and development center (I2)	7.3
	Providing facilities (I3)	6.48
	Offices related to industry (I4)	5.1
Learning and growth perspective (L)	Innovation (L1)	6.2
	Employee empowerment (L2)	7.5
	faculties training (L3)	9.13
		7.5

new technology (L4) completely (100%).

As shown in Table 11, we have an undesired deviation in goal programming result and that is in objective function four. The rest of objective functions do not have deviation, so we can obtain 100 percent in these goals.

6. CONCLUSION

Universities have a magnificent role in sustainable development and international scientific production of their country. Therefore, countries should invest on their universities and assist them to improve their performances.

Balanced scorecard system can help universities to grade

Table 10. The result of solving goal programming formulation.

Perspectives	Decision variable	Calculated decision variable
Financial perspective (F)	Budget (F1)	1
	Science and technology production (F2)	0.365079365
	Price control (F3)	0
	Revenue from selling technology(F4)	1
Customer perspective (C)	Students satisfaction (C1)	0.261904762
	University brand (C2)	1
	Providing high quality learning system (C3)	1
	Preferment in the international position of university (C4)	0
Internal processes perspective (I)	Gradation of service quality (I1)	1
	Extension of research and development center (I2)	1
	Providing facilities (I3)	0.888888889
	Offices related to industry (I4)	1
Learning and growth perspective (L)	Innovation (L1)	1
	Employee empowerment (L2)	1
	faculties training (L3)	1
	Applying new technology (L4)	1

Table 11. The deviations from goals (perspectives).

Perspectives	Deviations
Financial Perspective (F)	$d^-_1 = 0$, $d^+_1 = 0$
Customer Perspective (C)	$d^-_2 = 0$, $d^+_2 = 0$
Internal processes Perspective (I)	$d^-_3 = 0$, $d^+_2 = 0$
Learning and Growth Perspective (L)	$d^-_4 = 6.4$, $d^+_4 = 0$

their performance and find any action that impasse them to have a perfect performance. Balanced scorecard evaluates performance in four perspectives and recognizes any deviation in every activity. Fuzzy DEMATEL method is based on digraphs, which not only works to visualize the causal relationship of criteria with a causal diagram, but also divides engaged criteria into cause group and effect group. Results of the DEMATEL method – cause and effect relationship between the criteria – assist to calculate Shapley value. Goal programming approach is the way to achieve multi goal in the same time and minimizes the deviations from goals.

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