An Urban Management Performance Modeling Via Evaluation Using Improved Green Balanced Score Cards And Fuzzy DEMATEL Under Uncertainty Solving By A New Compromised Method Based On TOPSIS And VIKOR

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Abstract

Environmental awareness is one of the most important issues that in which general public interest are growing rapidly, especially in the industrialized countries. Some trends that can be clearly seen these days are: the number of members/financial contributors of various environmental preservation societies and associations are increasing dramatically, the amount of legislation related to environmental protection both nationally and at a super-national. The number of recycling and reuse schemes, both in industry and privately is on the rise and most people engage in one or more such programs, Unnatural climate effects suspected to stem from pollution have increased and receive much media attention and so on. This means that it is becoming increasingly more important for an enterprise to be able to manage its operations in a way that minimize the negative environmental impact they might result in, directly or indirectly. At the same time, it is a fact that you can't manage what you can't measure. Thus, performance measurement is a key element in enabling performance management, performance improvement and performance documentation. When combining the pivotal importance of environmental friendliness with the need for performance measurement, we'll face with concept of green performance measurement, an area that has been largely neglected as a pure source of competitive advantages. The balanced scorecard is one of the performance evaluating tools that empower in this research by using of decision making technics and can be used to green performance evaluation. In this thesis, we proposed an urban management performance modeling via evaluation using improved Green Balanced Score Cards and fuzzy DEMATEL under uncertainty solving by a new compromised method based on TOPSIS and VIKOR simultaneously.

Keywords: Green performance evaluation, balanced scorecard card, MCDM technics, Fuzzy, new compromised solution method.

1. Introduction

Undoubtedly, organizations and executive agencies with any mission, goals, and vision are required to respond to customers, clients, and stakeholders. The firms which aim at profitability and organizational and customer satisfaction through complete fulfillment of legal duties and contribution to development goals are accountable. Therefore, performance results are considered an important and strategic process. Performance is the real work performed in order to achieve defined organizational mission (Neely, 1999). Based upon experts in the field of management and organization, performance evaluation is a suitable strategy to improve human resources. In order to have efficient and competent manpower, organization management has no choice but paying attention to training, strengthening creativity and innovation, promoting spirit and motivation, and growing staff personality, etc. To achieve these goals, organization performance needs to be evaluated. After clarifying weak and strong points, measures need to be taken into account in order to remove the weak points and strengthen the strong ones. Environmental issues are among growing topics in different communities especially industrialized ones. Increasing members or sponsors involved in various associations concerning environmental protection, increasing number of laws related to environmental protection at national and international levels (the United Nations, European Union, etc.), increasing number of plans in recyclable materials, and involvement of the public in such plans directly or indirectly, increasing attention of media to adverse effect of environmental pollutions such as global warming, etc. (Tseng and Lan, 2010) are some indicators which highlight the importance of environmental issues. Based upon above mentioned issues, operational management is growingly regarded in order to minimize the adverse effects on environment either directly or indirectly. On the other hand, firms are not able to manage what they cannot evaluate (Rolstadas, 1994). Therefore, performance evaluation is an integral part of empowerment in performance management, performance improvement, and performance documentation. When you need to evaluate performance related to critical issues such as nature, you are faced with a phenomenon called Green Performance Evaluation. This area, as a unique source for competitive advantage, has been neglected. Among performance evaluation methods, Balanced Scorecard (BSC) is an extensively-used tool to evaluate performance which appropriately plans and controls the organization to reach the objectives (Davis and Albright, 2004; Lawrie and Cobbold, 2004; Pinero, 2002). BSC breaks down the traditional financial constraints and evaluated organizational performance in four perspectives (financial, customer, internal processes, and learning and growth) (Kaplan and Norton, 1996). This study, adding the green perspective to environmental protection, aims to investigate the BSC perspectives, determine the cause-effect relationships among these perspectives using DEMATEL technique, and determine the intensity of each perspective on the others. Sub-indicators of each of perspectives are determined using the results of DEMATEL technique. Experts` opinions are used to study the useful indicators in urban agencies. Then, each of indicators is weighted using ANP[1]. Finally, final alternatives are investigated using each of modern compromise methods.

2. Literature Review

In the past, few studies have been conducted concerning the creation and implementation of BSC in order to evaluate the green performance of industrial activities. Some studies, however, have been conducted in other industries such as banking, textile, pharmacy, etc. Hsu and Lin (2010) evaluated the environmental performance and strategic management using BSC. They used BSC to evaluate the performance of automotive industry and understand the internal/external and financial/ non-financial relationships, and output, driving factors. They offered a hybrid approach of ANP and importance-performance analysis in order to evaluate the green performance in uncertainty conditions. They integrated green and conventional indicators in evaluating performance in BSC. Indicators taken from the literature review in five perspectives (financial, internal business processes, training and growth, customer, and environmental) consist of budget growth, the level of modified costs, efforts to discover new sources of revenue, financial productivity, urban revenue growth, cash flow, and invest return rate (Fu and Yang, 2012). *Internal process* includes labor productivity, organizational standards, bureaucracy, interaction with other organizations, service innovation, labor efficiency, cheap service-provider, and clear and transparent organizational goals (Fu and Yang, 2012). *Training and growth* consists of relevant educational courses, level of salary compared to other organizations, staff`s level of education, human capital, information capital, the importance of research, and workforce familiarity with relevant policies and rules (Wu et al., 2009). *Customer* consists of customer satisfaction, service quality, the amount of time spent by clients, quality of services, respect for clients, staff accountability, management, and clients` image (Koumpouros, 2012). *Environmental perspective* includes the importance of green environmental indices, green suppliers, clear and transparent goals concerning green urban management activities, cleaner working environment, in-service environmental courses, the return on environmental investment, innovation in green services, environmental green courses, and environmentally-friendly image (Sardinha and Reijendres, 2005). ANP is a more comprehensive mode of AHP[2] used to release from constraints of AHP structures considering correlational and feedback relationships in multiple criteria decision-making (Huang et al., 2005). This technique can integrate qualitative and quantitative information in order to deal with such issues. DEMATEL technique was mainly devised to deal with complex global issues which considers strategic objective of world issues in order to access appropriate solutions. This technique is used to structure a series of assumption (Li and Tzeng, 2009). In this technique, the intensity of relationships is rated and important feedbacks are investigated. These two techniques have been merged in multiple studies. Another multi-criteria decision-making method used in this article is a modern compromise method based on TOPSIS and VIKOR. The model was devised based on TOPSIS and VIKOR in order to fix the weaknesses of TOPSIS and VIKOR methods (Vahdani et al., 2013). After selecting 18 green performance evaluation indicators amongst indicators which were investigated and selected from literature review using interviews and five rating-scale questionnaires, we found the cause-effect relationships among perspectives using DEMATEL. Final weight of indicators was determined using ANP. Urban agencies are finally evaluated and ranked using the modern compromise method based on TOPSIS and VIKOR.

[1]analytic network process
[2]analytic hierarchy process

3. Methodology

Firstly, In order to obtain the green performance evaluation indicators, a five rating-scale questionnaire was devised for 10 experts. Items are scored on a five- point rating scale from Very Suitable, Suitable, Medium, Unsuitable, and Very Unsuitable. Opinions taken from 10 experts were merged. As a result, indicators with scores lower than medium levels were eliminated. Only 18 indicators had scores higher than medium used for evaluation. Finally, 18 performance evaluation indicators were extracted. The cause-effect relationships were determined using DEMATEL techniques consisting of 1) Fuzzy Decision Matrix 2) Average Decision Matrix 3) Defuzzification by CFCS method, 4) Normalized Matrix, 5) Overall Relationship Matrix, 6) Calculation of total sum of rows and columns (Cj, and Ri), 7) Calculation of Ri+ Cj and Ri- Cj, 8) Drawing cause-effect diagram, and 9) Calculating p threshold value and drawing CRM diagram. In diagram CRM, Only factors by the amount of effect higher than p threshold value in Overall Relationship Matrix were drawn and others by the amount of effect lower than p threshold value were eliminated. The weight of each of indicators was determined using ANP including 1) Pairwise comparison matrix, 2) Calculating relative weight vectors through pairwise comparison matrix, 3) Super matrix, and 4) the convergence of super matrix.

4. Results

In order to select the green performance evaluation indicators in sub-municipal agencies in Qazvin, Iran, 18 indicators were selected out of the ones mentioned in literature review by conducting interviews with 10 experts and devising a 5 rating-scale questionnaire (Very Suitable, Suitable, Medium, Unsuitable, and Very Unsuitable). Indicators with scores lower than medium levels were eliminated. Only 18 indicators had scores higher than medium used for evaluation. Finally, 18 performance evaluation indicators were extracted. The cause-effect relationships were determined using DEMATEL which is a comprehensive method to design and analyze the cause-effect structure among complex criteria. Despite AHP which assumes that each of criteria is independent from other criteria, DEMATEL considers the relationship among criteria and finds the level of relationship among them.

4.1 Application of DEMATEL

In order to find the interplay of each of criteria, pairwise questionnaire was devised and forwarded to 20 experts. However, the main criteria with each other and sub-criteria altogether have been considered. In order to determine the effect of each of factors on others, fuzzy numbers are used. Table 1 shows the effect of factors on each other ranging from no impact to very high impact.

First Step: After collecting questionnaires, pairwise comparison matrix is converted into triangular fuzzy numbers (Table 2).

Table 1. Interplay of criteria

No Impact	(0.7،0.9،1)
Low Impact	(0.5،0.7،0.9)
Medium Impact	(0.3،0.5،0.7)
High Impact	(0.1،0.3،0.5)
Very High Impact	(0،0.1،0.3)

Table 2. Normalized Decision Matrix of Main Criteria

#		Criteria														
		Financial			Customer			Internal Processes			Learning and Growth			Green		
		Xl(ij)	Xm(ij)	Xr(ij)	Xl(ij)	Xm(ij)	Xr(ij)	Xl(ij)	Xm(ij)	Xr(ij)	Xl(ij)	Xm(ij)	Xr(ij)	Xl(ij)	Xm(ij)	Xr(ij)
Criteria	Financial	0	0	0.26	0.42	0.667	0.89	0.57	0.829	1	0.22	0.479	0.74	0.52	0.778	0.97
	Customer	0.52	0.778	0.97	0	0	0.26	0.51	0.769	0.97	0.38	0.641	0.9	0.51	0.761	0.95
	Internal Processes	0.51	0.769	0.97	0.53	0.761	0.95	0	0	0.26	0.49	0.615	0.95	0.53	0.786	0.97
	Learning and Growth	0.24	0.556	0.76	0.55	0.778	0.95	0.53	0.786	0.98	0	0	0.26	0.23	0.479	0.74
	Green	0.2	0.419	0.71	0.44	0.692	0.93	0.21	0.47	0.73	0.2	0.453	0.74	0	0	0.26

Second Step: Defuzzification by CFCS Method

This method acts based on determining the maximum and minimum range of triangular fuzzy numbers including 4 stages as follows:

Stage 1: Decision matrix normalization

It is changed into fuzzy decision matrix based upon Eq. 1, 2, and 3.

$$x^n_{rj} = (r^n_{ij} - \min l^n_{ij}) / \Delta^{\max}_{\min} \quad (1)$$

$$xm^n_{rj} = (m^n_{ij} - \min l^n_{ij}) / \Delta^{\max}_{\min} \quad (2)$$

$$xl^n_{rj} = (l^n_{ij} - \min l^n_{ij}) / \Delta^{\max}_{\min} \quad (3)$$

Stage 2: Calculating normalized right and left values

Normalized left (ls) and righ (rs) values are calculated for triangular fuzzy numbers using Eq. 4 and 5.

$$xrs^n_{ij} = xr^n_{ij} / (1 + xr^n_{ij} - xm^n_{ij}) \quad (4)$$

$$xls^n_{ij} = xm^n_{ij} / (1 + xm^n_{ij} - xl^n_{ij}) \quad (5)$$

Stage 3: Calculating total normalized crisp values

Total normalized crisp values are calculated using Eq. 6.

$$x^n_{ij} = \left[xls^n_{ij}(1 - xls^n_{ij}) + xrs^n_{ij} \times xrs^n_{ij}\right] / \left[1 - xls^n_{ij} + xrs^n_{ij}\right] \quad (6)$$

Stage 4: Calculating crisp values

Crisp values are calculated using Eq. 7.

$$z^n_{ij} = \min{}^n_{ij} + x^n_{ij} \times \Delta^{\max}_{\min} \quad (7)$$

Third Step: Forming Average Decision Matrix

We formed overall average matrix after receiving the opinions of 28 decision makers concerning the interplay of factors.

Fourth Step: Forming Normalized Average Matrix

The normalized Average matrix is formed using Eq. 8.

$$S = \max\left(\max_{1\le i\le n} \sum_{j=1}^{n} a_{ij} ; \max_{1\le j\le n} \sum_{i=1}^{n} a_{ij} \right) \quad (8)$$

Fifth Step: Forming Overall Relationship Matrix

Matrix of overall relationship is formed using Eq. 9.

$$T = D\left(I - D\right)^{-1} = \left[t_{ij}\right]_{n\times 1} \quad (9)$$

Sixth Step: Calculating the total sum of rows and columns (r_i, and c_i)

After forming the matrix of overall relationship, total sum of rows of this matrix (r_i) shows the overall impact of i^{th} criterion on other criteria. Total sum of columns of this matrix (c_j) shows the overall impact of j^{th} criterion received from the other criteria.

Seventh Step: Calculating r_i+c_j, r_i-c_j, and weight of indicators

Table 3. Calculating ri+c_j and ri-c_j

r	c
8.43	7.91
8.89	8.78
8.95	8.63
8.14	7.24
6.76	8.62

Eighth Step: Drawing Cause-Effect Diagram

Fig. 1 shows the cause-effect relationship among criteria so that the horizontal axis shows ri+cj and vertical axis shows ri-cj. Criteria above the horizon show the causes and the ones under the horizon show effects. Considering the values calculated in the previous step, if ri-cj is positive, it means that i^{th} factor is the cause. Otherwise, it is the effect. Based upon the diagram, Learning (L) and Customer (C) are the causes, while Internal Processes (P), Financial (F), and Green (G) are the effects.

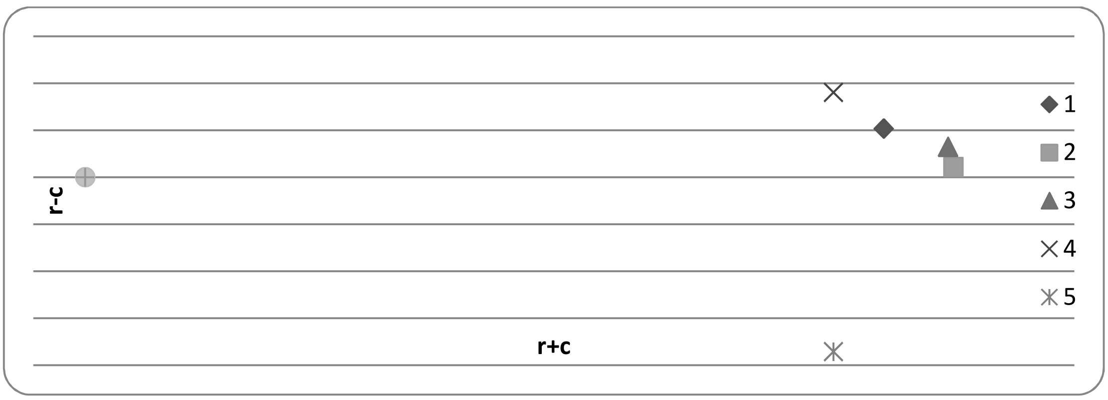

Figure 1. Cause-Effect Diagram

Ninth Step: Calculating p threshold value and Drawing CRM Diagram

Each entry of the matrix of overall relationship shows that to what extent i^{th} factor influences j^{th} factor. In order to determine the p threshold value for separating minor causes, only factors that their amount of effect in matrix of overall relationship greater than p threshold value are shown in CRM. P equals the average of elements in the matrix of overall relationship (1.647). Matrix of overall relationship is converted into Table 4 using this threshold value. Then, we draw CRM (Fig. 2)

Table 4. Matrix of overall Relationship based upon threshold value

Criterion \ Criterion	Financial	Customer	Internal Processes	Growth	Green
Financial	0.00	1.82	1.82	0.00	1.81
Customer	1.76	1.74	1.90	0.00	1.90
Internal Processes	1.77	1.94	1.72	0.00	1.91
Growth	0.00	1.79	1.76	0.00	1.69
Green	0.00	0.00	0.00	0.00	0.00

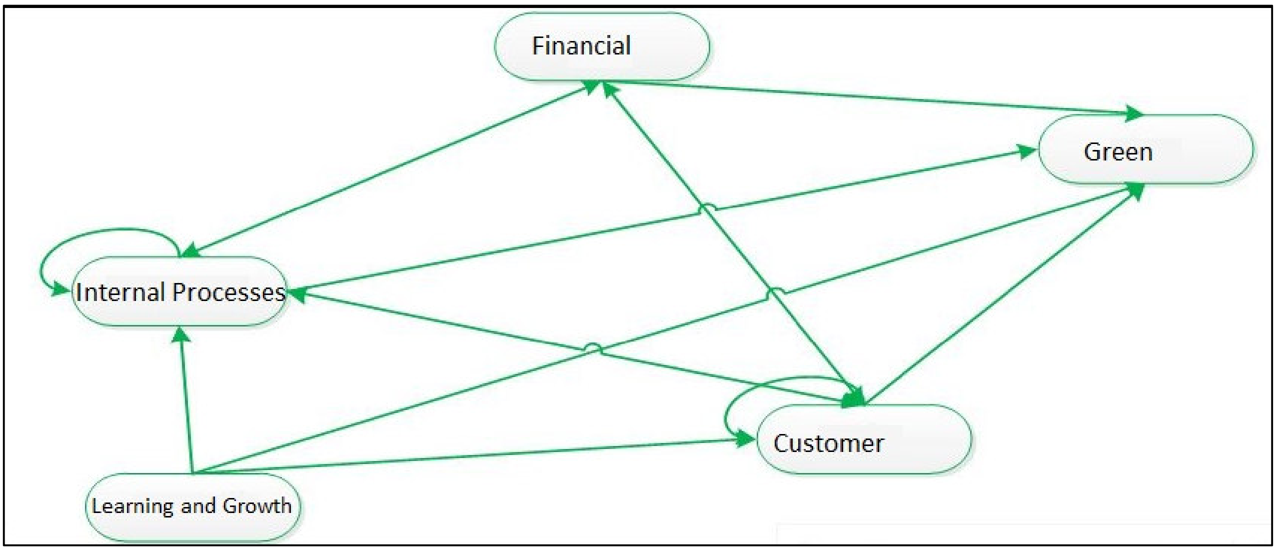

Figure 2. CRM Diagram

4.2 Applying ANP to analyze the index weight

After using DEMATEL for analyzing interplay of evaluation perspectives and creating network evaluation structure, standard network analysis questionnaire was devised. In this step, experts` opinions are used by asking the level of importance of each index compared to the other one. Then, opinions are collected and relative weight of performance evaluation criteria are extracted using pairwise matrix, EXCEL, and MATLAB. In order to calculate the level of consistency in each of pairwise comparison matrices, the relative weighting vectors need to be calculated using pairwise matrix. Experiences show that if Consistency Ratio is less than 0.1, then the consistency of comparisons is accepted. Otherwise, comparisons need to be performed again. Based upon the four mentioned perspectives of BSC shown in CRM, standard network analysis questionnaire is devised in order to obtain the relative weights of evaluation indices. The experts` opinions are collected using weighted average method. In this stage, considering the direction among five perspectives, we formed the matrices of pairwise companion. Unit vector of relative weights is extracted for each matrix and unweighted super matrix is formed. Next, we weighted the unweighted super matrix. The conventional method of normalization is to divide single element of each column of unweight super matrix into total sum of the same column in order to unify that column. In this method, it is assumed that clusters have equal weights. We, however, know that the level of effect by one cluster is almost always different from the other. Therefore, assuming equal weight of clusters does not seem logical while forming weighted super matrix. Non-normal super matrix is converted into a normal super matrix by dividing each entry into the total sum of elements in each column. After forming weighted super matrix, the exponentiation was performed for the matrix in order to ensure the convergence. In this study, the super matrix reached an acceptable level of convergence after exponentiation by 21 with three decimals places. Table 5 shows the final calculated weights from limited super matrix as the final weights of each of indicators.

Table 5. Final weights of indicators using super matrix

Indicator	Weight
F1	0.0019
F2	0.0009
F3	0.0007
C1	0.0010
C2	0.0011
C3	0.13
C4	0.10
G1	0.11
G2	0.11
G3	0.10
G4	0.13
P1	0.06
P2	0.10
P3	0.13
L1	0.10
L2	0.13
L3	0.11
L4	0.13

4.3 Final evaluation by modern compromise method

In the previous steps, performance evaluation indicators and corresponding relative weights were identified. Here, we thoroughly study the performance of organizations using fuzzy compromise method. To this end, a questionnaire was devised for this compromise model and forwarded to experts. The questionnaire was administered to evaluate the level of satisfaction from the indicators in organizations. The items are scored on a five- point rating scale from very low to very high. Data were collected. Then, different stages of fuzzy compromise method are performed in order to evaluate the green performance and rank the organizations. The questionnaire was forwarded to five executive managers and engineers in each of the organizations. Different stages of compromise decision-making method, offered by Vahdani et al. (2013) are as follows:

Step 1: Decision Matrix

The entries of decision matrix can generally be either crisp or fuzzy. The experts` opinions can be considered as a group in the form of the following matrix.

$$D = \begin{bmatrix} x_{11} & \cdots & x_{1(k-1)} & \tilde{x}_{1k} & \cdots & \tilde{x}_{1n} \\ x_{21} & \cdots & x_{2(k-1)} & \tilde{x}_{2k} & \cdots & \tilde{x}_{2n} \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{m(k-1)} & \tilde{x}_{mk} & \cdots & \tilde{x}_{mn} \end{bmatrix} \quad (10)$$

The values of decisions-making matrix equal corresponding value of i^{th} alternative compared to j^{th} indicator.

Step 2: All opinions taken from L experts are integrated. An integrated opinion is considered for each of alternatives instead of multiple opinions.

$$a_{ij}= \frac{1}{L}\sum_{l=1}^{L} a_{ijl} \qquad b_{ij} = \frac{1}{L}\sum_{l=1}^{L} b_{ijl} \qquad c_{ij} = \frac{1}{L}\sum_{l=1}^{L} c_{ijl} \quad (11)$$

Integrated weights of experts are as follows for each array:

$$w_{j1}=\frac{1}{L}\sum_{l=1}^{L} w_{jl1} \qquad w_{j2}=\frac{1}{L}\sum_{l=1}^{L} w_{jl2} \qquad w_{j3}=\frac{1}{L}\sum_{l=1}^{L} w_{jl3} \tag{12}$$

Step 3: Changing the decision-making matrix in to a non-dimensionalized matrix

3.1 If the values are crisp, normalization is as follows:

$$r_{ij}=\frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad i=1, 2\ldots m,\ j=1, 2, \ldots, k\text{-}1 \tag{13}$$

3.2 If the values are fuzzy, normalization is as follows:

$$\tilde{r}_{ij}=\left(\frac{a_{ij}}{e_j^*},\frac{b_{ij}}{e_j^*},\frac{c_{ij}}{e_j^*}\right) \quad i=1, 2\ldots m,\ j=k, k+1\ldots n. \tag{14}$$

$$e_j^*=\sqrt{\sum_{i=1}^{m} c_{ij}^2} \tag{15}$$

Step 4: Calculate the weighted matrix. Each of the weighted elements is calculated as follows:

$$\tilde{v}_{ij}=\tilde{w}_j r_{ij} \quad . \quad i=1, 2\ldots m,\ j=1, 2\ldots k\text{-}1 \tag{16}$$

$$\tilde{v}_{ij}=\tilde{w}_j \tilde{r}_{ij} \quad i=1, 2\ldots m, j=k, k+1\ldots n. \tag{17}$$

Step 5: Determining positive ideal solution (PIS) and negative ideal solution (NIS)

$$A^*=\{V_1^*, V_2^*, \ldots V_{(K-1)}^*, \tilde{V}_K^*, \ldots, \tilde{V}_n^*\} = \left(\max_i\{v_{ij}\} \middle| j \in J\right) \quad V_j^*=\max_i\{v_{ij}\} \tag{18}$$

$$A^-=\{V_1^-, V_2^-, \ldots V_{(K-1)}^-, \tilde{V}_K^-, \ldots, \tilde{V}_n^-\} = \left(\min_i\{v_{ij}\} \middle| j \in J\right) \quad V_j^-=\min_i\{v_{ij}\} \tag{19}$$

Step 6: Distance matrix from PIS and NIS

The distance matrix from PIS is as follows:

$$D=\begin{bmatrix} |\tilde{v}_{11}-\tilde{v}_1^*| & \ldots & |\tilde{v}_{1(k-1)}-\tilde{v}_{(k-1)}^*| & |\tilde{v}_{1k}-\tilde{v}_k^*| & \ldots & |\tilde{v}_{1n}-\tilde{v}_n^*| \\ |\tilde{v}_{21}-\tilde{v}_1^*| & \ldots & |\tilde{v}_{1(k-1)}-\tilde{v}_{(k-1)}^*| & |\tilde{v}_{2k}-\tilde{v}_k^*| & \ldots & |\tilde{v}_{2n}-\tilde{v}_n^*| \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ |\tilde{v}_{m1}-\tilde{v}_1^*| & \ldots & |\tilde{v}_{1(k-1)}-\tilde{v}_{(k-1)}^*| & |\tilde{v}_{mk}-\tilde{v}_k^*| & \ldots & |\tilde{v}_{mn}-\tilde{v}_n^*| \end{bmatrix} \tag{20}$$

The distance matrix from NIS is as follows:

$$D=\begin{bmatrix} |\tilde{v}_{11}-\tilde{v}_1^-| & \ldots & |\tilde{v}_{1(k-1)}-\tilde{v}_{(k-1)}^-| & |\tilde{v}_{1k}-\tilde{v}_k^-| & \ldots & |\tilde{v}_{1n}-\tilde{v}_n^-| \\ |\tilde{v}_{21}-\tilde{v}_1^-| & \ldots & |\tilde{v}_{1(k-1)}-\tilde{v}_{(k-1)}^-| & |\tilde{v}_{2k}-\tilde{v}_k^-| & \ldots & |\tilde{v}_{2n}-\tilde{v}_n^-| \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ |\tilde{v}_{m1}-\tilde{v}_1^-| & \ldots & |\tilde{v}_{1(k-1)}-\tilde{v}_{(k-1)}^-| & |\tilde{v}_{mk}-\tilde{v}_k^-| & \ldots & |\tilde{v}_{mn}-\tilde{v}_n^-| \end{bmatrix} \tag{21}$$

Step 7: We define the following functions as distance from the ideals:

$$\mathfrak{H}=\sum_{j=1}^{n} w_j d_{ij}^* \tag{22}$$

$$\mathfrak{I}=\max_i w_j d_{ij}^* \tag{23}$$

$$\zeta=\sum_{i=1}^{n} w_j d_{ij}^- \tag{24}$$

$$\xi=\max_i w_j d_{ij}^- \tag{25}$$

$$\tau_i = \nu \frac{\mathfrak{H}_i - \mathfrak{H}_i^*}{\mathfrak{H}_i^- - \mathfrak{H}_i^*} + (1-\nu) \frac{\mathfrak{I}_i - \mathfrak{I}_i^*}{\mathfrak{I}_i^- - \mathfrak{I}_i^*} \quad (26)$$

$$\eta_i = \nu \frac{\zeta_i - \zeta_i^-}{\zeta_i^* - \zeta_i^-} + (1-\nu) \frac{\xi_i - \xi_i^-}{\xi_i^* - \xi_i^-} \quad (27)$$

Where

$$\begin{cases} \mathfrak{I}^* = \min_i \mathfrak{I}_i \\ \mathfrak{I}^- = \max_i \mathfrak{I}_i \end{cases} \quad (28) \qquad \begin{cases} \zeta_* = \max_i \zeta_i \\ \zeta^- = \min_i \zeta_i \end{cases} \quad (29)$$

$$\begin{cases} \mathfrak{H}^* = \min_i \mathfrak{H}_i \\ \mathfrak{H}^- = \max_i \mathfrak{H}_i \end{cases} \quad (30) \qquad \begin{cases} \xi^* = \max_i \xi_i \\ \xi^- = \min_i \xi_i \end{cases} \quad (31)$$

Step 8: Ranking based upon the function from τ_i and η_i values

$$CI_i = \tau_i + \frac{1}{\eta_i} \quad (32)$$

The above function is a decreasing one, meaning that the lower value of this function shows that the alternative is more valuable. Table 6 shows the performance of each of four organizations including Waste Management Organization, Modernization and Improvement Organization, Urban Development and Revitalization Organization, and Culture-Sports Organization using compromise method.

Table 6. Rank of Organizations based upon different strategy values

	Waste Management Organization	Modernization and Improvement Organization	Urban Development and Revitalization Organization	Culture-Sports Organization
$\nu = 0$	1	3	4	2
$\nu = 0.1$	1	3	4	2
$\nu = 0.2$	1	3	4	2
$\nu = 0.3$	1	3	4	2
$\nu = 0.4$	1	3	4	2
$\nu = 0.5$	1	4	3	2
$\nu = 0.6$	1	3	4	2
$\nu = 0.7$	1	4	3	2
$\nu = 0.8$	1	4	3	2
$\nu = 0.9$	1	4	3	2
$\nu = 1$	1	3	4	2

One advantage of this method is the consideration of average and maximum distance strategy. Based upon the equations in this method (VAhdani et al., 2013), $\nu = 0$, meaning that the total value has been considered for maximum distance. Therefore, it can range between 1 and 0 by 0.1 step. When $\nu = 1$, it means that all weights to average distance have fully been allocated. Fig. 3 shows the type of behavior for each of the functions.

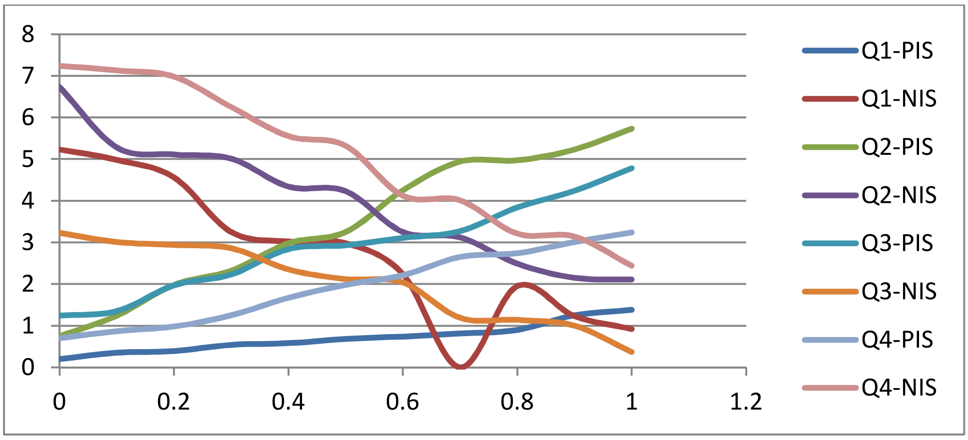

Figure 3. Behavior of each of functions

As it can be seen in Fig. 3-4, the behavior of Q^{PIS} functions is similar and the behavior of Q^{NIS} functions is correspondingly similar. We aim to select an option of which its Q^{PIS} is minimum and Q^{NIS} is maximum.

5. Conclusion

In this study, we investigated the cause-effect relationships between main BSC perspectives (Financial, Internal Processes, Learning and Growth, Customer, and Green) using DEMATEL. After determining the relationships among these five perspectives, sub-indicators were extracted from the literature. Then, 18 indicators, as the most important indicator, were verified using experts` opinions. After determining final indicators, sub-indicators were evaluated in each perspective using ANP. Afterward, the weight of each indicator was calculated. Finally, we evaluated four urban organizations using modern compromise method. The results show that Waste Management Organization has the best performance considering the equal importance strategy for maximum and average distance. Culture-Sports Organization, Urban Development and Revitalization Organization, and Modernization and Improvement Organization ranked the next positions.

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