



Evaluating and prioritizing of performance indices of environment using fuzzy TOPSIS

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Abstract

One of the integral elements of sustainable development is to maintain environmental standards and to minimize environmental losses resulting from the development. Key environmental indices are used in developed countries to improve the performance of an environmental management system (EMS) along with their strategic goals. This paper aims to present a comprehensive approach for decision-makers to evaluate and prioritize environmental indices using a technique for order performance by similarity to an ideal solution (TOPSIS) as one of the most powerful and practical tools in multi attributed decision making (MADM) problems in the fuzzy environment. Considered indices for prioritizing of performance indices of Environment include specific, measurable, attainable, realistic, time-sensitive (SMART) indices. Results show that, Air quality Index, Sound Pressure Level, Green Space Index, CO₂ and CH₄ Emission rate index, Energy index, have the first to sixth rank in the field of performance selective indices. This research helps managers and decision makers in Environment to determine and rank the performance indices of environment in the organization and finally design an appropriate and practical plan for continuous improvement.

Keywords: Environment Performance Indices, Sustainable development, TOPSIS, Fuzzy.

Introduction

Being a sustainable city is one of the fundamental objectives of any metropolitan's municipality. Many efforts are done to use suitable tools for achieving a sustainable developed city. One of the urban sustainable development's tools is the environmental management system (EMS). According to standard ISO 14031, environmental performance evaluation can be defined as "an internal process and management tool designed to provide management with reliable and verifiable information on an ongoing basis to determine whether an organization's environmental performance, is meeting the criteria set by the management of the organization. Environmental management system applies structured approaches to minimize negative effects on environment and people living at the neighbor. EMSs provide a framework by which they manage legal compatibility. In addition, EMSs using mentioned framework improve environmental performance including identification and analysis of risks and opportunities, targeting, and measurement (Donaldson, 1996; Melnyk *et al.*, 2003).

Many studies have become in the field of an environmental management system. Klassen and McLaughlin (1996) proposed a theoretical model that links environmental management and performance to the financial performance of the firm. Munda *et al.*, (1994) presented a Qualitative multi-criteria evaluation for environmental management in the fuzzy environment. An evolution of models to performance, evaluation for environmental management can be found at Kolk and Mauser's (2002) study. They gave a comprehensive overview of the development of environmental management models (environmental behaviours and

environmental performance evaluation), analyzing their characteristics, strengths and weaknesses.

Burvill *et al.* (2009) proposed a novel engineering-based risk evaluation framework to overcome some limitations in accommodating changes in environmental performance methods. They reviewed and assessed these methods according to their suitability for evaluation of operational environmental performance. Zhang *et al.* (2011) studied on a new environmental management tool for Environmental Performance Evaluation Index System of Power Generation Enterprise including two categories (basic indicators and reference indicators). Saengsupavanich *et al.* (2009) integrated the procedures of ISO14001 and port state control to establish environmental performance indicators (EPIS), specific to industrial ports and estates. They developed 12 environmental performance indicators to assess five environmental management aspects being success, awareness, determination, preparedness, and environmental policy coverage, and identified Industrial Estate Authority of Thailand's deficiencies in managing the environment for each management aspect. Nawrocka and Parker (2009) presented a meta-study for a pool of 23 studies connecting environmental performance to EMSs. The outputs of meta-study were 1. There is no agreement on what environmental performance is or how to measure it; 2. there is neither clarity nor agreement about how or why environmental management systems are expected to aid performance. Jelena *et al.* (2010) proposed a performance evaluation for improvement of environmental management system using Balanced Scorecard and analytic hierarchy process model.

Tuzkaya *et al.* (2009) proposed a methodology for the evaluation of suppliers' environmental performances based on a hybrid Fuzzy-Analytic Network Process (fuzzy ANP) and Fuzzy-Preference Ranking Organization method (fuzzy PROMETHEE). Awasthi *et al.* (2010) presented a fuzzy multi-criteria approach (fuzzy TOPSIS) for evaluating environmental performance of suppliers. They demonstrated the strength and practical applicability and ability of the fuzzy TOPSIS (under partial or lack of quantitative information) for evaluating environmental performance by a numerical application.

Wang *et al.* (2011) proposed an environmental performance evaluation of Beijing's energy use planning which integrates the analytical hierarchy process, fuzzy extent analysis, and membership degree analysis. Their model was including 18 sub-indicators of environmental performance from energy use planning that were classified into four categories: structure of energy use and industry, technology and efficiency of energy use, environmental impacts caused by energy use, and the socio-economic benefits of energy use. The results of literature review show that multi-criteria decision-making methods to evaluate the environmental performance in fuzzy environment have attracted more attentions recently.

It should be mentioned that in standard ISO 14031's definition, environmental performance evaluation refers to "A process, comparable to the environmental management systems process" and "A tool, dealing with indicator application" (Christine, 2000). Key environmental performance's indices can provide situations in that organization's strategies are controlled and managed while future success driving factors and past actions' results are evaluated. The key environmental performance indices help the organization to translate strategies as the general statements in the vision statement of organization to clear quantitative and qualitative objectives. In other words, by environmental performance indices, extensive and accessible objectives for improving environmental performance are concerned and countries are evaluated how much they could achieve these objectives. This index as quantitative factor in controlling pollutions and consequences of natural resources management provides strong tools for improving management, policy makings, decision makings, and determining environmental strategies. On the other hand, by comparing indices in different time periods, system's performance causes of increased and decrease in indices rate can be analyzed. This paper concerned with prioritizing of environmental indices using the multi attribute decision making approach as a quantitative method.

The aim of research is to apply a new approach for prioritizing and evaluating performance indices of Environment based on the integration of TOPSIS and

SMART (Specific, Measurable, Attainable, Realistic, Time-sensitive) in fuzzy environment. In this paper, fuzzy TOPSIS is applied to Evaluate and Prioritize of Performance Indices of Environmental because four advantages: (1) a sound logic for the rationale of human choice, (2) a scalar value that accounts for both the best and worst alternatives simultaneously, (3) a simple computation process that can be easily programmed, and (4) the performance measures of all alternatives on attributes can be visualized as a polyhedron, at least for any two dimensions. These advantages make TOPSIS a suitable decision making method as compared with other related MADM methods (Kim *et al.*, 1997; Shih *et al.*, 2007).

The remaining parts of this paper are organized as follows: Section 2 describes fuzzy TOPSIS methodology; in Section 3, the fuzzy TOPSIS is applied to evaluate and prioritize of performance indices of Environmental in Tehran municipality as a case study; Section 4 is dedicated to discussion; and finally, Section 5 concludes our work.

Materials and methods

Hwang and Yoon (1981) firstly, proposed TOPSIS method. The basic concept of this method is that the chosen alternative should have the shortest distance from the positive ideal solution and the farthest distance from negative ideal solution. Positive ideal solution is a solution that maximizes the benefit criteria and minimizes cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria (Wang & Elhag, 2006).

As mentioned, human thinking has uncertainty, which influences on the decision makings. Therefore, fuzzy methods are used to tackle with the uncertainty. One of the fuzzy methods is fuzzy TOPSIS method. In this method, elements of the decision making matrix or the weights of measures than each other or both are presented as fuzzy numbers. There are numerous methods for fuzzy TOPSIS. In this paper, we use Chen (2000) algorithm.

Step 1: forming fuzzy decision matrix

Suppose we have *m* alternatives, *n* measures, and *k*

$$\tilde{D} = \begin{matrix} A_1 \\ \vdots \\ A_i \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} x_1 & \dots & x_j & \dots & x_n \\ \tilde{x}_{11} & \dots & \tilde{x}_{1j} & \dots & \tilde{x}_{1n} \\ \vdots & & \vdots & & \vdots \\ \tilde{x}_{i1} & \dots & \tilde{x}_{ij} & \dots & \tilde{x}_{in} \\ \vdots & & \vdots & & \vdots \\ \tilde{x}_{m1} & \dots & \tilde{x}_{mj} & \dots & \tilde{x}_{mn} \end{bmatrix} \quad i = 1, 2, \dots, m; j = 1, 2, \dots, n \quad (1)$$

decision makers. The fuzzy multi criteria group decision making problem can be presented as a following matrix: Where A_1, A_2, \dots, A_n are alternative that should be selected or prioritized. C_1, C_2, \dots, C_n is evaluation measure or indicators, \tilde{x}_{ij} represents the value of importance degree

of alternative A_i than measure C_j by evaluator k . To integrate fuzzy performance score \tilde{x}_{ij} of k evaluators.

Average value method is used as follows:

$$\tilde{x}_{ij} = \frac{1}{k}(\tilde{x}_{ij}^1 + \tilde{x}_{ij}^2 + \dots + \tilde{x}_{ij}^k) \quad (2)$$

Where, \tilde{x}_{ij}^k indicates the degree of alternative A_i than indicator C_j by evaluator k .

$$\tilde{x}_{ij}^k = (a_{ij}^k, b_{ij}^k, c_{ij}^k).$$

Step 2: normalizing the fuzzy decision making matrix

Raw data obtained for deletion of units deviations and different scales of measurement in the MADM problems should be normalized. In this paper, linear normalization method is applied. If \tilde{R} is the normalized fuzzy decision matrix, then according following matrix would act:

$$\tilde{R} = [\tilde{r}_{ij}]_{m \times n}, \quad i=1,2,\dots,m; j=1,2,\dots,n$$

Where,

If j benefits criteria:

If j is benefit criteria

$$\tilde{r}_{ij} = \begin{cases} \left(\frac{a_{ij}}{c_j^+}, \frac{b_{ij}}{c_j^+}, \frac{c_{ij}}{c_j^+} \right) \\ \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}} \right) \end{cases} \quad (3)$$

$$c_j^+ = \max_i c_{ij}$$

$$\text{If } j \text{ is cost criteria: } a_j^- = \min_i a_{ij}$$

Step 3: forming weighted normalized fuzzy decision matrix

By considering different weights for each index, weighted normalized decision matrix can be calculated by multiplying importance weight of criteria to normalize fuzzy decision matrix. Weighted normalized decision matrix \tilde{V} is defined as follows:

$$\tilde{V} = [\tilde{v}_{ij}]_{m \times n}, \quad i=1,2,\dots,m; j=1,2,\dots,n \quad (4)$$

$$\tilde{v}_{ij} = \tilde{r}_{ij} \otimes \tilde{w}_j$$

Where, \tilde{w}_j indicates the weight of criterion j .

Step 4: determination of ideal solution and negative ideal solution

Since positive triangular fuzzy numbers are between zero and one, fuzzy ideal solution and the negative fuzzy solutions can be defined as follows:

$$A^+ = (\tilde{v}_1^+, \tilde{v}_2^+, \dots, \tilde{v}_n^+) \quad (5)$$

$$A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \dots, \tilde{v}_n^-)$$

Where,

$$\tilde{v}_j^- = (0,0,0), \quad \tilde{v}_j^+ = (1,1,1), \quad j=1,2,\dots,n$$

Step 5: calculating the distance size

Distance of each alternative with the ideals solution (positive) and negative fuzzy ideal solution are computed

$$d_i^+ = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^+), \quad i=1,2,\dots,m; j=1,2,\dots,n \quad (6)$$

$$d_i^- = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^-), \quad i=1,2,\dots,m; j=1,2,\dots,n$$

as follows:

Where, $d(\tilde{v}_a, \tilde{v}_b)$, d_i^+ , and d_i^- represent the distance between two fuzzy numbers, distance of alternative, i from ideal solution, and distance of alternative, i from negative ideal solution. If $\tilde{v}_{ij} = (a, b, c)$,

$$d(\tilde{v}_{ij}, \tilde{v}_j^+) = \sqrt{\frac{1}{3}[(a-1)^2 + (b-1)^2 + (c-1)^2]}$$

$$d(\tilde{v}_{ij}, \tilde{v}_j^-) = \sqrt{\frac{1}{3}[(a-0)^2 + (b-0)^2 + (c-0)^2]} \quad (7)$$

Step 6: calculation of closeness coefficient and prioritization of alternatives

By calculation of the closeness coefficient, ranking of all alternatives can be determined, and decision makers can select the best alternative. Closeness coefficient of each alternative can be computed as follows:

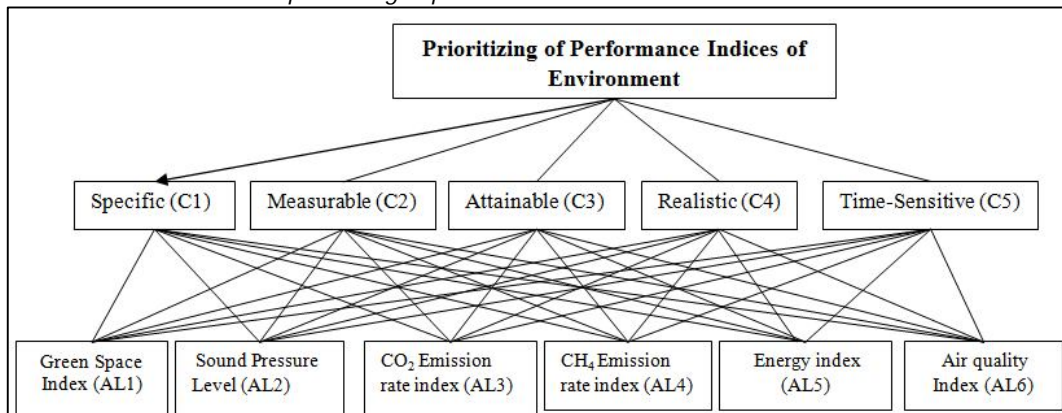
$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-}, \quad i=1,2,\dots,m \quad (8)$$

Criterion CC_i near to one represents the closeness of alternatives to the ideal solution and remoteness from the negative ideal solution. Therefore, more values of CC_i indicate good performance of alternative A_i .

Case study

In this paper, the proposed method is applied for assessment and prioritizing of performance indices of Environmental in Tehran municipality. One of the results of implementation of environment management systems in Tehran municipality is to ensure on-going improvement of environmental indices and achieving the high goals and finally international ISO certificate related to management of environment, and trying to keep these standards in 22 regions of Tehran and dependent organizations.

Fig. 1. The proposed hierarchical structure for evaluation and prioritizing of performance indices of environment



Environmental management system (EMS) refers to the management of an organization's environmental programs in a comprehensive, systematic, planned and documented manner. It includes the organizational structure, planning and resources for developing, implementing and maintaining policy for environmental protection.

Performance indices should be quantitative or have time scope, and be realistic and attainable. Assessment of indices in organizations converts the strategies in the form of nice and general clauses in the vision statement to certain qualitative and quantitative objectives and criteria (Kaplan & Norton, 2001). To organize the environmental efforts for keep an improvement of health of staffs in Tehran municipality, municipality needs to determine the performance measures in the fields related to the environment. With calculation of evaluation indices for each of major activities, success of each section in performing tasks and reaching to the objectives can be measured. On the other hand, indices can be used for analysis of system performance in different time lags by which causes of decrease and increase in indices rates could be traced. By review of literature and experts opinions, measures such as SMART at evaluation and prioritizing of Environmental performance measures are proposed in this paper.

In this study, to achieve the performance indices of environment, a list of Environmental indices is collected using the set of measures presented by international organization of environment, an environment committee of Tehran municipality, organization of stable development of metropolitans, ministry of oil, ports and sailing organization, and so on. By these indices, performance of organizations can be assessed. To evaluate the performance of each organization, there exist many different measures. To measure the performance of the management system of Environmental in Tehran municipality, by use of expert's opinions, six main indices including Green Space Index, Sound Pressure Level, CO₂ Emission rate index, CH₄ Emission rate index, Energy index, and Air quality Index are chosen. To calculate the importance of each criterion

and rating of criteria than each others, a questionnaire is designed and given to 21 experts. After gathering the experts' answers, fuzzy TOPSIS method is applied to evaluate and prioritizing the performance indices of Environment. Fig.1 shows the proposed hierarchical structure for prioritizing of the Environment performance measures.

In this figure, the main goal, criteria, and performance evaluation measures of Environment are reflected in the first, second, and third levels, respectively.

The relative importance weights of the five criteria SMART are described using linguistic variables i.e. Very low, Low, Medium Low, Medium, Medium High, High, and Very High., which are shown in Table 1. Table 2 shows linguistic variables i.e. Very Poor, Poor, Medium Poor, Fair, Medium Good, Good, and Very Good to evaluate the ratings of indicators with respect to each criterion

Table 2. Linguistic variables for the relative importance weights of five criteria SMART

Linguistic Variable	Triangular fuzzy number
Very Low (VL)	(0,0,0.1)
Low (L)	(0,0.1,0.3)
Medium Low (ML)	(0.1,0.3,0.5)
Medium (M)	(0.3,0.5,0.7)
Medium High (MH)	(0.5,0.7,0.9)
High (H)	(0.7,0.9,1)
Very High (VH)	(0.9,1,1)

Table 1. Linguistic variables for ratings

Linguistic Variable	Triangular fuzzy number
Very Poor (VP)	(0,0,1)
Poor (P)	(0,1,3)
Medium Poor (MP)	(1,3,5)
Fair (F)	(3,5,7)
Medium Good (MG)	(5,7,9)
Good (G)	(7,9,10)
Very Good (VG)	(9,10,10)

according to Wang and Elhag (2006).

First, average of all people's opinions (average of first, second, third numbers for all individuals and for each separate criterion) has to be calculated by equation 2. The calculated average is a positive triangular fuzzy number which shows the importance of each criterion. Table 3 indicates a brief summary of the calculations.

According to Table 2, for scoring the Environmental performance measures, average of all experts' opinions for this matrix are shown in Table 4.

For criteria to be compared with each other, we should make them without any unit. To do so, we use the

Table 3. Fuzzy weights of five criteria

Row	Criterion	Weight
1	Specific	(0.6524, 0.8286, 0.935)
2	Measurable	(0.6905, 0.8524, 0.95)
3	Attainable	(0.6905, 0.8429, 0.945)
4	Realistic	(0.700, 0.8571, 0.955)
5	Time-Sensitive	(0.6048, 0.7762, 0.9)

normalization method of Chen (2000) which is indicated in equation 3. It should be mentioned that in this problem, for calculations all indices of SMART are kind of profit. Results of normalization of fuzzy matrix of Table 4 are shown in Table 5.

Table 4. Fuzzy decision matrix of six alternatives

	Specific	Measurable	Attainable	Realistic	Time-Sensitive
AL1	(6.143,7.857,9.000)	(5.762,7.476,8.667)	(5.571,7.238,8.429)	(5.952,7.667,8.952)	(5.571,7.333,8.571)
AL2	(6.048,7.857,9.095)	(6.238,7.952,9.143)	(5.524,7.190,8.476)	(5.905,7.524,8.714)	(5.619,7.333,8.667)
AL3	(5.476,7.286,8.714)	(5.286,7.190,8.762)	(4.476,6.333,8.000)	(4.762,6.571,8.095)	(4.714,6.476,7.952)
AL4	(5.524,7.381,8.810)	(5.286,7.190,8.810)	(4.143,6.048,7.905)	(4.571,6.333,7.905)	(4.619,6.429,7.952)
AL5	(3.33,5.190,6.952)	(4.571,6.429,8.095)	(3.429,5.238,7.048)	(3.619,5.429,7.238)	(3.429,5.286,7.095)
AL6	(6.190,7.762,8.810)	(6.048,7.762,8.952)	(5.476,7.190,8.429)	(6.143,7.905,9.143)	(5.667,7.333,8.476)

Table 5. Normalized fuzzy decision matrix

	Specific	Measurable	Attainable	Realistic	Time-Sensitive
AL1	(0.672,0.859,0.984)	(0.630,0.818,0.948)	(0.609,0.792,0.922)	(0.651,0.839,0.979)	(0.609,0.802,0.938)
AL2	(0.661,0.859,0.995)	(0.682,0.870,1.000)	(0.604,0.786,0.927)	(0.646,0.823,0.953)	(0.615,0.802,0.948)
AL3	(0.599,0.797,0.953)	(0.578,0.786,0.958)	(0.490,0.693,0.875)	(0.521,0.719,0.885)	(0.516,0.708,0.870)
AL4	(0.604,0.807,0.964)	(0.578,0.786,0.964)	(0.453,0.661,0.865)	(0.500,0.693,0.865)	(0.505,0.703,0.870)
AL5	(0.365,0.568,0.760)	(0.500,0.703,0.885)	(0.375,0.573,0.771)	(0.396,0.594,0.792)	(0.375,0.578,0.776)
AL6	(0.677,0.849,0.964)	(0.661,0.849,0.979)	(0.599,0.786,0.922)	(0.672,0.865,1.000)	(0.620,0.802,0.927)

After calculation of normalized fuzzy decision matrix, the weighted normalized fuzzy decision matrix should be determined. Table 6 presents the weighted normalized fuzzy decision matrix calculated by equation 4.

For Table 6, we can calculate the distance between each criterion from the positive and negative ideal fuzzy numbers for each indicator 'specific' and criterion 'Green Space Index (AL1)' is defined by equation 7 as follows:

$$d(\tilde{v}_{ij}, \tilde{v}_j^+) = \sqrt{\frac{1}{3}[(0.438-1)^2 + (0.712-1)^2 + (0.920-1)^2]} = 0.367$$

$$d(\tilde{v}_{ij}, \tilde{v}_j^-) = \sqrt{\frac{1}{3}[(0.438-0)^2 + (0.712-0)^2 + (0.920-0)^2]} = 0.718$$

As all calculations for all indices and alternatives are the same, results of distance between each criterion and negative and positive ideals are shown in Tables 7 and 8.

d_i^+ and d_i^- of six indicators are calculated using equation (6) and are shown in Table 9.

Then closeness coefficients CC_i of six indicators are calculated using equation (8).

Closeness coefficient for the indicators is calculated as follows:

$$CC_1 = \frac{3.472}{1.924+3.472} = 0.643; CC_2 = \frac{3.507}{1.901+3.507} = 0.648; CC_3 = \frac{3.208}{2.198+3.208} = 0.593$$

$$CC_4 = \frac{3.179}{2.234+3.179} = 0.587; CC_5 = \frac{2.713}{2.658+2.713} = 0.505; CC_6 = \frac{3.501}{1.895+3.501} = 0.649$$

Fig. 2 shows the diagram of comparison of closeness coefficients of performance measures of Environment.

Discussion

Results show that air quality index has the highest rank among six environmental performance monitoring indices according to Table 9 with closeness coefficient 0.649. Table 9 shows that two criteria (realistic and Time sensitive) with the minimum distance from positive ideal are the most important criteria for air quality index to have the highest rank. Closeness of this index to organization's activities, mission, and policies and strategies according to how the index is realistic and also installing stations for

controlling and monitoring the air-quality index in main squares and recording information on air pollutants based on simple measurement approach are the main factors for high values of weights in the fuzzy structures' method. Sound pressure level index is of the second rank with closeness coefficient 0.648. In addition, energy index has the lowest rank with closeness coefficient 0.505. The criteria (specific, measurable, attainable, realistic, and time sensitive) of this index have the minimum distance from the negative ideal. It seems that inaccessibility to real consume and generated energy in the considered time frame and misunderstanding of the index are the factors that experts degraded this index.

Reports on environmental performance in different countries have analyzed and evaluated a number of environmental indices are a few studies that can be mentioned here. Those reports did not mention how they selected the indices. For instance, NOVART health, safety, and environment report in 2006 just indicate that a number of keys environmental performance indices are selected. It measures and presents monthly and yearly reports. Among indices in NOVART report, only three energy, CO2, and air quality indices are used in this paper. Prioritizing environmental performance indices in Tehran municipality using specific criteria is another advantageous of the current paper than previous studies.

Table 6. Weighted normalized fuzzy decision matrix

	Specific	Measurable	Attainable	Realistic	Time-Sensitive
AL1	(0.438,0.712,0.920)	(0.435,0.697,0.901)	(0.421,0.667,0.871)	(0.456,0.719,0.935)	(0.369,0.623,0.844)
AL2	(0.432,0.712,0.930)	(0.471,0.741,0.950)	(0.417,0.663,0.876)	(0.452,0.705,0.910)	(0.372,0.623,0.853)
AL3	(0.391,0.660,0.891)	(0.399,0.670,0.910)	(0.338,0.584,0.827)	(0.365,0.616,0.846)	(0.312,0.550,0.783)
AL4	(0.394,0.669,0.901)	(0.399,0.670,0.915)	(0.313,0.558,0.817)	(0.350,0.594,0.826)	(0.306,0.546,0.783)
AL5	(0.238,0.470,0.711)	(0.345,0.599,0.841)	(0.259,0.483,0.728)	(0.277,0.509,0.756)	(0.227,0.449,0.698)
AL6	(0.442,0.703,0.901)	(0.457,0.724,0.930)	(0.414,0.663,0.871)	(0.470,0.741,0.955)	(0.375,0.623,0.834)

Table 7. Distances between $AL_i (i=1, 2, 3, 4, 5, 6)$ and A^- with respect to each criterion

	Specific	Measurable	Attainable	Realistic	Time-Sensitive
d(AL1,A ⁻)	0.718	0.704	0.679	0.730	0.642
d(AL2,A ⁻)	0.721	0.747	0.678	0.714	0.646
d(AL3,A ⁻)	0.679	0.692	0.616	0.640	0.581
d(AL4,A ⁻)	0.687	0.694	0.599	0.621	0.579
d(AL5,A ⁻)	0.511	0.629	0.526	0.550	0.497
d(AL6,A ⁻)	0.707	0.730	0.676	0.749	0.639

Table 8. Distances between $AL_i (i=1, 2, 3, 4, 5, 6)$ and A^+ with respect to each criterion

	Specific	Measurable	Attainable	Realistic	Time-Sensitive
d(AL1,A ⁺)	0.367	0.375	0.393	0.356	0.434
d(AL2,A ⁺)	0.370	0.341	0.395	0.363	0.432
d(AL3,A ⁺)	0.408	0.399	0.462	0.438	0.491
d(AL4,A ⁺)	0.403	0.399	0.484	0.454	0.495
d(AL5,A ⁺)	0.561	0.453	0.545	0.524	0.575
d(AL6,A ⁺)	0.369	0.354	0.398	0.341	0.432

Table 9. Computations of d_i^+, d_i^-, CC_i and ranking

Row	Environment performance indices	d_i^-	d_i^+	CC_i	Rank
1	Green Space Index	3.472	1.924	0.643	3
2	Sound Pressure Level	3.507	1.901	0.648	2
3	CO2 Emission rate index	3.208	2.198	0.593	4
4	CH4 Emission rate index	3.179	2.234	0.587	5
5	Energy index	2.713	2.658	0.505	6
6	Air quality Index	3.501	1.895	0.649	1

Conclusion

In project-based organizations, determination and use of the performance indices of the system, especially in periodic evaluation, is of high importance. In this research, after screening the indices and removing some of the less-important environmental indices, influential indices in ranking have been selected and analyzed by fuzzy TOPSIS method.

Concurrent analysis of "quantitative and qualitative criteria" and "influential factors in the present states" in the large-scale and diverse organizations (even if same units are not included in the organization) is one of the strengths of fuzzy TOPSIS (Sadoughi *et al.*, 2011; Zarbini-Sydani *et al.*, 2011).

In this paper, due to using general indices, it is proposed that in next research, regarding the structure and strategic objectives, major and minor organization's objectives, specific index of each zone or organization are considered to evaluate the performance. Basically, extension of results of each subsection to the whole organization can be justified only whenever objectives of

subsections are the same as the whole organization's objectives. Further, in the current paper, since fuzzy TOPSIS method is applied to achieve the key performance indices, the current paper can be analyzed by using other multi criteria decision making models in the literature in order to compare results and test the precision of results.

For future research, other MCDM methods in fuzzy environment for evaluating and prioritizing performance indices of environment can be applied. These methods are fuzzy analytical hierarchy process (Azadeh *et al.*, 2009; Azadeh *et al.*, 2011; Nazari-Shirkouhi *et al.*, 2011), fuzzy Entropy method, weighted least square method, and fuzzy PROMETHEE. The results of other methods can be compared with current method results.

To serve as guidance for future research, another criteria and alternatives can be considered instead of SMARTs' criteria.

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