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Evaluation of the performance of construction project organizations with balanced scorecard approach and multi-criteria decision-making technique

Seyed Hosein Seyedi[*1], Payam Farhadi[2], Mohammad Sadegh Rasoolzadeh[3], Seyed Mohammad Seyedi[4]

1 -Assistant professor, Department of Industrial Engineering and Management, Shahrood University of Technology, Shahrood, Iran.
2- Assistant professor, Department of Management, Zand Higher Education Institute, Shiraz, Iran.
3- Master of Project Management, Department of Management, Apadana Higher Education Institute, Shiraz, Iran.
4- PHD Candidate in industrial engineering, Department of industrial engineering, K. N. Toosi University of Technology, Tehran, Iran.

ABSTRACT

construction projects are designed and implemented for the development and expansion of cities. Governments and municipalities allocate a lot of funds to such projects every year. Therefore, it is important to evaluate the success or failure of construction projects. In this paper, a framework for evaluating the municipality's performance through the evaluation of construction projects with a balanced scorecard approach and multi-criteria decision-making techniques is presented. For this purpose, according to the perspectives of the balanced scorecard, those criteria are selected that have a significant effect on the performance of construction projects. These criteria are selected in 6 perspectives, financial, customer, internal process, employees, environmental and growth and learning. In the next step, the criteria are refined using the fuzzy Delphi. In the third step, the weights of the criteria were obtained using the fuzzy DANP, and finally, the districts of Shiraz municipality are ranked based on performance in construction projects by the fuzzy VIKOR. The results show that environmental and climatic conditions have the most weight, Also, the criteria of Comprehensive contract, Commitment and reparation in the organization, performing activities correctly and on time and reducing rework, Recruitment of skilled and experienced personnel, Giving importance to assigned work and responsibilities and Dust emission have the greatest impact on other criteria in every perspective. Finally, the 15 districts of Shiraz municipality were ranked and categorized into 5 Compromise groups. The obtained results from the implementation of the evaluation show the effectiveness of the framework for implementation in other project-oriented organizations.

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*Corresponding author: Seyed Hosein Seyedi.
Email address: sh.seyedi@shahroodut.ac.ir

1. Introduction

Construction projects, especially in developing countries, are one of the important factors that have a significant impact on economic growth [1]. Therefore, achieving success in construction projects is a national issue for every country [2]. Basically, performance measurement plays an important role in ensuring the success of a projects [3].

In Iran, construction projects are often evaluated with the iron triangle criteria. [4,5]. In this method, projects are evaluated based on cost, time and quality criteria [1,6,7]. While projects have other dimensions such as environmental and social impacts and should be evaluated from these dimensions [8]. Therefore, project-oriented organizations should pay attention to various functional aspects and not only focus on cost and time in evaluating their success or that of affiliated organizations.

One of the project-oriented organizations that should update their evaluation methods are municipalities [9]. Implementation of construction projects and selection of construction companies in Iran is the responsibility of municipalities [10]. Such projects must be planned and organized in such a way that they will be completed on time. But sometimes one of the reasons that cause delays in projects and sometimes failures in projects is the lack of a proper evaluation system during the implementation of strategic planning and after its implementation [11].

Therefore, Organizations need models to measure the degree of success in achieving their goals and objectives, and with the help of these models, by comparing the current situation and the desired situation, they can get a real picture of their situation [12]. Regarding the issue of evaluating projects from various perspectives, the balanced scorecard model [13] was chosen as the basic evaluation model because it has the ability to pay attention to projects from different perspectives [14]. for this purpose, In this paper, in addition to the four perspectives of financial, customer, internal processes and learning and growth in the balanced scorecard presented by Kaplan and Norton (1992), two perspectives of employee [15] and the environment [16] are also considered. Because human power plays a more important role in the success of projects than other organizational capitals [17], the perspective of employees, and because the implementation of construction projects have a great impact on the environment [18], the perspective of the environment was added to the balanced scorecard model.

The balanced evaluation model with a comprehensive view of companies aims to link the short-term operational control of companies with the long-term prospects and strategies [19]. The strength of balanced evaluation is the use of financial criteria along with non-financial criteria to achieve organizational goals. Considering the important success factors of performance evaluation systems will enrich organizations with new ideas to achieve their goals [20].

In this paper, performance evaluation criteria of construction projects in municipalities of districts of Shiraz city (Iran) will be investigated with a balanced scorecard approach. That, the financial perspectives represents the criteria affecting the financial management of projects, the customer perspective represents the relationship criteria between municipalities and construction project contractors, the internal processes perspective represents the process criteria of the organization, the employee perspective represents the performance criteria of human resources, the growth and Learning perspective represent the infrastructural and technological criteria and finally the environmental perspective is the representation of environmental protection criteria as a result of project implementation. Fuzzy Delphi is used to identify the balanced scorecard criteria and fuzzy DANP is used to rank the importance of the criteria. Finally, municipalities of districts are ranked by the fuzzy VIKOR method.

2. Literature review

A construction project is considered successful when it is completed on time, without extra costs and with good quality. Traditional approaches to performance evaluation focus only on financial measures such as profit and return on investment [21]. Therefore, in various papers, researchers identified the

factors influencing the success of the project or identified the success criteria of the project from different aspects and in projects with different types.
Takim, and Akintoye (2002) identified the success criteria of the project from the point of view of the employer and the contractor [22]. Chan and Chan (2004) identified and measured the key performance indicators of construction projects with objective and subjective approaches [23]. Izabela et al, (2019), examined the organizational factors affecting the success of projects in the automobile industry and the relations between the factors in an integrated manner, and teamwork, empowerment, and training of human resources have been the most important influencing factors [24].
Husam et al, (2022) presented the Impact on performance (IP) criteria in Malaysian construction projects. [25] Cha, Kim, (2011) presented a quantitative model for evaluating construction projects in Korea and evaluate 22 projects [26]. Ingle & Mahesh (2020) examined various functional aspects of projects in India and identified functional areas [27]. Mcleod, Doolin, Macdonell (2012) illustrated project evaluation based on the perspectives of project stakeholders and showed that over time, the project stakeholders' opinion about the success of the project changes [28]. Frefer et al (2018) have an overview of success criteria and critical success factors of projects [29]. Barry, Braun, and Derocchi (2010) evaluated the decision-making model for the approval of construction projects [30]. For this purpose, they used the multi criteria decision making method. Criteria such as project costs, strategic communication, communication with project investors, project development plan and project benefits were introduced as effective criteria in approving a construction project.
Some researchers evaluate projects in a specific sector; Solanki, Sarkar & Kapdi (2022) evaluated the key performance indicators of the use of Internet of Things and cloud computing in Indian infrastructure projects [31]. Bapat, Sarkar & Gujar (2023) identified key performance indicators of integrated project delivery and BIM in transport infrastructure projects [32]. Madushika et al (2020) presented key performance indicators of the value chain of the construction industry in Sri Lanka [33]. Hemanata et al. (2012) identified the key factors influencing the delay of construction projects in India and the results indicate that lack of commitment, inefficient management, poor coordination, improper planning, poor communication, non-standard contract, slow decision-making, Low productivity of staff and rework are important factors in the delay of construction projects [34]. Van Tam et al. (2023) evaluate the impact of BIM-related factors on the success of construction projects [35]. Nethathe, Van Waveren, & Chan, (2011) emphasized the attention to the commitment and experience of the team, the use of the latest technology and the forecast of manpower and the required equipment and proper logistics [36]. Adafin, Rotimi and Wilkinson (2021) investigate the impact of risk factors on project budgeting in New Zealand, in this article, a literature review was used to identify the factors and a questionnaire was used to measure the impact of the factors [37]. Jian Zhu et al. (2016) examine the soft skills of managers and project success factors through the structural equation model [38]. Kassem, Khoiry, and Hamzah (2020) examine the impact of external risk factors on the success of oil and gas projects and assess the effectiveness of these factors through structural equations [39]. Shakeri, Khalilzadeh (2020) investigate the factors affecting project communication with the combined approach of Fuzzy DEMATEL and interpretive structural model [40]. Jitpaiboon, Smith & Gu (2019) examines the factors affecting project success, management tools and supports [41].
Other researchers have also investigated the impact of a limited number of criteria on the success of the project statistically; Iqbal et al. (2019) examined the impact of transformational leadership factors on project success, information was collected from 125 project managers, and the results show the great impact of transformational leadership [42]. Satish, Kamalendra & Kumar. (2019) have investigated the impact of risk reduction on project success factors. In this article, the impact of three actions has been investigated by structural modelling [21]. Pre-project planning, local participation and contract selection. Vittal, Anantatmula & Rad (2018) have investigated the impact of organizational project management maturity on project success factors, which has a significant impact on achieving project

goals and quality [43]. Matthews, Stanley, and Davidson (2018) examine the human factors and project challenges that affect employee participation in project-oriented organizations through a qualitative analysis [44]. Vahabi, Nasirzadeh & Mills (2022) measure the impact of project brief transparency on construction project performance [45]. Irfan et al. (2023) examined the impact of work-life balance and organizational support on project performance [46]. Gomes & Romão, (2016) measured the effect of the benefits management process on project success [47]. Ahmadabadi and Heravi (2019) examine the impact of critical project success factors on the success of collaborative projects between the private and government sectors in Iran's highway projects through structural equation modelling [48].

From the literature review in the field of construction project performance evaluation indicators, it can be understood that most of the papers are directly focused on the performance evaluation of construction projects, not construction project-oriented organizations. Also, performance criteria have been identified from different aspects, and there is a need to integrate these criteria with a balanced view of different performance areas. On the other hand, these criteria are not independent from each other and a change in one criterion can affect the performance of other criteria. Therefore, it is important to identify the effects and determine the weight of each criterion in the evaluation, which is addressed in this research.

3. Methods

In the first step of this research, the criteria for evaluating the performance of construction projects are extracted from the literature review, in the second step, these criteria are categorized and refined through fuzzy Delphi, in the third step, the relations between the factors and their weight are obtained through fuzzy DEMATEL. And finally, the municipal districts are evaluated through fuzzy VIKOR and based on the identified criteria. (Image 1)

The statistical population of the present study are the experts of Shiraz municipality. In this research, the target sample is 15 experts of Shiraz Municipality. The selection criteria for these experts are as follows:

1- Experts should have at least a bachelor's degree.

2- The field of study of experts should be architecture, civil engineering, urban planning, project management and construction and construction management.

3- Have more than 10 years of work experience.

4- Have worked on at least 4 construction projects in the city.

5- Have executive positions in the municipality.

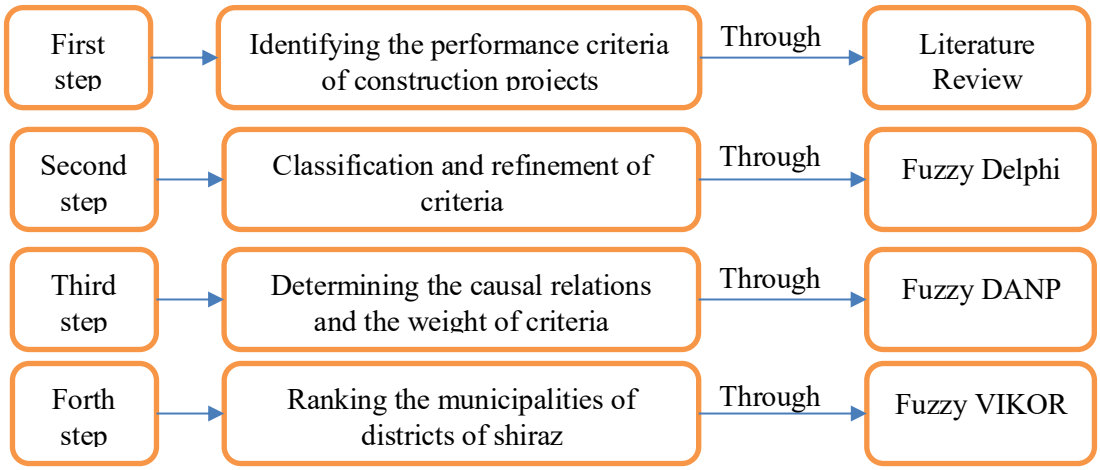

Figure 1. Methods

3.1. Fuzzy Delphi

The steps of implementing the fuzzy Delphi method are as follows [49]:
First step: gathering experts' opinions; In the first stage of Delphi, a structured questionnaire was designed based on the results of the first stage of the research and the experts were asked to specify the importance of each of the identified steps using the verbal variables very little, little, medium, much and very much.
Second step: converting verbal variables into triangular fuzzy numbers; at this stage, the verbal variables are changed in the form of the table 1.

Table 1: Fuzzy number equivalent of verbal variables

triangular fuzzy number	verbal variables
(0.75,1,1)	Very High
(0.75,0.75,1)	High
(0.25,0.5,0.75)	Medium
(0,0.25,0.5)	Low
(0,0,0.25)	Very Low

Third step: In this step, the average of sets (Am) of all sets (Ai) is calculated through the following relation.

$$A_m = (a_{m1}, a_{m2}, a_{m3}) = (1/n\sum_{i=1}^{n} a_1^i, 1/n\sum_{i=1}^{n} a_2^i, 1/n\sum_{i=1}^{n} a_3^i) \quad (1)$$

Step 4: After the initial feedback was given to the experts and the second stage of Delphi was done, the revised opinions of the experts were presented in the form of triangular fuzzy numbers in the form of the following relation.

$$B^{(i)} = (b_1^{(i)}, b_2^{(i)}, b_3^{(i)}), i = 1,2,3,...,n \quad (2)$$

Fifth step: De-fuzzification. There are different methods to de-fuzzify the final values of each criterion. In this study, the simple method of the center of gravity based on the following relation is used to de-fuzzify the values of each of the Delphi steps.

$$S_j = \frac{u_j + m_j + l_j}{3} \quad (3)$$

The sixth step: calculating the difference in expert opinions in two stages; the amount of difference between experts' opinions in the two Delphi stages was calculated through the following relation.

$$S(B_m, A_m) = \left| \frac{1}{3}\left[(b_{m1}, b_{m2}, b_{m3}) - (a_{m1}, a_{m2}, a_{m3}) \right] \right| \quad (4)$$

3.2 Fuzzy DANP

FUZZY DANP method is one of the multi-criteria decision-making methods, the basis of this method is the combination of DEMATEL and ANP methods. In the traditional method, to combine the DEMATEL method with the ANP method, we first obtain the fuzzy DEMATEL total communication matrix, then we obtain the model network by using the threshold value and removing several partial relations. And then this network is entered into fuzzy ANP to obtain the weights of criteria and criteria. In many cases, this approach causes the weights in the ANP super matrix to become zero, because the ANP method is very sensitive to relations, and if a relation should exist but does not exist, the weights of a large number of criteria in the infinite ANP super matrix l be equal to zero. Therefore, the DANP technique has solved this problem. In this technique, it group to the step of forming the matrix of the fuzzy total communication and then by implementing the steps of the fuzzy DANP, the final weights of the criteria are obtained.
Step 1: formation of fuzzy direct correlation matrix

In this step, the research criteria are compared two by two from the point of view of effectiveness and influence on each other

$$g = 1/(n(n-1))\sum_{i=1}^{n}\sum_{j=1}^{n}(|t_{ij}^{p} - t_{ij}^{p-1}|/(t_{ij}^{p}))\times 100 \quad (5)$$

Where t_{ij}^{p} represents the matrix of the average opinions of all experts and t_{ij}^{p-1}, the matrix of the moderate views of experts excluding the ith expert, and n is the number of criteria.
Reliability is obtained from the following relationship:

$$\text{Re}\,liability = 1 - g \quad (6)$$

The reliability index is examined to validate the opinions of experts. Then, the experts' opinions are integrated with the arithmetic mean method, and the fuzzy direct correlation matrix of criteria ($\tilde{A}_c$), an n by n matrix, is obtained.
Step 2: The normalization of the fuzzy direct correlation matrix.

$$\tilde{X}_{ij} = \frac{\tilde{a}_{ij}}{\tilde{r}} = (\frac{l_{ij}}{r}, \frac{m_{ij}}{r}, \frac{u_{ij}}{r}) \quad (7)$$

$$r = \max_{i,j}(\max_{1\le i\le n} u_{ij}, \max_{1\le i\le n}\sum_{i=1}^{n} u_{ij}).i, j \in (1,2,...,n) \quad (8)$$

Step 3: calculating the fuzzy total correlation matrix of the criteria
After calculating the $\tilde{X}_c$ matrix, calculate the total fuzzy correlation matrix of criteria ($\tilde{T}_C$) using relation 9, where I is the identity matrix.

$$\tilde{T}_C = \tilde{X}_C(1-\tilde{X}_C)^{-1} \quad (9)$$

Step 4: calculation of the definite total correlation matrix
In this step, the complete fuzzy correlation matrices of criteria ($\tilde{T}_C$) are determined using the relation 10.

$$X = \frac{L+2M+U}{4} \quad (10)$$

Step 5: Determining causal relationships between criteria
This step calculates the components ($D_i + R_i$, $D_i - R_i$) for dimensions and criteria. R_i and D_i are respectively equal to the sum of the elements of the rows and columns of the total relationship matrix (dimensions and measures) (relationships...)

$$D_i = \sum_{i=1}^{n} t_{ij}, i = 1,2,...,n \quad (11)$$

$$R_i = \sum_{j=1}^{n} t_{ij}, j = 1,2,...,n \quad (12)$$

Step 6: normalizing the correlation matrix of dimensions

In this step, first, the correlation matrix of dimensions is calculated; In this way, the total fuzzy matrix of dimensions ($\tilde{T}_D$) is obtained by using the arithmetic mean of each block in the fuzzy correlation matrix of criteria ($\tilde{T}_C$).

Step 7: normalizing the correlation matrix of criteria

In this step, the correlation matrix of criteria ($\tilde{T}_C$) is normalized in rows; In this way, the components of each row of the correlation matrix of criteria are divided by the sum of the elements of the corresponding row (in the same cell).

Step 8: formation of unweighted super-matrix (initial)

In this step, the transmutation of the matrix (T_C^{α})is calculated, which is called the unweighted or primary super-matrix.

$$W = (T_C^{\alpha}) \tag{13}$$

Step 9: Calculation of weighted super-matrix

In this step, the matrix (T_D^{α}) is multiplied by the unweighted supermatrix to form the weighted supermatrix.

Step 10: Calculation of the final super-matrix

In this step, the final weight of the criteria is calculated.

3.3. Fuzzy VIKOR

Fuzzy VIKOR is a multi-criteria decision-making method based on the decision matrix using the principles of fuzzy computing. In this method, instead of the traditional VIKOR method calculations, calculations are done using fuzzy numbers and fuzzy logic calculations. For the first time, Opricovic (1998) used the VIKOR technique with a fuzzy approach in an article entitled Fuzzy VIKOR method and its application in water resources planning [51]. The fuzzy VIKOR method is developed to determine the consensus solution of the fuzzy multi criteria problem. The VIKOR method has been developed for the optimization of complex multi-criteria systems. This method suggests compromise solutions and is able to stabilize decision-making performance by replacing the compromise solution with the initial weight obtained. Compromise solution theory is a practical solution that is close to the ideal solution, and compromise means an agreement created by mutual concessions [52]. VIKOR's method provides the maximum productivity of the "majority" group and the minimum regret of the "dissident" individual, and the obtained consensus solution can be easily accepted by the decision makers. The VIKOR method is combined with the fuzzy method and is known as the fuzzy VIKOR method. VIKOR's fuzzy process and methodology includes the following steps:

Step 1: forming a team of decision makers, determining possible options and identifying evaluation criteria.

Step 2: Determining appropriate linguistic variables for scoring the options according to the obtained criteria.

Step 3: Integration of priorities and opinions of decision makers. The decision is calculated by gathering the fuzzy weight of the options obtained by the opinions of n decision makers.

$$X_{ij} = \frac{1}{n}\left[\sum_{e=1}^{n} x_{ij}^{e}\right] \tag{14}$$

Step 4: Calculate the average fuzzy weight and build the fuzzy (normal) decision-making matrix.

$$D = \begin{bmatrix} X_{11} & X_{12} & \dots & X_{1n} \\ X_{21} & X_{22} & \dots & X_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ X_{m1} & X_{m2} & \dots & X_{mn} \end{bmatrix} \tag{15}$$

Step 5: De-fuzzifying the values using the following equation

$$X_{ij} = \frac{\left[\left(U_{\tilde{X}_{ij}} - L_{\tilde{X}_{ij}}\right) + \left(M_{\tilde{X}_{ij}} - L_{\tilde{X}_{ij}}\right)\right]}{3} + L_{\tilde{X}_{ij}} \quad (16)$$

Step 6: Determine the best value (BV) and worst value (WV)

$$f_i^- = \min_i X_{ij}, f_i^+ = \max_i X_{ij} \quad (17)$$

Step 7: Calculate the values of Ri, si

$$S_i = \sum_{j=1}^{n} w_j (f_i^+ - X_{ij}) / (f_i^+ - f_i^-) \quad (18)$$

$$R_i = \max_i \left[w_j (f_i^+ - X_{ij}) / (f_i^+ - f_i^-) \right] \quad (19)$$

Step 8: Calculate the values of R*, S-, R* Qi, S

$$S^* = \min_i S_i, S^- = \max_i S_i \quad (20)$$

$$R^* = \min_i R_i, R^- = \max_i R_i \quad (21)$$

$$Q_i = v((S_i - S^*) / (S^- - S^*)) + (1-v)((R_i - R^*) / (R^- - R^*)) \quad (22)$$

Step 9: Ranking the options based on the Qi value and determining the consensus solution

$$Q(a) - Q(b) \geq DQ \quad (23)$$

$$DQ = \frac{1}{m-1} \quad (24)$$

[53].

4. Findings

In this section, the findings are presented based on the steps described in the method.

4.1. Identifying the performance criteria of construction projects

In the initial stage, performance evaluation criteria of construction projects were identified in the literature review and these criteria were divided into 6 perspectives of a balanced scorecard which is presented in Table 2.

Table 2. Classification of criteria identified in 6 perspectives of the balanced scorecard

Refrences	Financial criteria	
[28], [38].	Continuous attention to the market and prices	1
[1], [36], [47].	Availability of equipment and logistics management	2
[41].	comprehensive contract	3
[39], [41], [54].	reliable and sufficient financial credit resources	4
[28], [41], [54].	Continuous monitoring and follow-up during the project	5
[1], [21], [36], [37], [39].	Stable political and economic situation	6
[37], [47].	Financial expertise of the project manager	7
[36], [41], [55].	Reliable forecasting for the supply of manpower and machinery	8
	Customer criteria	
[21], [47].	Choosing an experienced and suitable component contractor	9
[42], [55].	personal and behavioural characteristics of the project manager	10
[28], [42].	Employer's attention to contractual obligations	11
[36], [42].	Commitment and preparation in the organization	12
[1], [41].	Existence of competitive bidding system	13
[1], [55].	Participation of stakeholders in the project	14

	Internal process criteria	
[24], [43].	Good relations between project team	15
[54].	Clear division of tasks between project team members	16
[24], [34], [43].	Appropriate structure of the organization	17
[24], [41], [54].	appropriate WBS and realistic scheduling design	18
[34], [41], [54].	Development of the appropriate project control ystem	19
[34], [56].	Performing activities correctly and on time and reducing rework	20
[28], [38], [48].	Connecting with the private sector	21
	learning and Growth criteria	
[36], [57], [58].	Using up-to-date technologies and standards	22
[36], [41], [59], [60].	Documenting activities and creating archives	23
[36], [61].	Recruitment of skilled and experienced personnel	24
[28], [38], [56], [60].	transfer of individual experiences	25
[56], [57].	Design and implementation using the Benchmarking	26
[38], [62].	consultant's mastery of technical, contractual and operational issues	27
[57].	Training of personnel and project team	28
	Employee criteria	
[34], [59], [61].	Giving importance to assigned work and responsibilities	29
[38], [63].	Support of senior managers	30
[44], [54].	Coordination and solidarity of the project team	31
[34], [44].	Incentives and penalties	32
[38], [44], [61].	Good interaction between employer, consultant and contractor	33
	Environment criteria	
[63], [64], [65], [66].	Implementation and control of environmental health	34
[62], [64], [65], [67], [68], [69], [70].	Environmental and climatic conditions	35
[63], [64], [66], [71].	Dust emission	36
[63], [64], [67].	Reducing the effects of floods and droughts	37
[65], [67], [68], [69].	Sufficient knowledge of the external factors of the project	38

4.2. Classification and refinement of criteria

After reviewing the literature on evaluating the performance of construction projects with the balanced scorecard approach and multi-criteria decision-making, we reached a general list that includes 38 criteria. To validate the criteria, a questionnaire was prepared and distributed among 15 experts of Shiraz Municipality and evaluated in two Delphi rounds. In the second round, the coordination coefficient between the opinions was done through calculating the Kendall coefficient, that obtained value was 0.78, This value indicates the appropriate coordination between the opinions, therefore, Delphi was stopped and the average scores of the final round were used as the criterion for action; Therefore, criteria whose average score is higher than the average of their group will remain, and the rest of the criteria will be removed. For example, Table 3 presents the results obtained from two Delphi rounds after defuzzification of the values for the financial aspect.

Table 3. Ranking criteria in the financial aspect with the Delphi method

Status	Second Round	First Round	criteria
Accept	0.860467788	0.860467788	Continuous attention to the market and prices
Reject	0.70997544	0.698121818	Availability of equipment and logistics management
Accept	0.836408217	0.836408217	comprehensive contract
Reject	0.765204577	0.765204577	reliable and sufficient financial credit resources
Reject	0.68345322	0.661508817	Continuous monitoring and follow-up during the project
Reject	0.760774011	0.760774011	Stable political and economic situation

Accept	0.8154798	0.8154798	Financial expertise of the project manager
Reject	0.752725689	0.752725689	Reliable forecasting for the supply of manpower and machinery
	Ave: 0.77306109		

In the financial perspective, the criteria of Continuous attention to the market and prices, comprehensive contract, financial expertise of the project manager, received an acceptable score, and the rest of the criteria were eliminated. The remaining criteria in each perspective are shown in Table 4.

Table 4. The Accepted criteria in each perspective

Internal process criteria	Customer criteria	Financial criteria
Clear division of tasks between project team members	Choosing an experienced and suitable component contractor	Continuous attention to the market and prices
Appropriate structure of the organization	Existence of competitive bidding system	comprehensive contract
appropriate WBS and realistic scheduling design	Employer's attention to contractual obligations	Financial expertise of the project manager
Development of the appropriate project control system	Commitment and preparation in the organization	**learning and Growth criteria**
Performing activities correctly and on time and reducing rework	**Employee criteria**	Using up-to-date technologies and standards
Environmental criteria	Giving importance to assigned work and responsibilities	Recruitment of skilled and experienced personnel
Dust emission	Coordination and solidarity of the project team	transfer of individual experiences
Environmental and climatic conditions	Good interaction between employer, consultant and contractor	Design and implementation using the Benchmarking
Sufficient knowledge of the external factors of the project		consultant's mastery of technical, contractual and operational issues
		Training of personnel and project team

4.3. Determining the causal relations and the weight of criteria

In this section, 24 criteria extracted by Fuzzy Delphi were distributed in the form of a questionnaire among 15 experts of Shiraz Municipality and the criteria were evaluated. The results obtained in the fuzzy DANP method in the form of tables and graphs are as follows. In the first step, the experts were asked to show the impact of criterion i on criterion j. The opinions of 15 experts were used to check the criteria. Therefore, a 24x24 matrix is formed, for example, a part of the matrix is presented in Table 5.

Table 5. Part of the direct communication matrix

		Continuous attention to the market and prices			**comprehensive contract**			**Financial expertise of the project manager**		
Financial	Continuous attention to the market and prices	0.467	0.6	0.817	0.433	0.6	0.833	0.466	0.55	...
	comprehensive contract	0.6	0.733	0.917	0.567	0.7	0.9	0.6	0.766	...
	Financial expertise of the project manager	0.45	0.666	0.833	0.417	0.667	0.8	0.416	0.616	...
Customer	Choosing an experienced and suitable component contractor	0.617	0.716	0.917	0.533	0.65	0.866	0.616	0.733	...

	Employer's attention to contractual obligations	0.583	0.766	0.9	0.5	0.7	0.85	0.516	0.7	...
	Commitment and reparation in the organization	0.0517	0.7	0.883	0.683	0.8	0.966	0.683	0.866	...
	Existence of competitive bidding system	0.567	0.683	0.883	0.517	0.667	0.866	0.516	0.666	...
Internal process	Clear division of tasks between project team members	0.533	0.683	0.867	0.65	0.767	0.9	0.566	0.75	...
	…	...	...	...	...	...	...	...	...	...

In the second step, the initial matrix was normalized, in the third step, the complete correlation matrix of the criteria (T_C) was calculated, in the fourth step, the complete correlation matrix of the perspectives was calculated, and finally, the intensity and direction of the influence of the criteria on each other were obtained, and the final results were as is below.

4.3.1. Total effect matrix for the criteria of the Balanced Scorecard perspectives

By separating the values obtained for each perspective of the balanced scorecard in a separate matrix, the effect matrix of the criteria in each perspective is obtained. For example, in Table 6, the effect matrix of the criteria in the financial perspective is presented.

Table 6: The matrix of the total effect in the financial criteria

financial criteria	Continuous attention to the market and prices	A comprehensive and flawless contract	Commitment and expertise of the project manager
Continuous attention to the market and prices	0.224849568	0.22467392	0.225350973
A comprehensive and flawless contract	0.25660467	0.256630279	0.256957012
Commitment and expertise of the project manager	0.22503421	0.224898659	0.225591516

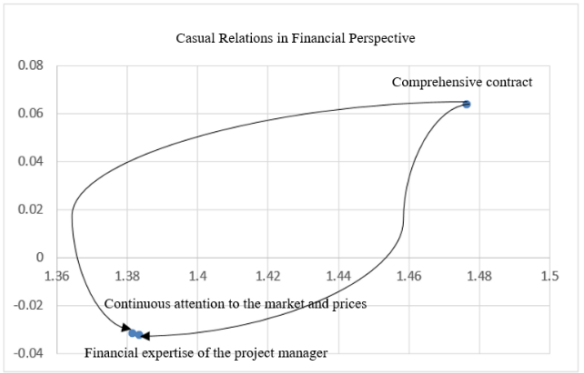

Figure 2: The relation between the criteria of financial

Referring to Figure 2, the Comprehensive contract has the most impact and Continuous attention to the market and prices is the most affected.

That is, if the project has a comprehensive and flawless contract, it makes the financial expertise of the project manager and Continuous attention to the market and prices perform better.

Also, it is cited from Figure 3, Commitment and reparation in the organization has the most impact and the Existence of competitive bidding system is the most affected.

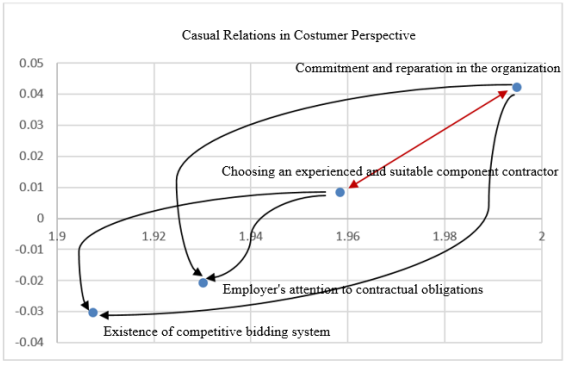

Figure 3: The relation between the criteria of customer

Commitment and preparation in the organization have a two-way relationship with the selection of an experienced and suitable component contractor, in other words, both influence each other, commitment will lead to the selection of a suitable component contractor, a suitable component contractor raises the level of preparation and commitment in the project organization. Also, both of these criteria affect the employer's attention to contractual obligations and the existence of the competitive bidding system.
From Figure 4, it can be seen that the Performing activities correctly and on time and reducing rework has the most impact and Development of the appropriate project control system is the most affected.
As it is clear from the figure, most of the relations in the perspective of the internal process are two-way. It means that the criteria both affect each other and are affected by each other. The 4 criteria of performing activities correctly and on time, clear division of tasks, appropriate WBS and realistic scheduling design and appropriate structure of project have mutual influence and these 4 criteria are effective in the development of the project control system.
Also, Figure 5 showed that the Recruitment of skilled and experienced personnel has the most influence and Transfer of individual experiences is the most affected.
in growth and learning perspective, the results are similar, so that the recruitment of skilled and experienced personnel, consultants' mastery, personnel training, and design and implementation by superior options have a mutual effect on each other. And these criteria affect the 2 criteria of using up to date technology and transfer of individual experiences.

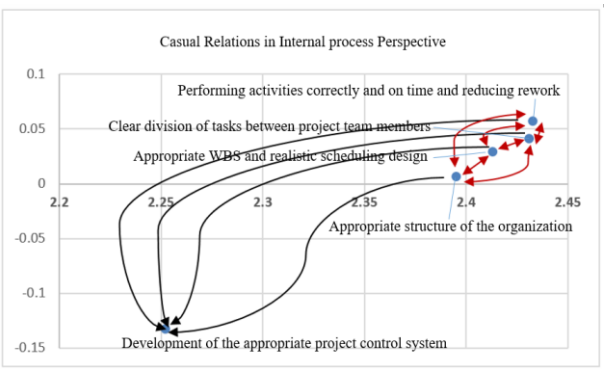

Figure 4: The relation between the criteria of internal process

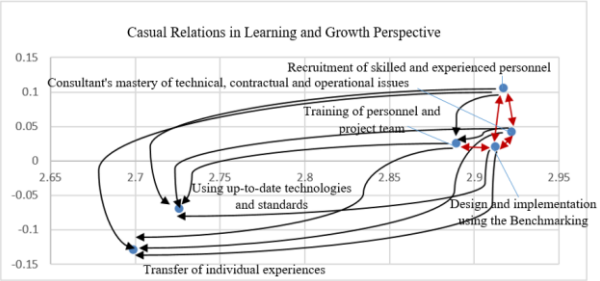

Figure 5: The relation between the criteria of growth and learning

It is cited from Figure 6, that the giving importance to work and assigned responsibilities has the most impact and Coordination and solidarity of the project team is the most affected.
In this perspective, the criteria of giving importance and good interaction have a mutual effect on each other and both have an effect on the coordination and solidarity of the team.
It can be seen from Figure 7 that dust emission has the most influence and environmental and climatic conditions is the most affected.
In other words, the dust emission affects the environmental and climatic conditions and sufficient knowledge of the external project factors. That is, the dust emission shows the need for further investigation of environmental conditions.

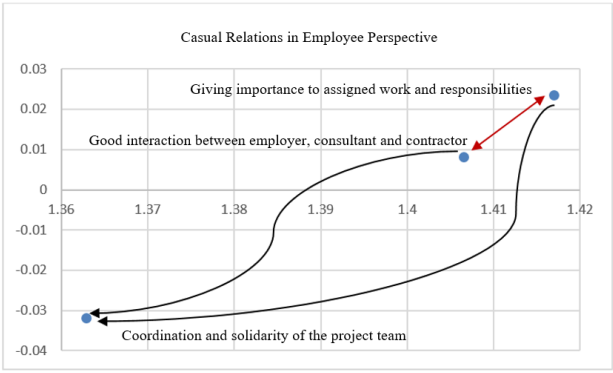

Figure 6: The relation between the criteria of employee

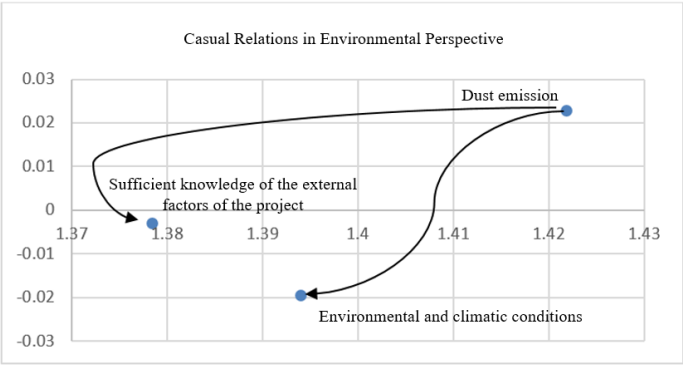

Figure 7: The relation between the criteria of environmental

4.3.2. Total effect matrix for balanced scorecard perspectives

After calculating the effect matrix of the criteria, the effect matrix was calculated for the perspectives of the balanced scorecard (Table 7), whose effectiveness and affectedness are shown in the form of a diagram (Figure 8). As can be seen from the chart, the internal process has the most impact and the environmental is the most affected. internal process and Customer criterion influence five other

perspectives. The financial criterion affects the Internal process and the customer. The learning and Growth have an effect on four other perspectives except the employee.

Table 7. Calculations of the total effect matrix for perspectives of the balanced scorecard

	Financial	Customer	Internal process	learning and Growth	Employee	Environmental
Financial	0.235621	0.238264	0.235928	0.235252	0.233048	0.233711
Customer	0.240196	0.243451	0.239986	0.237392	0.236356	0.238869
Internal process	0.240096	0.242227	0.238498	0.238543	0.238355	0.239137
learning and Growth	0.238734	0.243221	0.237474	0.236999	0.235733	0.237176
Employee	0.234313	0.237898	0.235754	0.235135	0.232569	0.234107
Environmental	0.232986	0.221564	0.211803	0.233210	0.232153	0.233025
R	1.421948	1.426627	1.399441	1.416533	1.408217	1.416028
D	1.411826	1.436252	1.436855	1.429341	1.409778	1.364743
D+R	2.833774	2.862880	2.836269	2.845874	2.817995	2.780771
D-R	-0.010122	0.009624	0.037413	0.0128079	0.001561	-0.051285

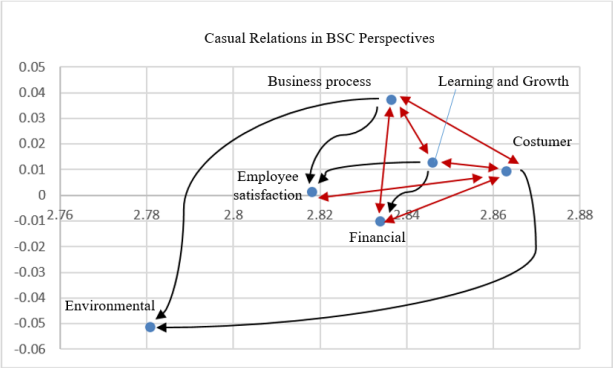

Figure 8: How the perspectives of the balanced scorecard are related

Figure 8 shows that most of the relationships between the 5 perspectives of finance, growth and learning, internal process, customer and employees are two-way and they influence each other, but the environmental is influenced by two perspectives of internal process and customer. In other words, the environment is a landscape that is affected by the implementation of the project.

4.3.3. Determining the weight of criteria

As presented in the method, the DANP method provides us simultaneously achieving the effects and weights of the criteria. In other words, one criterion may be generally more influential than other criteria, but that does not mean it is less important.

Next, by normalizing the complete correlation matrix of the criteria T_C^{α}, the unbalanced super matrix is formed, then the balanced super matrix and finally the limited balanced super matrix is calculated in order to calculate the final weights of the criteria. In Table 8, the final weights are obtained.

Table 8. The final weight of the criteria.

Weight	criteria	Perspective	Weight	criteria	Perspective
0.027374	Using up-to-date technologies and standards	**learning and Growth**	0.055659	Continuous attention to the market and prices	**Financial**
0.027519	Recruitment of skilled and experienced personnel		0.055822	comprehensive contract	

0.027631	transfer of individual experiences		0.056049	Financial expertise of the project manager	
0.028251	Design and implementation using the Benchmarking		0.042695	Choosing an experienced and suitable component contractor	
0.028118	consultant's mastery of technical, contractual and operational issues		0.042632	Employer's attention to contractual obligations	**Customer**
0.028008	Training of personnel and project team		0.042549	Commitment and preparation in the organization	
0.055149	Giving importance to assigned work and responsibilities	**Employee**	0.040143	Existence of competitive bidding system	
0.055297	Coordination and solidarity of the project team		0.031976	Clear division of tasks between project team members	
0.055474	Good interaction between employer, consultant and contractor		0.03196	Appropriate structure of the organization	**Internal process**
0.056051	Environmental and climatic conditions	**Environmental**	0.033695	appropriate WBS and realistic scheduling design	
0.055667	Dust emission		0.033649	Development of the appropriate project control system	
0.055119	Sufficient knowledge of the external factors of the project		0.033511	Performing activities correctly and on time and reducing rework	

4.3. Ranking the municipalities of districts of shiraz

In the previous stage, using the fuzzy DANP method, the evaluation of the criteria, cause-effect relations and the weight of the criteria were done. In this step, the classification of Shiraz city municipal districts will be done using the checklist of the VIKOR criteria matrix. In the first step, the matrix of fuzzy experts' opinions is integrated. (Table 9)

Table 9: A part of the matrix of the integration of experts' opinions in the fuzzy VIKOR method

	Continuous attention to the market and prices			**comprehensive contract**			**Financial expertise of the project manager**			**Choosing an experienced and suitable component contractor**			
Type	positive			positive			positive			positive			
District1	0.583	0.766	0.9	0.5	0.7	0.85	0.516	0.7	0.85	0.5	0.666	0.833	..
District2	0.516	0.7	0.883	0.683	0.8	0.966	0.683	0.866	0.966	0.666	0.733	0.933	..
District3	0.566	0.683	0.883	0.516	0.666	0.866	0.516	0.666	0.866	0.533	0.7	0.883	..
District4	0.533	0.683	0.866	0.65	0.766	0.9	0.566	0.75	0.9	0.516	0.7	0.866	..
District5	0.666	0.8	0.95	0.583	0.7	0.883	0.566	0.65	0.866	0.533	0.7	0.883	..
District6	0.45	0.666	0.833	0.633	0.8	0.916	0.466	0.616	0.783	0.583	0.75	0.9	..
District7	0.333	0.483	0.717	0.45	0.633	0.8	0.45	0.633	0.833	0.45	0.616	0.816	..
District8	0.716	0.85	0.983	0.533	0.666	0.883	0.5	0.616	0.816	0.433	0.566	0.8	..
District9	0.35	0.5	0.733	0.583	0.55	0.8	0.5	0.683	0.866	0.466	0.583	0.8	..
District10	0.633	0.783	0.933	0.583	0.7	0.916	0.65	0.766	0.95	0.4	0.533	0.783	..
District11	0.667	0.75	0.933	0.666	0.8	0.933	0.6	0.8	0.916	0.566	0.733	0.883	..

District12	0.683	0.816	0.966	0.666	0.783	0.95	0.616	0.733	0.916	0.516	0.65	0.85	..
District13	0.466	0.633	0.833	0.483	0.616	0.8	0.6	0.733	0.916	0.566	0.783	0.9	..
District14	0.6	0.733	0.917	0.566	0.7	0.9	0.6	0.766	0.916	0.633	0.766	0.933	..
District15	0.45	0.666	0.833	0.416	0.666	0.8	0.416	0.616	0.8	0.366	0.566	0.75	..
Positive Ideal	0.716	0.85	0.983	0.683	0.8	0.966	0.683	0.866	0.966	0.666	0.783	0.933	..
Negative Ideal	0.333	0.483	0.717	0.383	0.5	0.8	0.416	0.616	0.783	0.366	0.533	0.75	..

4.3.1. Calculating the values of the indices of usefulness (S_i) and dissatisfaction (R_i) and calculating the index (Q_i)

At this stage, based on the identification of ideal positive and ideal negative options, the values of S, R and Q have been calculated for each option, and the results obtained are presented in Table 10.

Table 10. Calculation of S, R, Q for each District

	Fuzzy S_i			Fuzzy R_i			Fuzzy Q_i			Defuzzified S_i, R_i, Q_i		
District1	0.440	0.454	0.451	0.055	0.055	0.055	0.191	0.017	0.239	0.451	0.055	0.186
District2	0.329	0.318	0.294	0.029	0.037	0.033	0.567	0.504	0.567	0.316	0.351	0.525
District3	0.556	0.614	0.519	0.42	0.048	0.046	0.536	0.517	0.500	0.588	0.046	0.517
District4	0.341	0.306	0.294	0.037	0.039	0.038	0.425	0.44	0.444	0.309	0.038	0.438
District5	0.406	0.476	0.406	0.031	0.048	0.036	0.596	0.363	0.617	0.453	0.044	0.444
District6	0.372	0.382	0.369	0.045	0.056	0.056	0.303	0.076	0.140	0.378	0.054	0.124
District7	0.778	0.779	0.739	0.055	0.055	0.056	0.508	0.481	0.505	0.773	0.056	0.489
District8	0.259	0.367	0.273	0.038	0.056	0.46	0.3243	0.061	0.268	0.333	0.051	0.139
District9	0.777	0.809	0.714	0.056	0.056	0.56	0.498	0.5	0.476	0.787	0.056	0.495
District10	0.398	0.508	0.337	0.043	0.43	0.038	0.382	0.542	0.497	0.461	0.042	0.508
District11	0.268	0.319	0.271	0.04	0.037	0.039	0.306	0.513	0.421	0.303	0.038	0.463
District12	0.402	0.404	0.388	0.035	0.043	0.040	0.530	0.439	0.506	0.401	0.041	0.466
District13	0.449	0.413	0.384	0.038	0.053	0.056	0.519	0.197	0.159	0.414	0.051	0.244
District14	0.270	0.320	0.225	0.055	0.058	0.056	0.017	0.024	0.008	0.296	0.056	0.020
District15	0.658	0.570	0.599	0.056	0.056	0.055	0.384	0.026	0.369	0.589	0.056	0.300
Min	0.026	0.031	0.225	0.029	0.037	0.033						
Max	0.779	0.809	0.738	0.056	0.056	0.056						

4.3.2. Calculation of the ranking results of municipalities

As mentioned in the introduction, the purpose of this paper is to provide a framework for evaluating project-based organizations in the field of construction. Therefore, in this step, the municipalities of the districts Shiraz are evaluated and ranked with the presented approach, through the analysis of the Q value. Here, because the distance between the highest values of Q is less than the value of DQ, a compromise group and not a superior option is selected. (Table 11)

Table 11: Ranking of the districts of Shiraz municipality

Grade	Q	Districts	Grade	Q	Districts
Compromise group2	0.4443	District5	Compromise group1	0.5248	District2
	0.4382	District4		0.5173	District3
Compromise group3	0.3007	District15		0.5081	District10
	0.2444	District13		0.4956	District9

Compromise group4	0.1856	District1		0.4895	District7
	0.1393	District8		0.4658	District12
	0.1245	District6		0.4633	District11
Compromise group5	0.0204	District14			

5. Conclusion

The evaluation of project-oriented organizations is very important, especially with construction projects, because construction projects are one of the largest numbers and most expensive projects that countries implement for their development. Therefore, this paper focused on identifying criteria for evaluating project-based organizations, the findings of which are summarized below.

1. according to the perspectives of the balanced scorecard that two perspectives of employee and the environment have also been added to, 38 criteria were extracted according to previous studies. In the next step, the criteria were refined to 24 criteria, using the fuzzy Delphi method.
2. the effectiveness and affectedness and weight of the criteria were obtained using the fuzzy DANP method. The criteria of Comprehensive contract from the financial, Commitment and reparation in the organization from the customer, correct and Performing activities correctly and on time and reducing from the internal process, Recruitment of skilled and experienced personnel from the Learning and Growth, giving importance to assigned work and responsibilities from the employee, the Dust emission from the environment has the most impact on their criterion.
3. the criteria of Continuous attention to the market and prices from the financial, the Existence of competitive bidding system from the customer, the Development of the appropriate project control system from the internal process, the Transfer of individual experiences from the Learning and Growth, Coordination and solidarity of the project team from the employee, Environmental and climatic conditions from the environment are the most affected in their criterion. Effective criteria become important for us because the manager of the organization realizes that direct attention to these criteria is not necessarily enough to improve them. And if the organization intends to perform better in these criteria, it should pay enough attention to the criteria that affect them. Otherwise, direct investment in these criteria may not produce a favourable effect.
4. In BSC perspectives, the internal process has the most impact and the environment is the most affected.
5. The criteria of financial, internal process and environment, which include 9 criteria, with scores greater than 0.05, are recognized as the most important criteria by experts. The total weights of these criteria include about 50% of the total, which determine the organization's attention points. In other words, if these criteria have a high impact along with high weight, they need the attention and emphasis of the management. But if they have a high weight and are influencing criteria, management needs to pay more attention to the influencing criteria.
6. according to the weights obtained for the criteria, the municipalities of the 15 districts of Shiraz city were ranked. Due to the fact that the first ranking condition was not met in VIKOR, instead of presenting the best option, the best options were presented in Compromise groups, and 15 districts were categorized into 5 groups. District 2, 3, 10, 9, 7, 12, 11 were placed in Group 1.

5.1. Research Limitations

The results of this study can be applied to other municipalities. However, when generalizing the findings to other organizations, the specific conditions of those organizations must be taken into account. That said, this study can help identify relevant criteria.
In this study, the evaluation of municipal areas was conducted using the balanced scorecard approach. One limitation of this approach is its focus on the internal environment of the organization, while external factors such as economic, social, and political conditions can also significantly influence the success of projects.
Finally, another limitation of the study is that obtaining data for some of the identified criteria may be challenging or time-consuming. As a result, experts were consulted to provide evaluations, which may reduce the accuracy of the results.

5.2. future research suggestion

Using frameworks such as Pestel, which seeks to identify external factors affecting phenomena, can compensate for the limitation of focusing solely on the internal environment.
Simulating the relations between the effective criteria of the project, by system dynamics, using several decision-making methods with multiple criteria and combining these methods for more confidence in the evaluation results and implementation of the framework in non-construction project-oriented organizations can be used for future research.
Designing statistical and sampling methods, as well as developing automated systems for data collection and analysis, could be promising avenues for future research in evaluating criteria that are time-consuming or challenging to measure.

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