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Effective Factors on the Difference between the Amount of Initial Estimation and the Cost of Construction Projects (Case: Shiraz Municipality)

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Abstract: Actual (Final) price of construction projects are usually deviations compared to their initial estimates. At runtime, these projects face increasing in costs for various reasons and may lose their economic justification. Therefore, identifying factors affecting this price difference are one of the most important issues in this field. This study identifies the importance of the factors affecting the difference between the amount of initial estimation and the actual cost of five mega-projects of the Shiraz municipality as example. This research is descriptive-survey and data collection was done using questionnaire and interviewing tool. In order to determine the weight, priority and categories of factors, the best-worst method, gray TOPSIS and weight-quality matrix were used, respectively. The results of this study show that nine important price deviations are effective in five superstructures that fall into three broad categories: "high quality and high weight", "low quality, high weight or vice versa", "low quality and weight". According to the research findings, the "existence of adversaries" is the most influential factor in the price deviation of Shiraz municipality's superstructures.

Keywords: construction projects, price deviation factors, Gray TOPSIS, BWM, Shiraz Municipality
JEL Classification: N65, C14, C22, L32

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1- Introduction

Studies show that in most construction projects, there is a significant difference between the initial estimated costs and the final costs. Since economics is the study of the optimal allocation of scarce resources to human needs, the correct costing of financial resources is very important. Hence, to avoid wasting these resources and to perform the construction projects in the planned time table and budgeting, it is necessary and indisputable to recognize the factors influencing price deviation and to try to reduce it. In reviewing the goals of each program and plan, the economic category is of great importance in policy making and decision making. The economic planning affects the prosperity and development, backwardness and deprivation, survival and growth, or stagnation and destruction of a society. Usually, the cost of construction deviates from the initial budget and overruns. This is one of the major problems that are always referred to by project management consultants (Montri, 2003).

Many civil engineering projects, such as highways, urban tunnels, bridges and intersections, are planned and performed with the aim of reducing traffic congestion and facilitating transportation and reducing the traffic load, especially in metropolises. However, due to different reasons and factors, the cost of a project differs from the initial estimated one, and creates many financial problems for local governments. If, during the performance of the project, the contractor asks for an increase in funding and the municipality cannot finance it, in addition to the consequences of urban unsustainable scenarios and traffic disruptions in the transportation network, citizens' confidence will be lost (Hejazi et al., 2015).

All of the above economic, managerial and social problems will ultimately lead to the waste of resources, problems in urban development, backwardness in development prospects, lack of efficiency in the economic sectors, backwardness of development programs of other sectors, decline of foreign investment in construction sectors, and many other problems.

Therefore, in this research study, first, the factors affecting price deviation are identified. Then, the importance of each of the factors is evaluated. Finally, according to their impact and rank, some suggestions are made to eliminate them.

2- Literature Review

a) Foreign Researches

Memon et al., (2014) explored the factors influencing the construction costs of management projects, specifically MARA large projects. The survey showed that the most influential factors included the fluctuations in material prices, cash flow and financial problems faced by contractors, lack of workers, lack of necessary communications among sections, and contractors' improper scheduling. In addition, it was noted that repeated design changes and the owner's interference were less important than the above-mentioned factors. The most important reason of the difference between the estimated and the actual costs was the lack of sufficient and punctual allocation of credits.

In a study entitled "the factors affecting the cost overruns of the construction projects", Subramani, et al. (2014) investigated the factors in the construction projects of India. Most construction projects were experiencing the cost overruns, which put heavy financial burden on customers or landlords. Therefore, they tried to identify the

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factors leading to cost overruns of construction projects. To do so, a field study with a questionnaire was conducted. The results showed that poor decision making, poor time management, increase in material prices and machinery, poor contractor's management, poor design or delay in design, duplication due to wrong operation, problems in the land purchase, erroneous estimation, and the long time between design and bidding were the main factors of cost overruns.

Wanjari & Dobariya (2016) explored the cost overruns factors of construction projects in India. They believed that delay and cost overruns are common in projects all around the world; however, the problem is more severe in developing countries. According to the Ministry of Statistics and Implementation, In India, out of 410 specific projects, 235 projects were heavily affected by cost overruns. In the study, a questionnaire survey was conducted considering 15 significant factors affecting cost overruns; the questionnaire was distributed among 190 construction professionals (i.e., specialists in construction) throughout India. The identified factors included rising raw material prices, delay in planned performances, and lack of coordination between construction sections, which could significantly increase the cost of construction projects in India.

Al-hazim, et al., (2017) conducted a study entitled "delay and cost overrun in infrastructure projects in Jordan". The objective of this study was to investigate factors affecting the cost overrun compared to the initial estimated cost. To do so, they collected and analyzed data from a sample of 40 infrastructure and developmental projects performed in 2000-2008. The findings indicated that 20 final factors increased the cost of infrastructure projects in India. In fact, land and climatic conditions were the most important factors of delay and cost overrun in the projects.

Belay & Torp (2017) investigated if longer projects encounter more cost deviations than shorter projects. In fact, they analyzed two specific types of construction projects (i.e., roads and buildings), and examined the cost performance and construction time. In order to achieve this objective, the researchers considered construction projects with different completion time and different sizes, and used a quantitative research method. The results showed that longer projects do not necessarily have higher cost deviations. In addition, unlike construction projects, in road projects, there was a negative correlation between cost and the construction time. However, relatively more cost deviations were observed in some of the great projects than smaller ones.

b) Iranian Researches

In a study entitled "investigating the causes of delay in urban construction projects", Safavi, et al., (2010) considered the key reasons of long duration of time to complete road projects, bridges and tunnels in Tehran as the weakness of the employer, the contractor and the consultant.

In a study entitled "prioritizing the delays in urban construction projects in Isfahan", Kazemi & Chitsazzadeh (2013) used Fuzzy AHP method and rated the importance of delay factors and their effects on construction projects in Isfahan. They found that the environmental issues affecting the performance of urban projects, including long bureaucracy in government institutions, were the first factor affecting the delays; consultants and contractors gained the next ranks.

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In a study entitled "prioritizing the causes of delay in construction projects using multi-criteria decision-making methods and providing a solution for improvement: the case of Mazandaran province projects", Abdollah zadeh, et al., (2013) analyzed the reasons of delay, ranked the factors by distributing questionnaires among specialists in construction projects and estimated their average contribution. After prioritizing through multi-criteria decision-making methods, it was concluded that employer is the most important factor in delaying construction projects.

In a study entitled "investigating the causes of delay in construction projects in Kish", Majruhi, et al., (2014) used a questionnaire and TOPSIS method. They found that the factors affecting the delay and cost overruns included atmospheric conditions, type of project, organizational factors, employer, consultant and contractor, respectively.

3- Theoretical Background

The price deviation between the initial estimated costs and the actual costs of the projects also occurs in the developed countries. However, it can be more evident in developing countries since most of these countries do not have favorable conditions in terms of political stability, economics, laws and regulations, financial resources, technology, knowledge and skills; this issue can be effective in causing such price deviations.

Most of Iran's metropolitan areas have a large number of large and medium-sized construction projects ran by municipalities. When there is a significant difference between the initial estimated costs and the actual costs of a project, the project will not be performed following the basic budgeting and will result in additional financial burdens. In such circumstances, completion of the project requires new financial costs that the local government may not manage. Such costs impose an additional burden on the economy of a country (Darbani, 2010).

Most large construction projects, such as tunnels, highways, and intersections, are designed to facilitate transportation, reduce traffic, and save time and cost. Therefore, punctual performance within the frame of the designed budget is important. If the projects end up with higher costs and delays, there will be some unfavorable consequences, such as waste of financial resources, urban disruptions and disturbance in traffic, waste of time and cost, distrust and mental burden imposed on citizens, lagging behind metropolitan programs and even the development prospects, decline in foreign investment and many other problems.

The initial cost of a project shows the total estimated cost for project planning and construction up to the completion of the project. This estimation is sometimes called a conceptual estimation, which is usually less accurate than the estimate being made in the subsequent phases of design and bidding (Bent & Humphreys, 1996).

The initial cost is an important component of construction costs and can be used as a basis for being compared with actual cost to check deviations. Time is an important and influential factor in project performances; it leads to cost overruns.

Project planning is an important element in the accurate cost estimation; it determines the order of activities and explains the internal relations of all activities required to complete the project.

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Gould (2002) states that planning is an initial control tool. However, the quality of the raw material required by the contractor can help punctual completion of the project and prevent price deviations. According to Matthews (2002), many factors, such as the lack of accurate estimation and inaccuracy in completing project documents, could increase costs. Other factors, such as unplanned costs, high income estimates, and non-consideration of environmental factors, can also affect price deviations (Flyvbjerg, 2003). In addition, inappropriate design can increase the cost of construction projects. It is important to note that even 1% deviation in the price of large projects will be significant. In a construction project, each section must have close cooperation with other sections to perform the project within the framework of the specified budget. As cost overruns can create significant risks, it is recommended that owners and contractors share this risk (Kormani, 2002). Expenditures such as local labor costs, equipment and material costs, and worker productivity should be precisely estimated. These data can be obtained from previously completed projects. The type of contract can also have a significant impact on price deviation (Darbani, 2010).

Azhar, et al., (2008) pointed to the importance of cost and attention to it during the project. According to them, it is one of the most important parameters of the project and the driving force for project success. Thus, it can be stated that the performance of the project at a given time and proper budgeting are two criteria of project success (Le-Hoai, 2008).

There are four main criteria in project management that require special attention: purpose (scope), cost, time and quality. In order to manage projects successfully, it is necessary to consider whether the project is suitable considering these four criteria (Ali & Kamaruzzman, 2010).

Arguing that cost and time are the main pillars of a project's management, Remfon Fayek Aziz (2013) referred to them as success factors of the project.

Cost estimation before bidding requires extensive knowledge and expertise. The ultimate goal of each company is profitability at the end of each project. In order to achieve this goal, the company must complete the projects considering the budget, the expected duration and qualitative objectives. However, in most construction projects, a sharp cost overrun, especially in small companies, may even lead to bankruptcy. It also causes legal disputes, and in extreme cases the project would be abandoned. Therefore, the employer must accurately identify and eliminate the factors influencing the price deviation (HajiRasooliha, 2012).

In general, several factors can cause a price gap between the initial project cost and the expenses at the end of the work. These factors may occur at different phases of the project. Sometimes in pre-construction phase (i.e., in planning and designing processes), inaccurate estimates, inappropriate planning, inappropriate consideration of all aspects of the project, failure to eliminate opponents, incorrect decisions, and all mistakes made cause the price deviation. In addition, most of the time during the process of construction and performance of the project, factors such as coordination problems between construction workers, lack of high quality materials and machinery, lack of efficient workforce, lack of completed technical documents of the project cause such a

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price gap. On the other hand, some environmental and external factors can also affect the price deviation; factors such as sanctions, inflation, weather conditions, and the weakness of laws and regulations can affect all phases of the project (Hejazi et al, 2015).

In general, there are 16 factors influencing the price deviation, which are derived from the literature. These factors are presented in Table 1.

Table1. Effective factors on the price deviation of the construction projects

No	Factors
1	Management weakness of the employer
2	Budget problems
3	Short preparation
4	Failure to eliminate opponents
5	Management weakness and contractor's experience
6	Incorrect status
7	Lack of knowledge and experience of designers and consultants
8	Shortage of materials
9	Inflation
10	Inappropriate weather conditions
11	Complexity of the project
12	Workforce problems
13	Worn machinery and low quality materials
14	Sanctions
15	Problems with laws and regulations (inadequate administrative bureaucracy)
16	Delay in the completion of the project

4- Research Method

This descriptive-survey study used field methods (i.e., questionnaire and interviews) to identify the factors which affect the price deviation of Shiraz Municipality's construction projects. To determine the weight, rank and classification of factors, Best-Worst method (BWM), Gray TOPSIS and Weight Quality matrix were used. In addition, Excel software was used to analyze the data.

The questionnaire, including16 factors extracted from the literature, was distributed among experts in the municipality of Shiraz and consulting and contracting companies. Six factors were added to the above-mentioned factors, which included the interference of municipality-affiliated organizations in the project, non-competitive choice of contractors, failure to complete the project's technical documents, non-conformity of the contracts with management organization instructions, poor basic price list and the weakness of the national laws (related to the organization of management and municipalities). Then, a Likert questionnaire containing 22 questions was given to the participants to rate the mentioned factors.The respondents included 11 senior managers and experts in the technical and development departments of Shiraz municipality and managers of contracting and consulting companies, who were selected through snowball sampling method. The investigated projects included five intersection projects of Basirat, Sattar khan-Motahari, Ehsan, Delgosha and Ayatollah Mahallati highway in 1392-1389.

Gray TOPSIS

TOPSIS method is one of the accepted methods for multi-level decision making; it is both attractive and practical. The initial form of this method is used to solve

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problems with definite data. However, since there is uncertainty in the nature, and in order to face the ambiguity in these phenomena, one cannot use the two-value logic or definite numbers, and decision-making methods are developed in the conditions of uncertainty. Thus, the researchers developed TOPSIS method with gray and distant data; different frameworks and methods for developing this technique with gray data were presented. Various steps of this applied method are presented below (Razavi, 2014).

Step 1: In the first step, a set of properties and criteria of the alternatives are identified and determined.

Step 2: The second step is the formation of a decision matrix. In this matrix, $\otimes r_{ij} = \left[\underline{r_{ij}}, \overline{r_{ij}}\right]$ is the intersection of each alternative and the criteria, which is the actual information obtained from the alternatives; it is expressed as a gray and limited number.

Step 3: In the third step, the gray decision matrix will be normalized. The gray number $\otimes\left[\underline{n_{ij}}, \overline{n_{ij}}\right]$ shows the normalized number $\otimes r_{ij}$.

$$\otimes\left[\underline{n_{ij}}, \overline{n_{ij}}\right] = \left[\frac{\underline{r_{ij}}}{\sqrt{\sum_{i=1}^{m}\left[\left(\underline{r_{ij}}\right)^2 + \left(\overline{r_{ij}}\right)^2\right]}}, \frac{\overline{r_{ij}}}{\sqrt{\sum_{i=1}^{m}\left[\left(\underline{r_{ij}}\right)^2 + \left(\overline{r_{ij}}\right)^2\right]}}\right]$$

Step 4: In the fourth step, the weights of the criteria are calculated.

Step 5: In the fifth step, the weighted normalized decision matrix will be determined.

Step 6: In the sixth step, the positive ideal and negative ideal solutions will be identified. Lin, et al. and other researchers calculated the positive and negative ideal solutions as follows:

$$A^+ = \{v_1^+ ، v_2^+ ، \dots ، v_n^+\} = \left\{\left(max\ \bar{v}_{ij} ، j \epsilon J\right)\right\}$$

$$A^- = \{v_1^- ، v_2^- ، \dots ، v_n^-\} = \left\{\left(min\ \underline{v_{ij}} ، j \epsilon J\right)\right\}$$

In other words, the positive ideal is the maximum of high points, and the negative ideal is the minimum of low points in the decision matrix.

Step 7: In the seventh step, the separation measure from positive and negative ideal solutions are calculated. Lin, et al., presented the following relations to calculate them:

$$d_i^+ = \sqrt{\frac{1}{2}\sum_{j=1}^{m}\left[\left|v_j^+ - \underline{v_{ij}}\right|^2 + \left|v_j^+ - \overline{v_{ij}}\right|^2\right]}$$

$$d_i^- = \sqrt{\frac{1}{2}\sum_{j=1}^{m}\left[\left|v_j^- - \underline{v_{ij}}\right|^2 + \left|v_j^- - \overline{v_{ij}}\right|^2\right]}$$

Step 8: in the eighth step, the relative closeness to the ideal solution should be calculated. In fact, the separation measure from positive and negative ideal solutions helps one to identify the relative closeness to the ideal solution through the following relation:

$$C_i^* = \frac{d_i^-}{d_i^+ + d_i^-}$$

The higher the C_i value is, the better the i-th alternative will be. Then, the obtained numbers should be compared, and the alternatives would be ranked.

The difference between this method and the commonly used TOPSIS is the gray definition of the variables of the separation measure model. Meanwhile, the determination of the gray relation is modified. In fact, it reflects the influence of the decision theory on the preference of the standard weight. As a result, an agreeable satisfactory solution can be found; the degree of the relationship between each alternative and the positive and negative solutions can also be considered (Chen & Tzeng, 2004).

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Table2. Decision matrix

Indices / alternatives	Project 1		Project 2		Project 3		Project 4		Project 5	
	max	min	max	min	max	min	max	min	max	min
The 1st factor										
The 2nd factor										
The nth factor										

Best-Worst Method (BWM)

Best-Worst method is one of the new multi-criteria decision-making methods proposed by Rezaei (2015). It is based on a systematic pairwise comparison of the criteria. The most important and the least important criteria will be identified. The procedure is described as follows.

There are pairwise comparisons between the criteria using a number from a predefined scale (i.e., 1 to 9). In the Best-Worst method, the paired comparison is done between the most important criterion and all criteria, as well as the least important criterion and all criteria.

First, decision criteria should be identified.

Second, the most important and the least important criteria should be identified by an expert for the sake of paired comparisons.

Third, the preference of the best criterion over all the other criteria using a number between 1 and 9 will be expressed. The best criterion over all the other criteria (BO) is shown with A_B. In fact, a_{Bj} is the preference of the best criterion (B) over the jth criteria. Obviously, a_{BB} is equal to one.

$A_B = (a_{B1}, a_{B2}, \ldots, a_{Bn})$

Fourth, the preference of all the other criteria over the worst criterion using a number between 1 and 9 will be expressed. The other criteria over the worst criterion (OW) is shown by A_w . In fact, a_{jw} shows the preference of jth criterion over the worst criterion. Obviously, a_{ww} is equal to one.

$A_w = (a_{1w}, a_{2w}, \ldots, a_{nw})$

Fifth, in the last step, the optimal weights $(w_1^*, w_2^*, \ldots, w_n^*)$ should be found in a way that the maximum value of the following relations is minimized for all js.

$$\min \max_j \left\{ \left| \frac{w_B}{w_j} - a_{Bj} \right|, \left| \frac{w_j}{w_w} - a_{jW} \right| \right\}$$

$$\sum_j^{s.t.} w_j = 1$$

$$w_j \geq 0, \text{ for all j}$$

or

$$\text{Min } \xi$$

s.t

$$\left| \frac{w_B}{w_j} - a_{Bj} \right| \leq \xi, for\ all\ j$$

$$\left| \frac{w_j}{w_w} - a_{jW} \right| \leq \xi, for\ all\ j$$

$$\sum_j^{s.t.} w_j = 1$$

$$w_j \geq 0, \ for\ all\ j$$

Through the above relations, the optimal weights $(w_1^*, w_2^*, \ldots, w_n^*)$ and ξ^* will be obtained.

Then, based on the maximum preference available in the paired comparisons, the maximal value of the above relation should be divided by the consistency index (which is 5.23 for 9) to achieve the consistency ratio.

$$Consistency\ Ratio = \frac{\xi^*}{Consistency\ Index}$$

The following table shows the consistency index based on the criteria preference.

Table3. Consistency indices based on the maximum preference of the criteria

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a_{Bw}	1	2	3	4	5	6	7	8	9
$Consistency\ index\ (max\ \xi)$	.00	.44	1	1.63	2.30	3	3.73	4.47	5.23

5- Results

As noted in the theoretical background of the study, the factors leading to the price deviation of the construction projects were derived from the literature, and included 16 factors obtained from the construction projects around the world. In addition to the factors derived from the literature, there are some other factors obtained from the case studies and projects of Shiraz Municipality. These factors (see Table 4) were obtained through interviewing experts and filling out the questionnaire.

Table4. Effective factors on the cost overruns (derived from interviews)

No	Factors
1	The interference of municipality affiliated organizations in the project
2	Non-competitive choice of contractors
3	Failure to complete the project's technical documents
4	Non-conformity of the contracts with management organization instructions
5	Poor basic price list
6	The weakness of the national laws (related to the organization of management and municipalities)

The final list of the factors influencing the difference between the initial estimated costs of the construction projects of Shiraz municipality included 22 factors.

After identifying all factors, the experts were asked to rank them in order to express the impact of each of these factors on the projects. In fact, they ranked from much higher degree of impact to much lower degree of impact. Then, in the next step, the Likert scale was used to quantify the qualitative responses; in other words, much higher impact was assigned 5, higher impact was assigned 4, the average impact was assigned 3, slightly lower impact was assigned 2, and much lower impact was assigned 1. After calculating the mean of the responses to each factor, it was observed that 9 factors gained the highest ranks in all projects. These factors included short preparation time, poor basic price list, failure to eliminate opponents, inflation, failure to complete the project's technical documents, non-conformity of the contracts with management organization instructions, the interference of municipality affiliated organizations in the project, workforce problems, and management weakness. Therefore, these 9 factors were weighted based on the Best-Worst method, and their qualities were estimated. Table 5 shows the rank of price deviation factors using gray TOPSIS technique, and the mean of factors.

Table5. The ranking of price deviation factors using gray TOPSIS technique

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Factors	Mean	C_i^*	Rank
Short preparation time	3.11	.6166	1
Poor basic price list	3.03	.6132	2
Failure to eliminate opponents	3.11	.6086	3
Inflation	2.88	.5663	4
Failure to complete the project's technical documents	2.7	.5598	5
Non-conformity of the contracts with management organization instructions	2.66	.5521	6
The interference of municipality affiliated organizations in the project	2.55	.5248	7
Workforce problems	2.51	.5195	8
Management weakness	2.44	.5148	9
The weakness of the national laws (related to the organization of management and municipalities)	2.48	.5107	10
Delay in the completion of the project	2.37	.4980	11
Problems with laws and regulations (inadequate administrative bureaucracy)	2.4	.4971	12
Non-competitive choice of contractor	2.25	.4753	13
Budget problems	2.26	.4713	14
Complexity of the project	2.11	.4491	15
Lack of knowledge and experience of designers and consultants	2.14	.4419	16
Management weakness of the employer	1.88	.4220	17
Worn machinery and low quality materials	1.88	.4188	18
Sanctions	1.85	.4177	19
Inappropriate weather conditions	1.85	.3992	20
Incorrect status	1.48	.3506	21
Shortage of materials	1.37	.3115	22

At this stage, experts conducted some paired comparisons through gray TOPSIS technique, and weighted the 9 factors concerning the importance of price deviation. After filling out the second-phase questionnaire, the same experts weighted and analyzed the data through Best-Worst method. In fact, the weight of each factor was determined. Then, the final weight of each factor was obtained through calculating the mean of the weights assigned by the experts and the normalization of weights. The results are shown in Table 6.

Table6. The weight of the price deviation factors based on Best-Worst method

Factors	Weight	Rank
Failure to eliminate opponents	.1875	1
Failure to complete the project's technical documents	.1595	2
Non-conformity of the contracts with management organization instructions	.1119	3
Short preparation time	.0975	4
Management weakness	.0946	5
Poor basic price list	.0926	6
Inflation	.0923	7
Workforce problems	.0884	8
The interference of municipality affiliated organizations in the project	.0758	9
Total	1	-

In fact, the ranking of price deviation factors had been conducted based on the two methods of gray TOPSIS and mean. However, the most important point is that in many cases although a factor may have high importance and weight in price deviations, it is not so important in terms of quality. Therefore, in the next section, the quality of factors or indices is discussed.

The quality of a factor or an index

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Sometimes, an index (a factor) is important in terms of weight, but does not have the required quality, or vice versa. For instance, suppose that the inflation factor has a high weight concerning price deviation, but it might be weak in terms of quality (e.g., the cost of estimating the price deviation by this factor or the ability to track this factor in causing such a deviation). Thus, considering the weight of the factors alone will not work, and the quality issue should also be considered. Hence, to investigate the quality of factors affecting price deviation, this study examined the criteria determining the quality of factors or indices. In order to determine the quality of the indices, five criteria (i.e., clarity and perceptibility, relevance to the price deviation of the project, economy, adequacy in predicting price deviation, and monitorable changes of the index) were taken into account. These criteria, abbreviated as CREAM, were used to determine the quality of each factor, and were evaluated in a questionnaire composed of the 9 factors determined through gray TOPSIS and Best-Worst methods. There is a noteworthy point regarding the relevance to the price deviation of the project; the factors or indices in the questionnaire are necessarily related to the price deviation of the project since they had been extracted from the literature in the previous stages or had been observed during field surveys and interviews. In fact, these factors are scored in the previous stage questionnaire; the factors are relevant to price deviation. Therefore, the criterion of relevance is removed from the next stage questionnaire, and based on the remaining four criteria, the factors suggested by the experts were evaluated qualitatively.

When the experts filled out the questionnaire, the data were analyzed. To rate the factors based on the above criteria, the qualitative range from very low to very high was used. To quantify and normalize them, numbers from 1 to 5 were used. In other words, very low importance was shown by 1, low importance was shown by 2, moderate importance was shown by 3, high importance was shown by 4, and extremely high importance was shown by 5. Since the economy of measurement is a negative criterion, and the higher it is, the more improper it is, its weight should be subtracted from 6 so that it fits other positive criteria. Table 7 represents the quality rank of price deviation factors based on mean.

Table7. Quality rank of price deviation factors based on mean

Factors	Mean	Quality rank
Inflation	3.75	1
Preparation duration	3.4	2
The quality of basic price list	3.37	3
Opponents	3.37	
The completion of the project's technical documents	3.02	4
The conformity of the contracts with management organization instructions	3.02	
Workforce problems	2.9	5
The employer's management	2.82	6
The interference of municipality affiliated organizations in the project	2.72	7

Using the information in Table 6 (i.e., the weight of the price deviation factors based on the Best-Worst method) and Table 7 (i.e., the quality rank of price

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deviation factors based on mean), a graph showing weight and quality of factors were plotted (see Figure1). In fact, Table 8 summarizes the weight and quality matrix, needed for plotting the graph

Table8. Quality matrix and weight of the price deviation factors

Factors	Mean	Weight
Inflation	3.75	.0923
Preparation time	3.4	.0975
The quality of basic price list	3.37	.0926
Opponents	3.37	.1875
The completion of the project's technical documents	3.02	.1595
The conformity of the contracts with management organization instructions	3.02	.1119
Workforce problems	2.9	.0884
The employer's management	2.82	.0946
The interference of municipality affiliated organizations in the project	2.82	.0758

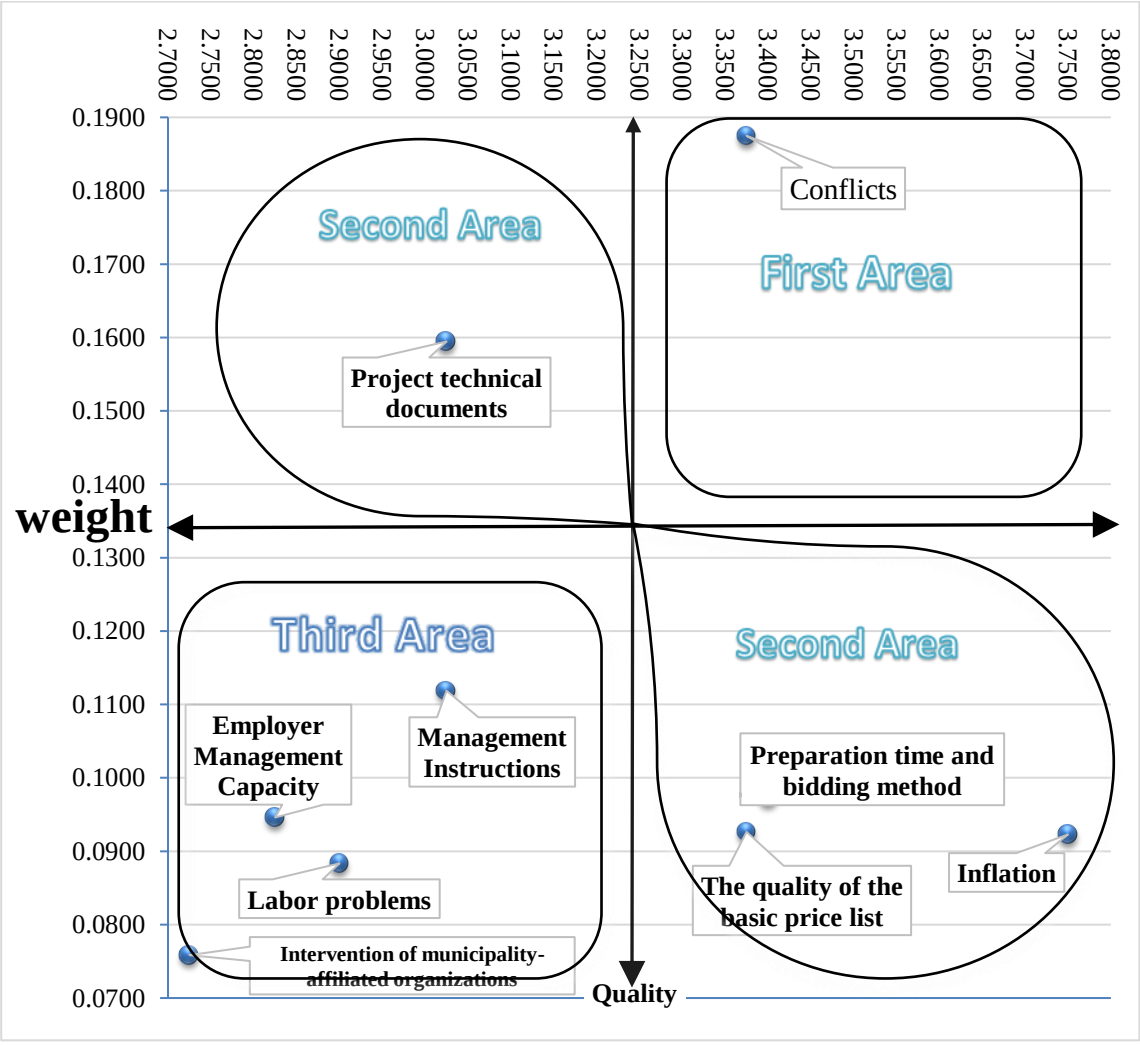


Fig1. Regional distributions of price deviation factors based on two components of weight and quality

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Figure 1 consists of three areas. In the first area, factors have high quality and weight; they are the most important factors. In the second area, factors have high quality and low weight, or vice versa. Finally, in the third area, factors have low weight and quality; they are the least important factors.

The results show that the existence of opponents is the most important factor affecting the cost overruns in the construction projects of Shiraz municipality because this factor has high weight and quality. In the second area, there are important factors, such as inflation, short project preparation time, the quality of price list, and the completion of the project's technical documents. The first three factors are of high quality although their weights are not so high. In addition, although the completion of the project's technical documents is of low quality, it has high weight. In the third area, the conformity of the contracts with management organization instructions is less important due to its low weight. Workforce problems and the employer's management (in the third area) are the next important factors. Finally, the interference of municipality affiliated organizations in the project is the least important factor, which is located in the third area.

6- Conclusion and Discussion

This study investigated and evaluated the factors affecting the cost overruns of the construction projects of Shiraz municipality. The factors were first identified through the literature and the questionnaire. Then, the factors were ranked through TOPSIS technique. In the next step, the 9 identified significant factors were weighted through B-W method. Finally, using the weight-quality matrix, the identified factors were evaluated. The results showed that the existence of the opponents (in the first area) was the most important factor affecting the difference between the initial estimated costs and the actual costs of the construction projects of Shiraz municipality. In addition, important factors, such as inflation, short project preparation time, the quality of price list, and the completion of the project's technical documents, were in the second area. Moreover, the conformity of the contracts with management organization instructions, workforce problems, the employer's management, and the interference of municipality affiliated organizations in the project were in the third area.

To eliminate the 9 identified factors which were classified into three categories, their origins should be attended. For instance, the opponent factor is due to lack of proper management of the employer. Or, the interference of municipality affiliated organizations in the project is due to the management weakness of the employer. Hence, each of the above factors can be distinguished as follows according to its origin:

1. The factors dealing with opponents, the interference of municipality affiliated organizations in the project, the short preparation time, the conformity of the contracts with management organization instructions are due to the management weakness of the employer.
2. Inflation and inappropriateness of the basic price list are due to environmental and external factors.
3. The completion of the project's technical documents is related to the consultant, designer or observer.
4. Workforce problems are due to contractor's management weakness.

To prevent the cost overruns, based on the results of the present study,

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Some implications suggested:

- At the beginning of a major construction project, Shiraz municipality should precisely examine the opponents of the project, if possible, eliminate them through negotiation, consultation or other alternative policies, and begin the project. Therefore, during the performance of the projects, no problems with the opponents would be evident. More specifically, they can interact with other government organizations to eliminate the government opponents.

- Shiraz municipality and consultants should set up contracts in full compliance with the management organization instructions.

- The interference of municipality affiliated organizations in the project should be prevented.

- Non-scientific and false biddings in which contractors make non-standard and unusual suggestions to access the projects should be avoided.

- Opening the construction projects while ignoring the preplanned schedule due to political, cultural and other reasons should be avoided. For instance, it has been observed that a planned project takes time to be completed; however, it is tried to be finished sooner than expected due to a specific occasion and the trip of a senior government official; it causes unexpected costs. Similarly, a project might be completed. However, they refuse to use the construction until the arrival of a responsible authority. Thus, not only time is wasted, but also citizens would be damaged because of the blocking of the path next to the construction.

- It is recommended that the municipality select the contractors from the private sector, and assign fewer projects to its contractors and the government sector.

- It is recommended that Shiraz municipality uses an expert group including civil, managerial and economic experts to operate and optimize various project processes. In this way, the team will interact and co-operate with each other from the planning and decision making stage in an executive manner; they carefully consider all the steps and details of the project in their analyses. This will continue in the design and performance phases.

- The municipality or employer should have a complete supervision over the consultants or observers' completion of the projects' technical documents.

- It is possible to identify the factors influencing the cost overruns of the construction projects of Shiraz Municipality such as the Kuhsar Mahdi tunnel, Moalem Square, Vali-e-Asl bridge, and some other projects in 1392-1396, or apply the same process for medium sized construction projects so that the factors affecting the price deviation of the projects and the importance of these factors would be identified. On the other hand, it is suggested to use other scientific methods such as Fuzzy TOPSIS, Fuzzy AHP, SAW and ELECTRE methods to study the significance and rank of these factors. Finally, it is recommended that these factors be evaluated for non-construction projects, such as services.

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