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An Integrated Model for Evaluation of Construction Projects

Aliakbar Eghbali*
Department of Civil Engineering, Yazd Branch, Islamic Azad University, Yazd, Iran
Corresponding author:Eghbalialiakbar@yahoo.com

Ahmadali Fallah
Department of Civil Engineering, Yazd Branch, Islamic Azad University, Yazd, Iran
ahmadali.fallah@maybodiau.ac.ir.

Abstract

It is an inevitable necessity to conduct technical and economic feasibility studies on construction projects to make relatively sure about the accurate application of national capitals regarding economic development and social welfare. Accordingly, the extant study aimed at providing an integrated model to evaluate construction projects. The data obtained from questionnaires were assessed through SPSS software. The designed questionnaire included 26 items that were divided into five groups and criteria. Technical, economic, environmental, social, and cultural criteria were employed in this research. According to the obtained results, 26 items were ranked based on the answers to questionnaires, and weights were assigned to each item based on the effect size of each case. Therefore, the technical criterion had the highest weight while the environmental criterion had the lowest weight. All criteria with maximum weights must be inserted into equations to achieve the most efficient feasibility studies to onset executive operations. To do so $Obj = Maximize\sum S$ was designed; where S represents feasibility studies. The purpose of this study was to maximize the efficiency of the aforementioned equation by using examined criteria.

Keywords: Construction Projects, Providing an Integrated Model, Technical Criterion, Environmental Criterion

INTRODUCTION

Feasibility studies are also known as justification, planning, identification, or pre-investment studies. Regarding the significance of feasibility studies that require high cost and time during the pre-investment stage, these studies are done within several stages to screen superior alternatives and carry out an extensive study and final feasibility before doing any final measure. In this case, investment is done only on the final project. Feasibility studies might be done within three stages, including identification of facilities, initial feasibility, and final feasibility. The technical-executive system of construction projects of Iran that is designed by management and planning organizations defines the stage of facilities identification in the step before preparing projects or the step of fundamental development, spatial planning, regional, and other types of studies. In this stage, investment areas and opportunities are usually determined and introduced based on the regional advantages in terms of natural and social aspects, demand, as well as general security, political, environmental, and cultural considerations. In centralized planning-based systems, feasibility studies are done by states to provide a guideline for public and private sectors in choosing investment projects. In free economies that centralized planning is not performed, demand is determined based on the market studies. Hence, feasibility studies differ from each other in terms of studies on demand, capacity determining, and project location (Islami, 2012).

There are many issues, including resource shortage, cost requirements, time, quality, safety, and environmental problems in most projects and plans. Sometimes, the projects are launched without considering theoretical steps, studies, and credit facilities, and such projects remain in the launch stage or are ended by spending more cost and time. According to the lack of cultural and

historical background of the opening ceremony, sometimes this ceremony is not taken seriously by different individuals making it insignificant in the viewpoint of the [public. On the other hand, the pickaxe that is used in the opening ceremony is a symbol of destruction instead of construction and development in Iranian culture.

Regarding the situation of imperfect, inadequate and undesired feasibility studies in the framework of construction projects, as well as certain rules or regulations in practice have made executive, planning and management organization to make decisions about construction projects based on the opinions and ideas existed in the feasibility report. Necessities of a project include the coverage area of issues and their depths in feasibility studies. On the other hand, it is required to determine choices in different study steps based on which bases, and it should be found that the whole project must be evaluated based on what criteria. By the passage of time, the necessity and importance of some investments not only did not improve study method and report preparation but also made their content more confusing.

Azimi Moghadam (2008) carried out a study to examine steps taken in feasibility studies of dam projects in the framework of project management in three planning, executing, and monitoring steps. Bemanian et al. (2009) explained in their research that construction and design system is one of project executing methods, especially in civil projects that are widely used in project implementation because of the integration between design and construction, acceleration execution time, and having a single responsibility for the whole project process.

Mirhashemi and Mahdizadeh Sari (2011) explained, based on clause 10 of Article 1 of Iran's Budget and Plan Law, construction projects must be selected and executed based on the technical and economic feasibility studies. Feasibility study means collecting data and analyses used to determine the effectiveness of the projects so that it is ensured that all desired alternatives of different solutions have been studied to meet one or more needs of society. In this case, the best option is chosen. A safety plan for schools is a construction project that is subjected to two general solutions of seismic recovery, destruction, and reconstruction. The correct option selection has been a critical point in the process so that this case has affected the macro-financial planning of the country.

Afshar Najafi and Jannatifard (2012) proposed a mathematical model of project scheduling with resource constraints. Shakeri et al. (2012) examined some cases of contracts signed by Consulting Engineers Companies, and their weaknesses and strengths that indicated some considerable results. Accordingly, it is possible to increase motivation in Consulting Engineers Companies to take part in tenders and give this chance to smaller counseling entering to such tender-based competitions by reforming tenders' processes and considering some factors, such as backgrounds and technical team. Farrokhizadeh and Akbari (2014) explained in their study that construction project management is along with some unpredicted situations in planning and building public and private facilities required for the actualization of society's needs.

Ibrahimnejad and Khalilzadeh (2014) expressed in a study there have been many evolutions in performing projects and plans in today's world especially in industrial projects, including the oil industry, power plants, and infrastructural projects that are affected by technological changes. In this research, six employers with executive experiences in different techniques were surveyed, and then after these opinions were analyzed based on AHP fuzzy technique the confirmability of methods was presented. Farrokhizadeh and Kamalvand (2014) expressed in research that all managers tend to accelerated projects or reduce any distorting in the projects; nevertheless, the average deviation of time and cost in construction projects of Iran is usually greater than the predicted rate despite the detailed planning seen in the early stage of these projects. As a factor affecting delay in construction projects, the nature of planning of these projects has remained neglected.

Farrokhizadeh and Tavakolinia (2014) expressed in a study that it is helpful for Iran's economy under the current crisis to pay attention to the construction sector, create motivation and incentives for engineers allowing them to enter the construction sector that is not dependent on the

foreign sector, is a job-creating sector, stimulates other economic sectors, and meets the housing shortage. Samee Ghahfarrokhi et al. (2014) explained in their studies that an active and futuristic look in Iran requires a vision management-based movement that is relied on the identification of the current situation and its factors, analysis of the national and international environment, and illustration of the desired perspective. It has been tried to achieve the mentioned goals by assessing one of the aspects of this document, which is general policies related to construction projects that lead to the execution of construction projects in the country and are determinable based on the policies seen in the outlook document of executable construction projects in Iran. Karimipoor et al. (2015) explained in research that studies show that most large construction projects in the world experience about more than 50% rise in cost. The main objective of this study was to identify and examine factors affecting delays in construction projects to propose solutions to reduce the delay in projects.

Fili et al. (2015) explained in a study that a neglected but important point is construction management that may cause longer project execution and higher cost than the initial estimates. Research results implied a significant relationship between financial factors and timely execution of construction projects during the Fourth Economic Development Plan in Ilam, Iran. The correlation coefficients indicated a direct and positive relationship between financial factors and the timely execution of projects. Mardani Mahaleh (2015) expressed in research that projection management of construction workshops is one of the substantial steps pre-onset and onset of construction of a civil project so that management of this step highly affects the efficiency of the construction-to-operation process of the project. This study aimed at identifying a case study of a large construction workshop and selecting the pre-step of facilities located in the workshop by using the selective references and opinions of experts in workshop facilities.

Kamalvand (2015) explained in research that construction management deals with many unpredicted situations in planning and construction of public and private facilities that are required for actualizing society's needs. Some new or critical problems that occurred in the construction industry over the recent years include environmental and legal controls, energy cost, and possible access to it, changing public tastes, and economic conditions. Jahri et al. (2015) explained in research that considerable executive techniques have been presented and used to apply value methodologies in construction projects. Reduction in cost and time of projects' execution within three steps of feasibility, design, and execution by keeping and even improving their qualities using value management leads to optimal use of limited resources and shorter time of return on investment.

Alipour and Bodaghi (2016) carried out a study to identify and rank the legal barriers to construction projects of Tabriz Monopoly Municipality from the viewpoint of employers and consultants. Baradari and Sobhieh (2016) explained in research that undesired performance and conflicts in construction project teams were one of the problems that construction projects face since these problems had negative effects on project achievement of the goals defined in the contractor company. According to the obtained results, if the project onset process is not used in the contractor part of construction in a structured form, there will be some difficulties in projects such as conflicts in the project team and delays in project execution. Vosough and Aghajeri (2016) conducted a study and introduced construction projects, such as dam projects and their pollutant effects on the environment as critical points of high significance. According to the obtained results of this study, environmental criterion (with a correlation coefficient of 0.80) had the highest effect on feasibility studies of dam construction followed by economic criterion (0.75), and the social criterion (0.47).

Taher Toloodel and Valizadeh (2017) found that there would be an increase in project success, economic benefits, desired velocity in non-delay, and sufficient satisfaction of benefactors if the project manager considered the efficacy concept. Hashemi and Robati (2017) introduced the fuzzy network analysis process as a tool used to rank different success criteria for construction projects. Regarding the lack of perception of project success criteria in local scopes, this study could be considered as one of the initial attempts in

improving construction projects, including rural construction projects. Rabiee (2017) explained in a study that delay is one of the common factors in construction projects that not only increase construction cost but also cause a delay in project productivity. Considering the necessity of the subject, Rabiee examined some ambiguities, conflicts, and shortcomings in the general situation of construction projects based on the case study of Articles 28, 37, 48, 49. In the next step, some recommendations were propose based on the aforementioned factors in general terms of the contract.

By the passage of time, the necessity and urgency of some investment not only could not improve feasibility study method and report but also made its content more confusing. Sometimes, the simplest popular concepts of project assessment have been changed in these reports. Some reports have been written with a vague structure that is not understandable for readers.

Hence, it is tried to present simple, understandable, and practical techniques in the frame of construction projects to evaluate the project based on a dynamic and standardized model for feasibility studies to help relevant executive organizations use them to do their daily tasks. This study aimed at providing a simple and pragmatic model compared with complicated theorizing. However, this model did not discuss the economic evaluation of investment projects.

The extant study aimed at identifying evolution stages of construction projects, efficiency and effectiveness of investment projects with a result-oriented approach, identifying beneficiaries, real and legal individuals with shared interests in the performance of projects or plans, and achieving desired results from management of procedures. The aforementioned results can be achieved by managing their associated activities and resources through a process. Therefore, the present study was conducted to provide an integrated model for the evaluation of construction projects.

Method

The extant study was applied research in terms of objective, a qualitative-quantitative study in terms of approach, and exploratory research in terms of objective. The present study is of exploratory type because aims to provide a dynamic model for executive operations onset. In the qualitative part, literature foundations were formed and a theoretical framework was extracted from bibliographic references. In the quantitative step that was used to make the qualitative part valid, the descriptive-analytical method was employed. References were searched, and a literature review was conducted based on the documentary or bibliographic technique. A researcher-made questionnaire and note-taking from bibliographic references were used to collect data. The extant study was survey research with case study since the data of the studied population were gathered from questionnaires. The statistical population comprised 200 engineers and managers working in investment projects of the construction industry in all executive organizations and public-private joint investment projects in the construction industry that are connecting to these projects directly or indirectly, and have information about planning methods and feasibility studies of projects. The sample size was calculated by using the Cochrane formula (n=131.751148913). The sample size equaled 132 based on the error level of 5% in the Morgan Table. Data and output analysis were done through SPSS software.

Findings

The purpose of the extant study was to provide an integrated model for the evaluation of construction projects. The results obtained from questionnaires and SPSS software have been examined in this section. The questionnaire included 26 items that were assigned to five categories or criteria (technical, economic, environmental, social, and cultural criteria). For accurate completion of questionnaires, 130 questionnaires were prepared and sent to Municipality, Social Security, Water and Sewage, Regional Electric, Agriculture, Budget, Plan, and Planning Organizations.

According to the effect of technical, economic, economic, environmental, social, and cultural criteria on feasibilities studies of construction projects, a model was provided in the present paper to evaluate these projects under different circumstances. To do so, 26 items designed in the

questionnaire were ranked based on the answers given to items, and different weights were assigned to them based on their effect sizes. Therefore, the weight of each criterion was obtained (Figure 1) using items related to each criterion. According to Figure 1, weights of technical, economic, environmental, social, and cultural criteria equaled 0.31, 0.20, 0.11, 0.18, and 0.20, respectively. Therefore, the technical criterion obtained the highest weight, while the environmental criterion had the lowest weight.

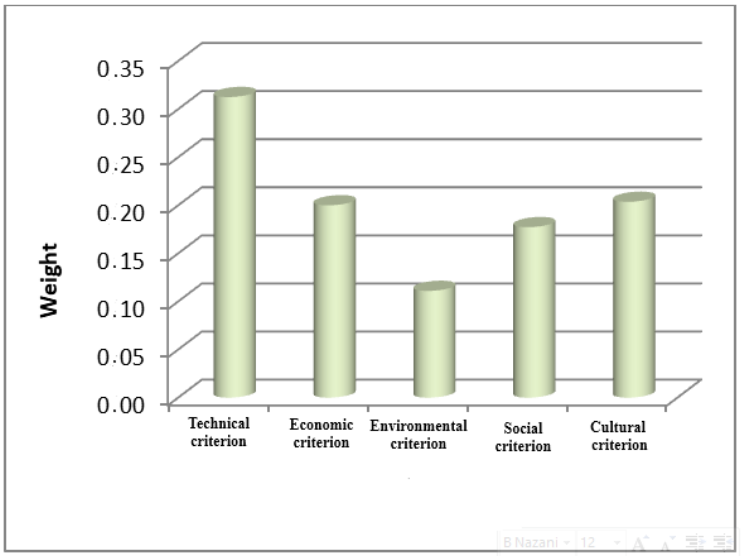

Figure 1. Weighing Criteria

Each criterion has some subcriteria that questions have been designed for them. Accordingly, weights of subcriteria have been depicted in figures 2-6. Figure 2 illustrates the weights of technical subcriteria. According to Figure 2, subcriteria 5 and 6 had the highest and lowest weights, respectively. Figure 3 presents weights of subcriteria of economic criterion. According to Figure 3, subcriteria 21 and 6 had the highest and lowest weights, respectively. Figure 4 presents weights of subcriteria of environmental criterion. According to Figure 4, subcriteria 21 and 6 had the highest and lowest weights, respectively. Figure 5 presents weights of subcriteria of social criterion. According to Figure 5, subcriteria 3 and 12 had the highest and lowest weights, respectively. Figure 6 presents weights of subcriteria of cultural criterion. According to Figure 6, subcriteria 8 and 9 had the highest and lowest weights, respectively.

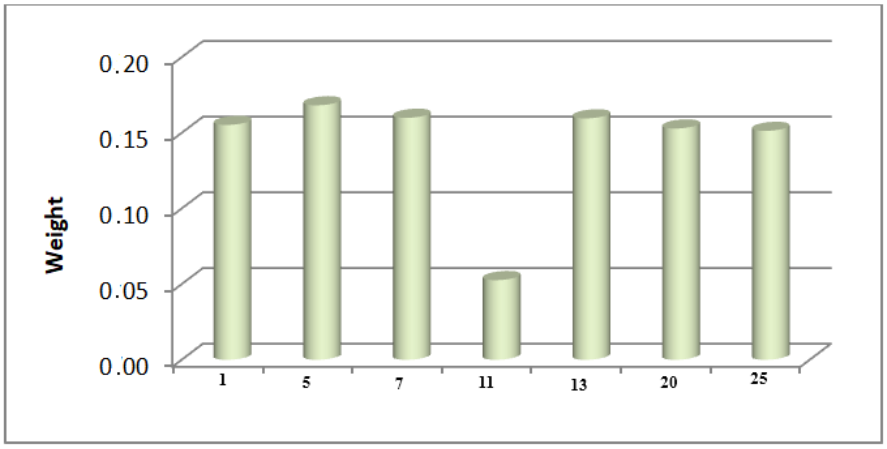

Figure 2. Weights of subcriteria of technical criterion

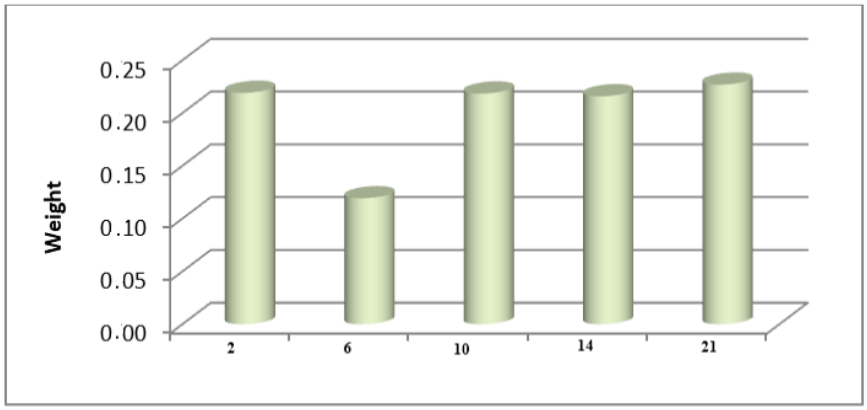

Figure 3. Weights of subcriteria of economic criterion

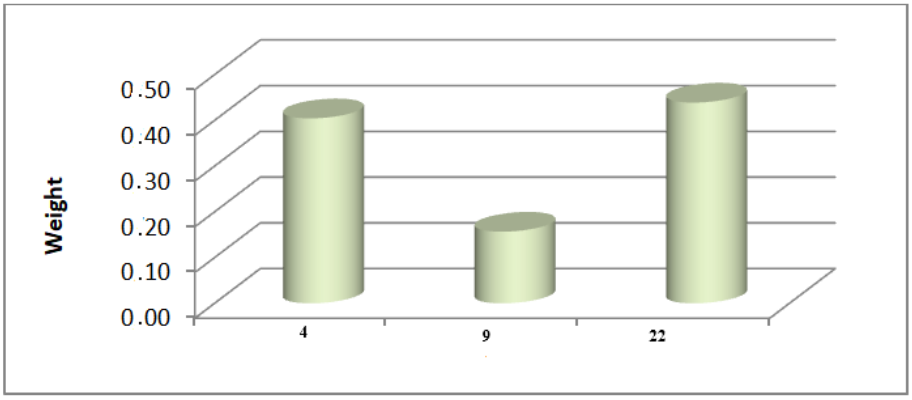

Figure 4. Weights of subcriteria of environmental criterion

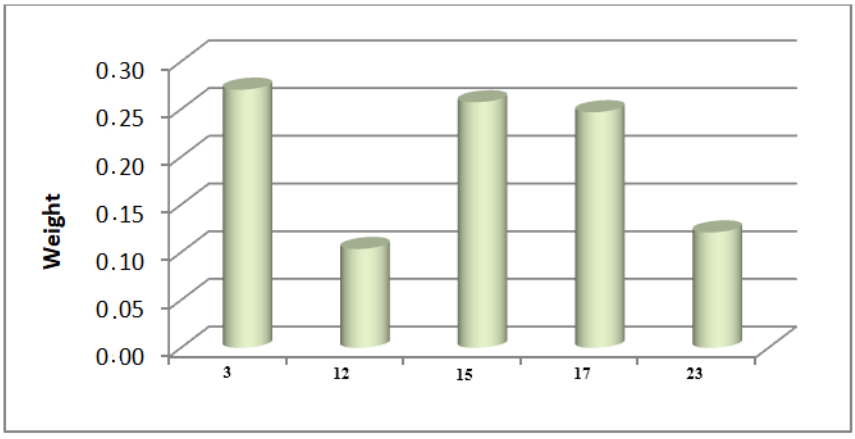

Figure 5. Weights of subcriteria of social criterion

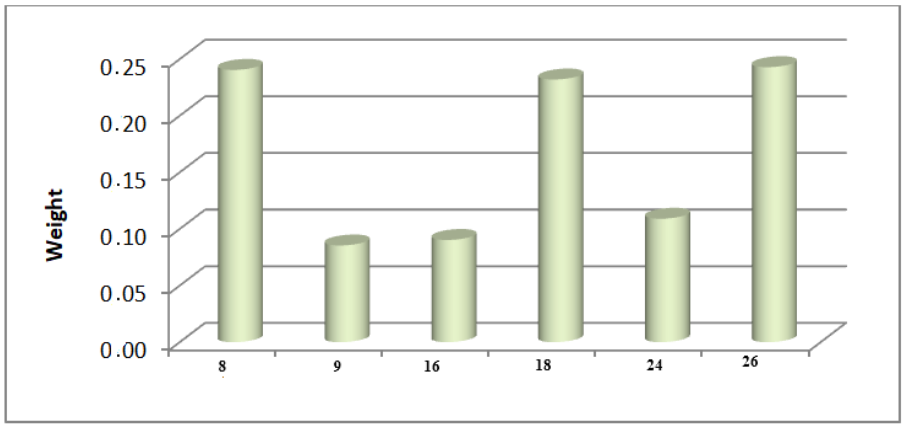

Figure 6. Weights of subcriteria of cultural criterion

According to the obtained weights for criteria and subcriteria, the purpose of criteria valuation is to provide a model for feasibility studies of construction projects. Therefore, all criteria with maximum weights must be entered into the equations to achieve more efficient feasibility studies for executive operations onset. To this end, equation (1) has been designed:

(1) $$Obj = Maximize \sum S$$

Where S represents feasibility studies aimed to maximize the efficiency of these studies using criteria examined in this research. Therefore, $\sum S$ has been presented based on Equation (2):

(2) $$\sum S = w_1 \times criteria1 + w_2 \times criteria2 + ... + w_5 \times criteria5$$

Where, $criteria1$ to $criteria5$ indicate criteria 1-5, and w_1-w_5 shows weights of criteria 1-5. Weights of technical, economic, environmental, social, and cultural criteria (criteria 1-5) equaled 0.31, 0.20, 0.11, 0.18, and 0.20, respectively. Therefore, Equation (2) is rewritten as Equation (3):

(3) $$\sum S = 0.31 \times criteria1 + 0.20 \times criteria2 + 0.11 \times criteria3 + 0.18 \times criteria4 + 0.20 \times criteria5$$

Each criterion has some subcriteria leading to more efficient feasibility studies. Therefore, Equation (13) is converted to Equation (4):

(4)
$$\sum S = 0.31 \times \left[\alpha_{1,1} \times subcriteria_{1,1} + \alpha_{1,2} \times subcriteria_{1,2} + ... + \alpha_{1,n} \times subcriteria_{1,n} \right]$$
$$+0.20 \times \left[\alpha_{2,1} \times subcriteria_{2,1} + \alpha_{2,2} \times subcriteria_{2,2} + ... + \alpha_{2,m} \times subcriteria_{2,m} \right] + ...$$
$$+0.20 \times \left[\alpha_{5,1} \times subcriteria_{5,1} + \alpha_{5,2} \times subcriteria_{5,2} + ... + \alpha_{5,k} \times subcriteria_{5,k} \right]$$

Where $\alpha_{1,1}$ - $\alpha_{1,n}$ indicate weights of subcriteria 1-n of criterion 1; n, m, and k represent the number of subcriteria. $subcriteria_{1,1}$ - $subcriteria_{1,n}$ represent subcriteria of criterion 1. For instance, weights of subcriteria 1, 5, 7, 11, 13, 20, and 25 of technical criterion (criterion 1) equaled 0.16, 0.17, 0.16, 0.05, 0.16, 0.15, and 0.15, respectively. Therefore, α_{11} - α_{15} equal the aforementioned values. According to the mentioned points, equation (4) is rewritten as equation (5):

(5)
$$\sum S = 0.31 \times \begin{bmatrix} 0.16 \times subcriteria_{1,1} + 0.17 \times subcriteria_{1,5} + 0.16 \times subcriteria_{1,7} \\ +0.05 \times subcriteria_{11,1} + 0.16 \times subcriteria_{1,13} + 0.15 \times subcriteria_{1,20} \\ +0.17 \times subcriteria_{1,25} \end{bmatrix}$$
$$+0.20 \times \begin{bmatrix} 0.22 \times subcriteria_{2,2} + 0.12 \times subcriteria_{2,6} + 0.22 \times subcriteria_{2,10} \\ +0.22 \times subcriteria_{2,14} + 0.23 \times subcriteria_{2,21} \end{bmatrix}$$
$$+0.11 \times [0.4 \times subcriteria_{3,4} + 0.16 \times subcriteria_{3,9} + 0.44 \times subcriteria_{3,22}]$$
$$+0.18 \times \begin{bmatrix} 0.27 \times subcriteria_{4,3} + 0.10 \times subcriteria_{4,12} + 0.26 \times subcriteria_{4,15} \\ +0.25 \times subcriteria_{4,17} + 0.12 \times subcriteria_{4,23} \end{bmatrix}$$
$$+0.20 \times \begin{bmatrix} 0.24 \times subcriteria_{5,8} + 0.09 \times subcriteria_{5,9} + 0.09 \times subcriteria_{5,16} \\ +0.23 \times subcriteria_{5,18} + 0.11 \times subcriteria_{5,24} + 0.24 \times subcriteria_{5,26} \end{bmatrix}$$

According to equation (5) in which subcriteria related to each criterion have been considered as variables, their values are determined based on the subcriteria examined in each construction project. For instance, $subcriteria_{1,1}$ equals 1 if subcriterion 1 of criterion 1 is performed to start executive operations, meaning that feasibility studies of construction projects include all technical aspects to start executive operations, 0, otherwise. In terms of subcriterion 9 of criterion 3, $subcriteria_{3,9}$ equals 1 if the opening stage is done after completing feasibility studies of civil projects, 0, otherwise. Therefore, equation (5) is a dynamic model for executive operations that evaluated the criteria of feasibility studies.

Conclusion

The incomplete, inadequate, and undesired feasibility studies on most construction projects, lack of certain rules or regulations have made executive and management-planning organizations make decisions about construction projects based on the tastes and opinions that dominated the feasibility report. The necessary issue issues of each project include that feasibility study covers what issues with different importance levels, choices are done based on which bases within different project stages, the whole project is evaluated based on which cases.

Hence, it is attempted in most construction projects to provide a simple, pragmatic, and understandable method to evaluate the project to present a dynamic and standardized model for feasibility studies. In this case, associated executive organizations can use such models to do their daily tasks since these methods or practical and simple with the less complicated theorization of macro-purposes. However, this plan did not discuss the economic evaluation of investment projects.

It is essential to have a flexible program and model covering all subcriteria affecting the project to achieve the goal of deploying an integrated system and to create investment projects. Furthermore, optimal results will be obtained from processes management by identifying the evolution stage of construction projects, efficacy and effectiveness of investment plans and projects with a result-oriented approach, and identifying real and legal individuals who have shared interests in the performance of projects. The mentioned result will be achieved if relevant activities and resources are managed within a process.

The obtained results of this study ranked the designed 26 items based on the answers given to questions, and weight was assigned to each of them based on the effect sizes. Therefore, the technical criterion had the highest weight while the environmental criterion had the lowest weight. According to the weights of subcriteria associated with technical criteria, subcriteria 5 and 11 had the highest and lowest weights, respectively. According to the weights of subcriteria associated with economic criterion, subcriteria 21 and 6 had the highest and lowest weights, respectively. According to the weights of subcriteria associated with environmental criteria, subcriteria 3 and 12 had the highest and lowest weights, respectively. According to the weights of subcriteria associated with cultural criteria, subcriteria 8 and 9 had the highest and lowest weights, respectively.

Therefore, all criteria with maximum weights were entered into the equations to achieve more efficient feasibility studies for executive operations onset. To this end, the equation $Obj = Maximize\sum S$ was proposed where S represents feasibility studies that aim to maximize the efficiency of these studies using criteria examined in this research.

This equation indicates a dynamic model for executive operation onset that evaluates the criteria of feasibility studies.

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