Research Article

Selecting a model for infrastructure projects contracts using multi-criteria decision-making system (AHP group)

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1. Introduction

Public-private partnership projects including B.O.T, this service is not only to finance public sector projects to be implemented, but also to increase the quality and effectiveness of service listed before in partnership with public and private sector. In Iran, much research has been done on the shortcomings in the current contracts and somewhat EPC options alongside the conventional contracts have become a familiar option for the decision makers. Turning to the public and private contracts including B.O.T contracts in situations where more than ninety percent of infrastructure projects are performed in the three-factor model and few contracts in EPC in Iran, some research and opinions of experts in this field and the experience in other countries are required. Due to the fact that in developing countries including Iran, one of the most fundamental problems is to finance a large budget for the infrastructure projects and also common contracts in most countries are losing their popularity, and in this field, experts and authorities need to be more familiar with the types of contracts, such as contracts and its benefits and to reduce the costs, they can use the best type of contracts.

1.1. Introduction and reviewing the existing options

Conventional contracts or three-factor contracts

This method is also known as traditional, triangular or three-factor method and it is the most common method to build projects [1]. In this method, the employer hires the designer [consultant], contractor [builder of the project] by separate contracts. Many public and private employers use this method on the projects that the beginning of the construction requires the end of the design [2]. After determining the needs of the employer, he signs a contract with the consultant for the project and after finishing the design and preparation of the tender documents, and the project goes for the public competitive or limited bidding and due to the agreement, groups of employers or a general contractor are chosen to execute the construction phase of the project. The feature of this method is the separate relation of the consultant and the contractor with the employer. In this method given that in most cases, the consultant is responsible for the overseeing the project, the project management activities as an ancillary activity leave to the consultant as an employer. Generally in this method, both the consultant and the employer are required to notify the problems occurred in the mutual and they will be responsible for the lack of notifying these problems. The quality of the project increased due to this issue [3].

1.2. EPC

The projects which are performed by the EPC and DB method have specific executive features. This focus on planning is to control and accelerate the simultaneous activities and to maintain the quality of implementation. The company which accepts the responsibility to execute the project by EPC method is committed to implement a set of parallel activities in terms of project schedule [4]. EPC method, according to a general defini-
tion, has three major components: (engineering), (procurement), (construction). But the issue goes beyond and deeper than the combination of three words. In fact, the process of handling, delivery time, and anticipated costs and considering the risks of projects are the part of EPC projects. Each of the three stages has subsets which are used for better understanding, and to do these projects properly and timely, it is necessary that managers of the employer and consultant companies, who are involved in the contracts, have sufficient knowledge about the three stages. In the recent years in Iran, the employer’s trend to construct the projects by EPC method have been increased. Particularly in the oil and gas industry, it has a long history. Because the technology needed to run oil and gas structures and relevant studies were unique, and utilities and equipment manufacturers and oil companies, which are mainly related to the West, deliver the total package design and the performance to the employer. But in other industrial sectors, such as construction projects, the tendency to do the projects via EPC method is increasing.

1.3. Build, Operate, Transfer (BOT)

BOT stands for Build, Operate, and Transfer. Constructing a project via the BOT method is one of the best ways to build important and costly infrastructures for the host country as well as a phenomenal way to supply electricity, because plant construction is one of the most expensive cases. This is a great way to raise funds to help the country in the construction of other infrastructures such as roads, railways, health, and job creation that in the current situation in Iran, with a rapid cycle of growth and development is very timely [5]. Simply, specific types of contracts are advanced and complicated which are used for the construction of the infrastructures such as power plants, airports, highways and generally the other infrastructures projects that outsource the entire operation of the project for a specified period of time to the company and the consortiums in terms of strategic, it is not considered as a risk, and in fact, the government render this project to the joint consortium of the employer, consultant, bank, insurance and etc. and after the construction, the government allow them to exploit it for a specified period of time and after the specified period of time, the project is owned by the government without any payment, and in some countries, such as Australia, the government leave the ownership of the project to the company [6]. Perhaps the first BOT project in Egypt which was based on the BOT system has been the construction of the Suez Canal and its management [7]. For the first time, the term BOT was prevalent in the 1980s when the Turkish government put out patent of few plants to transfer for a specified period of time to the companies and the consortia based on four principles are:

Adverse conditions, the homogeneity, the dependence and the expectations. Paired comparisons criteria together and alternatives based on criteria by the specified values are shown in the table below.

1.4. Review of Literature

Al Sobhi and et al. studied the application of AHP in the project management in system project selection. The authors used a hierarchical structure (AHP) for the criteria of screening potential contractors [9]. Farajiyan and et al. called PPP method as an innovative delivery method that has been used as an option to boost public investment. Their research suggests a multipurpose decision support system which can integrate the qualitative and quantitative aspects of the PPP method [10]. Aybas and et al. have focused on explaining conventional approaches of DB and DBB in their research. They investigated the effect of temporal changes in the different types of projects in their study [11]. Mitkus and et al. examined the applications of AHP method in the field of construction in their study. In this article, the applications of AHP in the construction industry have been discussed. They recognize the choice of the appropriate conventional model as hierarchical analysis and multi-criteria decision task [12]. Kanchy attempted to offer a decision system for the project delivery options in his research. First, he surveyed the DBB methods. Then, using the decision tree, they begin to choose an alternative [13]. Tiung and et al. defined BOT as: a step forward to meet the needs of developing countries which help them to invest more in infrastructures. This paper describes six important success factors (CSF) deals with contracts [14].

2. Materials and Methods

In this study, one of a group decision support tools called analytic hierarchy process has been used. Paired comparison is based on a hierarchical process. This technique was developed in 1980 by Thomas L. Saati, and from then on, to solve the multi-criteria decision making issues, paired comparisons technique is used to select an option. As mentioned before, process means that to decide and choose an option from many options available, the two given criteria are compared and precedence over any other on each criterion is acquired, and after applying the criteria weights and the results, the option that makes the most points is chosen. This technique is based on four principles are:

Table 1. The Paired comparisons criteria together and alternatives based on criteria by the specified values

<table>
<thead>
<tr>
<th>a) Relative comparison of i on j</th>
<th>c) Degree of relative importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>b) (in relation with decision daily)</td>
<td></td>
</tr>
<tr>
<td>e) Equal importance (1)</td>
<td></td>
</tr>
<tr>
<td>f) Low importance of i on j (1)</td>
<td></td>
</tr>
<tr>
<td>g) High importance of i on j (1)</td>
<td></td>
</tr>
<tr>
<td>h) Very high importance of i on j (1)</td>
<td></td>
</tr>
<tr>
<td>i) Absolute importance of i on j (1)</td>
<td></td>
</tr>
</tbody>
</table>

For example, if $a_{21}=3$ is computed by DM, the second index is a little more important than the first index. These points show the mean values and DM can use them [15].

2.1. Identifying the factors influencing the choice of model contract

According to several criteria which is considered to choose a model contract for the project, choosing an optimum method to run the project is a multi-criteria decision issue. To solve this multi-criteria decision issue, first, the factors affecting the choice of optimum method to run the project should be selected carefully and then the relative weight should be assessed. To identify the factors affecting the choice to run the project, researches including the study of literature in this field a comprehensive survey of internal project managers were provided. In this study, the primary and the reference texts on management of infrastructures projects and the advantages and disadvantages of these projects have been considered and factors and methods have been extracted.

2.2. Claims and less contractual disputes

Due to the subjects mentioned before, we found that one of the disadvantages of three-factor method is the differentiation of the designer and the manufacturer organizations that in many cases, the revision will be implemented during the design which has a cost and time. Generally in this method, responsibility lacks transparency and the project risks cannot be divided properly. Using this method leads to numerous claims by consultants and employers. Claims problem and disputes between the contractor and the employer of the contractual model is so important that theses, dissertations, articles and
many books have been published in this field and the decision maker without considering this factor definitely will not be able to choose the best option.

2.3. Less effect of sanctions on the project
One of the factors that lead to the project delays and thereby increase the project time, reduce quality, reduce profitability is the delays in the payment of the statements made by the employer to the contractor. Regarding to this issue that Iran is already under sanctions and the displacement proceeds from the sale of oil and non-oil exports and even transfer funds in foreign currency accounts in international banks are the problems and Law pay for infrastructure projects has become a very costly and time consuming issue. Hence, if we choose a formal model which can neutralize these effects, these effects may be less and certainly the employers, contractors and the users of the project will be benefited.

2.4. The project cost
Naturally, to implement a project, far from being a public or a private employer is looking for ways to accomplish his projects. Hence, in decision making, it is one of the most important factors of cost of the project.

2.5. Employer payment method
In general conditions, strategic management and supervisory circulars allows the employers to verify the legal delays caused by delays in claims payment from the contractor; While the failure to pay the payments of the contractor by the employer destroys the organization. However, this factor is one of the factors that play the role of BOT contracts and other contracts in decision making process.

2.6. Flexibility against changes during the project cycle
During the implementation of infrastructure projects, due to the long duration and extensive, construction occurs during the project life cycle or the needs of the employer due to the infrastructure projects change that the flexible nature of the contractual model against these changes is an important factor in the long-term goals for the employer.

2.7. Project duration
Project completion time and all the factors that increase or decrease the duration, have effects on the selection process. Shortening the project time means the increase of the operation time and the profitability of the project. But this factor in infrastructure projects has different meanings. For example, some of the infrastructure projects prevent the currency out of the country and we find that the influence of these factors on the time will have the greatest impact on the economy.

2.8. Admittance of new technologies
Always the admittance of new technologies to the developing countries occurs with delays, and sometimes it takes years for a new technology to be imported to the country which has some reasons. Such as:

- Some conservative leaders
- Unwillingness of the executive contractors and the consultants into areas where they are not experienced.
- Failure to inform employees and contractors of new technologies

While new technologies try to increase the speed and quality and reduce the costs and the use of these technologies led to many improvements in this area.

2.9. Considerations of health, safety and environmental
One of the important issues in the project management is to consider the health, safety and environmental issues.

The employer’s role is to persuade the contractor to perform the health and safety considerations and also the role of the contractor on the contract model is very impressionable and with regard to the implementation of the requirements are the points that the decision maker will use in the contract model, is one of the most important factors in choosing. After doing this research and reviewing the results, finally, 8 effective indexes on the selection of optimized system to run the project were chosen:

- Cost of project
- Employer payment methods (financing)
- Completion time of the project
- Flexibility against changes during the project cycle
- Less effect of sanctions on the project
- Use of new technologies
- Claims and less contractual disputes
- Health, safety and environmental considerations

3. Results
Considering that in the AHP method, a geometric mean matrix is needed and we entered the data into Excel software and the geometry buffering, we entered the data into Expert choice, the by using the Expert choice software, we began to analyze the data and the following table shows the results. Several backup software has been developed for the AHP that the best of them is Expert choice. This software is developed by Saati and et al. This software has some capabilities and in addition, the hierarchical diagram design, decision making and question design, determining the preferences and priorities, computing the final weight, rate adaptation, sensitivity analysis of decision making rather than changes in the parameters, deriving different types and useful graphs are the other capabilities of this software. The following table shows the ranking weights.

<table>
<thead>
<tr>
<th>Criteria (factors)</th>
<th>Preferred Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completion time of the project</td>
<td>0/193</td>
</tr>
<tr>
<td>Claims and less contractual disputes</td>
<td>0/168</td>
</tr>
<tr>
<td>Use of new technologies</td>
<td>0/148</td>
</tr>
<tr>
<td>Health, safety and environmental considerations</td>
<td>0/141</td>
</tr>
<tr>
<td>Payment methods</td>
<td>0/108</td>
</tr>
<tr>
<td>Cost of project</td>
<td>0/108</td>
</tr>
<tr>
<td>Flexibility against changes during the project cycle</td>
<td>0/115</td>
</tr>
</tbody>
</table>

The table above highlights the importance of each of the experts. As you can see, time of the project is the most important factor in this table. And after that the Claims and less contractual disputes between the employer and the contractor and then use of new technologies. As it was expected, time factor was the most important factor in an infrastructure project. Because constructing the infrastructure projects often lead to huge savings. Savings that within a day and even an hour prevent wasting large sums. The second level of paired comparisons is the comparison between models based on each of the factors. The following table shows the overall results of the analysis.
Points are taken from reviews of options are divided into some general points. As it was expected, BOT option with nearly 45% of rated is the most preferred model rather than time criterion and it means that from the point of view of the decision makers, it is the fastest way to construct the BOT project. Since the most important factor was time and BOT as the fastest way, the biggest advantage of this model contract can be realized. EPC option is the best option is to have the least amount of litigation and legal disputes between the contractor and the employer. Considering the use of new technology, BOT option is preferable. More than two times BOT and more than the other two factors: 12:4, 327 times the three factors, five factors are less important than the other two factors:

1. Considerations of health, safety and environmental
2. Use of new technologies
3. Cost of the project
4. Employer payment methods (financing)
5. Less effect of sanctions on the project

4. Conclusion

According to the mentioned subjects and the achieved results from the software, it is clear that contract model of BOT is one of the most complete contracts in constructing the infrastructure projects. Some points were considered before that lead the employers and the contractors to design a more perfect contracts or contracts deformation. It can be noted that two main factors are almost equally important:

- Completion time of the project
- Claims and less contractual disputes

And after these two factors, five factors are less important than the other two factors:

References


