

Selecting an Appropriate Finance Method of Public-Private Partnership for Railway Projects in Iran through AHP Method

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Abstract—One of the recent innovations in developing countries has been taking advantage of private sector investment in setting up and managing infrastructure projects. In recent decades, these types of contracts are used extensively in developed countries with public-private partnership framework. Implementation and expansion of private partnerships in infrastructure projects results increase in investment and economical productivity. The paper purpose is to select the appropriate type of PPP contracts in financing railway projects in Iran benefiting from the decision making science and the expert opinions. The effect of criteria on selection method of financing railway project has been determined by using the questionnaire. Then the effect of criteria on financing method through partnerships (DBFO, BOT, BOO, Traditional PRI) has been assessed. Finally, suitable methods for financing rail projects are presented in order of preference, applying AHP methodology and Expert Choice software.

Index Terms—finance, railway projects, partnership, AHP method

I. INTRODUCTION

To meet increasing traffic demand of high populated developing countries, one of the competitive transportation modes is rail transportation. Using rail for transportation of passengers and cargo has a history of about 180 years. This transportation system has advantages such as safety, optimal fuel consumption, less environmental impacts and higher capacity compared to road and air transportation modes.

Public Private Partnership (PPP) is a possible solution for financing and complicated construction problems and risk management of the railway as it has been successfully implemented in other infrastructure sectors, including energy, telecommunications, transport, and water facilities [1].

Because of heavy initial investment needs of rail projects, governments often search for new financing methods for these projects. In recent years, several railway projects have been financed and implemented via

the PPP in the world. The majority of railroad projects which were implemented by PPP method confronted major difficulties in practice. Hence the extensive and detailed studies are required by the government agencies for successfully bringing expertise and financial resources from private sector in rail projects via PPP [2].

Due to the different structure of PPP in comparison to the other methods of finance, risks in these contracts are completely different and require careful investigation. Recently, great efforts have been made to identify the PPP risk in developed and the developing countries but it has rarely been attempted to identify and evaluate the PPP-railway risks [2].

Activities related to railway projects in Iran are mainly followed after formation of social-economic development program and financed from general revenues of the state budget. Therefore, the success of these projects is a prominent criterion in evaluating and judging the state performance and a reflection of the efficiency and effectiveness of management methods in Iran.

In Iran, one of the main problems of railroad projects is lack of quantity evaluation in optimal selection of finance method by PPP contracts. Available shortages and weaknesses in this subject cause unsuitable choosing of the opponent of contract, confusing the executives in understanding and correct using of the selected contract method for projects finance and sometimes wrong interpretations and results [3].

Therefore, survey and optimal choice of PPP method is very important because of the current challenges in finance method in Iran and the importance of proper selection in success of railway projects; And if there is sufficient attention and using of it in these projects, which they constitute one of the basic foundation of development, extraordinary progress is achieved, and make remarkable advantages for Iran economy.

II. IMPLEMENTING PPP CONTRACTS TO FINANCE RAILWAY PROJECT

PPP is a contractual agreement between a public agency and private sector entity. Through this agreement, the skills and assets of each sector are shared in delivering a service of facility for the use of the general

public. In addition to the sharing of resources, each party shares in the risks and rewards potential in the delivery of the service and facility [4].

Species of PPP contracts include Build, Operate and Transfer (BOT), Concessions Contracts (DBFO), Private Divestiture Contracts (BOO), Traditional Private Outsourcing Contracts [5].

PPP has been used extensively in developed countries for delivering various types of projects, ranging from transportation projects to health care facilities. In developing countries, shortage of financial resources and great needs for constructing infrastructures, encourage them to implement PPP in recent years [6].

It is clear that the role of government is significantly important in this case because: (1) such projects need a considerable amount of budget, long time for leadership and adequate tolerance for risk; (2) these projects incorporate a high social-economic cost which cannot be compensated by the money received from the user; (3) strategic role of the control. That is why the governments tend to adopt methods of financing the project from outside the government. So they could not only compensate for their budget deficit, but also can develop the needed important infrastructures such as construction and development of railway system. For this purpose, the use of private partnership for financing is an appropriate alternative.

PPP advantages such as reducing public sector administration expenses, solving public sector budget problem restraint, providing high quality public products and services, and saving delivering time of the projects, make it a popular procurement method in recent years [7]. Although the PPP contracts have lots of advantage versus the traditional contract, the results and statistics show that a high percentage of them are cancelled. These statistics also show these cancellations increase until 70% in those countries which don't have enough experience in use of such contracts. The real reason of these contracts failure is the basic differences in problems of the PPP contracts with identified problems of the traditional contracts. Therefore, it is necessary to choose the correct PPP contract.

III. RESEARCH BACKGROUND

Delmon suggested that the impact of risks in implementing a PPP project is usually significant, so the risk management is very important in PPP projects [8].

Risk identification is a critical phase in a project risk management process. It is desirable to identify the risks as early as possible [9]. In recent years a great effort has made in order to identify risks in construction project.

Grimsey and Lewis opined that much of the risk of PPP projects comes from the complexity of the arrangement itself in terms of documentation, financing, taxation, technical details, and sub agreements involved in a major infrastructure venture, while the nature of the risk changes over the duration of the projects [10].

Great efforts to identify PPP risks have been achieved [11], [12]. In 2010, Xu and his colleagues studied the PPP

projects of the china, they could identify the 37 risks related to those contracts and presented them in seven categories of politics, construction, operations, legal, marketing, economics and others [13].

With the aim of identification of PPP risks there have been several researches till now. For example in 2005 Bing et al. identified the PPP risks in Great Britain and divided the risks into the three categories of macro, meso and micro [14].

The researches about identification and assessment of PPP risks in developing countries considering their conditions are limited. In recent years, researchers have been tried to identify risks of PPP in one specific infrastructure.

Iyer and Sagheer specifically assessed the risks of public - private highway projects in India and from the 17 proposed risks, risks related to delays in funding and increasing cost and time of construction, has identified as main risks [15].

Recently PPP has been studied in specific infrastructures such as railways and urban light rail, but identification and assessment of specifically PPP-HSR projects has not been mentioned [16].

Researchers considered discussion of identifying success criteria and evaluating the final performance of PPP contracts in recent years. For example, the researches of Jefferies [17] and Ozorhon [18] can be noted. In 2012, Yuan offered a structured model for evaluating the performance of PPP projects [19]. Kashtiban and Sobhie surveyed on application of Management approach of PPP in a series of BOT contracts in power plant projects [20]. Also, Noorzai and Vahedi examined the optimal choice method of public private partnership projects for railway projects in road and urban ministry in Iran [21].

IV. RESEARCH METHOD

The used major tools for gathering information in this paper are library survey, interview, questionnaire, statistical analysis of data and finally using AHP method for decision making.

A. Main Population

Main population of this research includes expert population in the field of this survey. Common attributes of experts are at least a bachelor's degree in engineering and more than seven years' experience in owner part or first or second grade consultants and contractors companies in contract affairs sector. Following a survey that was conducted about list of active consultants and contractors in Iran rail projects, the number of reliable companies was considered about 180 companies that includes the consultants, contractors and professors that are in cooperation with ministry of road and urbanism in Iran or are working in relevant fields or worked previously. Main population of experts in the research field in the consultants, contractors and academics is about 60 people. Also it is assumed that there are experts in owner part as many as consultants and contractors, so

according to what was said main population was considered 120 people.

B. Estimation of Sample Size

In order to select the number of interviewees or experts, better to say for calculation of the number of statistical population, a formula proposed by Levy and Lemeshow is used. From the statistical population of research with 120 participants, a sample with 37 individuals was selected by using the sampling formula of Levy and Lemeshow [22].

C. Analytic Hierarchy Process (AHP)

AHP makes decision-making process easy by providing a structure for organizing and evaluation of importance of different criteria and ranking of options for decision-makers. Invented Thomas L. Saaty in 70s, AHP method is one of the most famous multipurpose decision making techniques. This method is hired when decision action is face with more than one option and criterion. AHP enables to combine qualitative criteria and quantitative criteria simultaneously. AHP method is based on paired comparison or one by one of options and criteria of decision making. For such a comparison we need to collect information from decision makers. This makes possible for decision maker to focus only on comparing two criteria regardless of any external influence or interference. Moreover one by one comparison provides valuable information to investigate the problems and makes rational decision making process because the respondent compare only two factors and has no attention to the other one [23]. In this survey, two original questionnaires were used. The first questionnaire determines the factors affecting selection of type of PPP contracts and second one examines effected factors on four groups of contract (BOT, DBFO, BOO, and Traditional Private Outsourcing Contracts). Then the results were analyzed using AHP process. The respondents were asked to determine the quantities importance and influence of each criterion in questionnaires according to the following numerical scale table (Table I).

TABLE I. PREFERENCES (ORAL JUDGMENT)

Extreme importance	9
Very strong and demonstrated importance	7
Strong importance	5
Moderate importance of one over another	3
Equal importance	1
Intermediate values between adjacent scale values	2, 4, 6, 8

D. The Study of Impact of Obtained Criteria on Each of the Four Contract Groups and Ranking using Expert Choice Software

Expert Choice software based on AHP method can do necessary calculations with high precision and make accurate results. The following steps are the same in AHP and Expert Choice:

- Making a hierarchical model
- To enable model for group decision-making

- Paired comparison of criteria and sub-criteria to determine of their importance in decision making
- Synthesis and integration to determine the best option

E. Determination of Criteria and Options

a) Factors affecting selection of type of PPP contracts in railway projects:

The results of the first questionnaire (i.e. expert views for identified criteria) were surveyed and 15 important criteria in selection of type of PPP contracts in rail construction projects are listed below.

1. Reduction of changes in laws
2. Paying the bills from the government
3. Increase of the applicability of government guarantees
4. Ease of receiving loans
5. Ease of receiving related insurances
6. Being clear in the ownership of project
7. Supply of quality and standards
8. Selection of appropriate private sector
9. Supply of equipment
10. Environmental preservation
11. Ease of maintenance and repair
12. Decrease of operating costs
13. Commitment of the parties to their obligations
14. Proper distribution of authorities and responsibilities between the parties
15. Increase of project profitability

b) Determination of options

The options that were considered in this study were defined as follows:

- Concessions Contracts (DBFO)
- Build- Operate- Transfer (BOT)
- Private Divestiture Contracts (BOO)
- Traditional Private Outsourcing Contracts

F. Data Survey

Formulation of Mean Utility Values

In the second questionnaire, the expert respondents choose a number of 1-9 for any criterion in each contract with regard to the paired comparison. After normalization of different weights corresponding matrix, Table II was gained.

Paired comparison

An example of a completed questionnaire can be seen in Table III that is related to comparison among 15 criteria for optimal PPP contract selection in rail construction projects. "Reduction of changes in laws" criteria, for instance, is more important than "Increase of project profitability" hence number 2 had been entered into the table, this is how the table should be filled.

Weight of each criterion totally and the weight of each item

After ideal synthesizing for every item we reach Table IV which is showing the weight of each criterion totally and the weight of each item. The numbers of table have been achieved by multiplying the weight of each criterion and gain weight of each option which is relate to the each criterion (Table II). Ultimately the IR for questionnaire is 0.04 that is less than 0.1. Thus questionnaire information is reliable.

TABLE II. THE VALUES OF THE WEIGHT OF EACH PPP METHOD IN ANY CRITERION

PPP options	Number of Selection Criteria														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DBFO	0.397	0.398	0.400	0.400	0.398	0.186	0.197	0.213	0.409	0.111	0.400	0.385	0.400	0.395	0.395
BOT	0.301	0.114	0.400	0.400	0.398	0.105	0.394	0.396	0.273	0.063	0.133	0.154	0.400	0.132	0.158
BOO	0.260	0.102	0.400	0.400	0.398	0.105	0.182	0.178	0.318	0.127	0.333	0.385	0.400	0.368	0.395
Traditional PRI	0.055	0.034	0.080	0.050	0.398	0.395	0.045	0.041	0.045	0.397	0.067	0.038	0.086	0.026	0.026

TABLE III. A SAMPLE OF COMPLETED QUESTIONNAIRE

Number of Selection Criteria	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	1	1/3	1	1/2	1	1	1/3	3	1	7	5	3	3	2
2		1	1	2	1	1	1	1/2	3	1	7	5	2	3	4
3			1	3	1	1	2	1/5	3	1	7	5	3	3	3
4				1	1/3	1/3	1/2	1/5	2	1	3	1	1	1/2	2
5					1	1	3	1	5	1	7	3	3	3	5
6						1	1	1/5	5	1	5	3	3	3	4
7							1	1/3	3	1	3	3	3	3	1
8								1	7	3	7	7	5	3	5
9									1	1/3	1	1	1	1/2	1/3
10										1	3	2	1	2	1
11											1	1/3	1/5	1/5	1/2
12												1	1	1	1/3
13													1	1	1
14														1	1
15															1

TABLE IV. WEIGHT TABLE OF EACH CRITERION TOTALLY AND GAIN WEIGHT OF EACH ITEM

PPP options	Number of Selection Criteria															Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Criteria weight	0.073	0.088	0.1	0.04	0.113	0.086	0.066	0.197	0.022	0.063	0.015	0.026	0.035	0.038	0.038	1
DBFO	0.029	0.035	0.04	0.016	0.045	0.016	0.013	0.042	0.009	0.007	0.006	0.01	0.014	0.015	0.015	0.312
BOT	0.022	0.01	0.04	0.016	0.045	0.009	0.026	0.078	0.006	0.004	0.002	0.004	0.014	0.005	0.006	0.287
BOO	0.019	0.009	0.04	0.016	0.045	0.009	0.012	0.035	0.007	0.008	0.005	0.01	0.014	0.014	0.015	0.258
Traditional PRI	0.004	0.003	0.008	0.002	0.045	0.034	0.003	0.008	0.001	0.025	0.001	0.001	0.003	0.001	0.001	0.14

V. CONCLUSION

At first the research was paid to the topic literature. In the next step the different groups of contracts were studied. subsequently The effective criteria for choosing of public private partnership method in rail projects using library resources and collected expert opinions was identified. Finally, in an overall conclusion the effect of each criterion on four PPP methods including Build-Operate- Transfer (BOT), Concessions Contracts (DBFO), Private Divestiture Contracts (BOO) and Traditional Private Outsourcing Contracts in rail projects was checked.

A. Determination of Optimal PPP Contract in Railway Projects in Iran

In Fig. 1, we can see ideal synthesizing results that its numbers show rank of PPP contracts in rail projects. It is clear that DBFO contract has received the higher score.

1. Concessions Contracts (DBFO)
2. Build- Operate- Transfer (BOT)
3. Private Divestiture Contracts (BOO)
4. Traditional Private Outsourcing Contracts

B. The Most Effective Criteria for Choosing PPP Contracts in Railway Projects

The most effective criteria for choosing PPP contracts in railway projects based on Fig. 2 in order of importance are as follows:

1. Selection of appropriate private sector
2. Ease of receiving related insurances
3. Increase of the applicability of government guarantees
4. Paying the bills from the government
5. Being clear in the ownership of project
6. Reduction of changes in laws
7. Supply of quality and standards
8. Environmental preservation
9. Ease of receiving loans
10. Proper distribution of authorities and responsibilities between the parties
11. Increase of project profitability
12. Commitment of the parties to their obligations
13. Decrease of operating costs
14. Supply of equipment
15. Ease of maintenance and repair

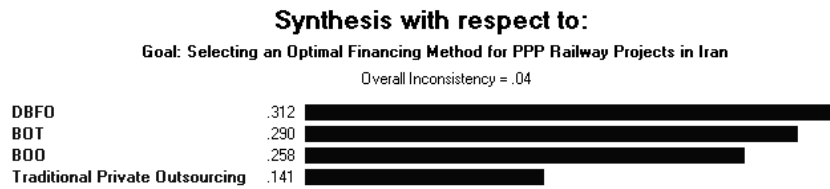


Figure 1. The results of the ideal synthesis (summery) - prioritization of PPP contracts

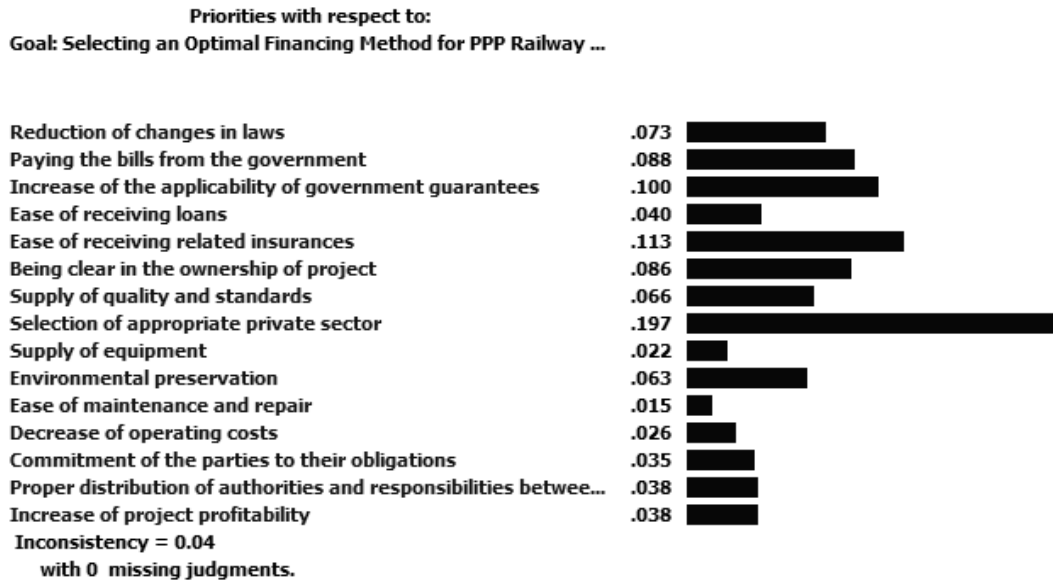


Figure 2. The importance of criteria based on gained weight from expert choice software

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