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**VALUE ENGINEERING IMPACT ON THE QUALITY OF ROAD CONSTRUCTION  
PROJECTS BASED ON IMPLEMENTATION TIME OF PROJECT MODELING**

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**ABSTRACT**

Road construction projects are very important due to the large volume of resources involved and associated with the project particularly the lack of financial resources of government to develop roads has expanded the use of "construction-exploitation-transfer" method in the sector. This type of contracts has high complexity and sensitivity. Value engineering is an organized attempt to investigate and analyze all activities of a project carried out since the formation of the initial idea to the stage of designing, implementing, starting up, and exploiting. It is known as one of the most effective and important economic methods in the field of engineering activities. The paper introduces "construction-exploitation-transfer" method and value engineering. It also examines the implementation and use of this process in these projects in Iran. The value studies provide appropriate opportunities to reduce costs, improved quality, improved construction, reduced construction time, longevity, and sometimes a combination of the above cases. This research is applied consisted of library and field survey studies application that concludes using by combination of library studies and field surveys. Its statistical analysis showed that, on average, about 55% of the study population have consensus on impact of value engineering principles and factors on time, quality and cost in "construction-exploitation-transfer" projects. In addition, in the field studies, it was observed that in the project of Zal – Andimeshk bridge freeway, value engineering is especially important in the early stages of the project.

**Keywords: Value, quality, time, cost, road construction**

## INTRODUCTION

One of the main indicators of development in today's world by countries is having reliable economic infrastructures based on infrastructure industries and installations. Having the necessary resources to implement major industrial-developmental projects, skilled manpower and managers are considered as main conditions for achieving it. Today, efficient managers is known and essential element in designing and guiding of systems, in fact proper actions of management has direct impact on improving methods, reducing costs, increasing efficiency, quality and quantity growth, and reducing the time of implementation of projects. Management element has constantly had direct relationship with experience and and its growing role in scientific and practical ability promotion of human societies is evident in history. Road construction projects, in particular those implemented by "construction-exploitation-transfer" method face with high volume of resources, both human, financial, machinery resources, and due to long life of project in these projects (at least 30 years since the construction of exploitation by the private sector and investors), they require high consideration and careful management of resources. Nowadays, the value engineering

is considered as a tool for optimal use of the project time improving the value of the project ultimately. Given the growing volume of investments in infrastructure projects of country and high unplanned delays in construction projects leading to much time spending and also losses due to lack of starting up major projects, value engineering can be used as appropriate solution to improve the process of project implementation and to achieve the objectives of the project. Therefore, use of value engineering to improve the quality of road construction projects implemented by "construction-exploitation-transfer" method means accurate knowledge of value engineering, appropriate use of value engineering, and analyzing and investigating the value engineering parameters. In this study, using value engineering, we tried to investigate its role in improving the quality of road construction projects and examine its impact on cost, time and quality of Zal-Andimeshk bridge freeway project. This study also aims to provide appropriate solutions to solve the related problems.

### **Statement of problem**

Perhaps the biggest problem in road construction projects and the projects implemented by "construction-exploitation-

transfer" method is incomplete executive operations both soil operation and technical buildings at the prediction time by management and all factors that must be investigated from the beginning of designing to implementation stage, so that increased implementation time and efficiency weakness of roads to be reduced. The purpose of this research is to assess the feasibility of the value engineering potentials in the road construction, especially ""construction-exploitation-transfer" method method, by the analysis time of construction of roads. For this purpose, obtaining information of time of one example of country roads and construction time modeling will be considered in terms of effective factors. The results of this investigations and comparing the level of various projects time can show the potential of time reduction by using different methods of value engineering.

### **Importance of research**

Studying the current situation of the roads of country shows its high potential in using "construction-exploitation-transfer" method, because government transfers all possible risks to the private sector in this method. On other hand, as these projects are financed by the private sector, no pressure on will be imposed on public budgets of country. In

addition, as the loans taken by the government are not guaranteed, these loans are not included in government debts and the country's credit will not be reduced.

Nowadays, value engineering's role is considered as a tool for optimal use of the project time and improving the value of project. Due to the growing volume of investments in infrastructure projects of country and high unplanned delays in road construction projects leading to much time spending and also losses due to lack of starting up the major projects, value engineering can be used as one appropriate solution to improve the process of project implementation and achieving objectives of the project. In general, regardless of project implementing methods, the following cases can be regarded as the most important requirements of the present:

- Optimization of expected functions of project
- Optimization and balancing the quality
- Identifying and reducing and optimizing the quality
- making the project features clear based on real functions
- Balancing the construction projects and exploitation of time
- Identifying the project risks and possibility of its management

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-Providing realistic plans for project time

### **Objectives of research**

As in most cases, most of the executive projects of country face with similar problems such as not completion of project based on time schedule, regardless of the management style and their implementation, it seems that use of value engineering technique can mitigate this problem as an appropriate method to help project implementation. Due to growing infrastructure projects of country, difficulties in advancing the road construction projects, and more or less available data of projects implementation results suggesting the longer process of implementing of project or lack of access to considered capacities and dysfunction of the project after the exploitation, the overall objective of the study was to reduce the time of construction projects implemented by "construction-exploitation-transfer" technique using value engineering.

### **Data collection**

According to the strengths of the survey method of study and as it is the most powerful method for studying the characteristics of a population, and as audiences of current interview are expert team of road construction by construction-exploitation-transfer", including investors

and employers, obtaining their views on value engineering and its impact on time, quality and cost of the project is necessary. Therefore, due to reasons mentioned survey method is the best method to achieve the objectives of the present study.

### **Introducing the Zal-Andimeshk bridge freeway project**

Construction of Zal-Andimeshk bridge freeway project was implemented, as part of transit freeway network in north - south of the country, and then Zal-Andimeshk-Ahwaz freeway was considered, and it started near a river known as Zal that is the location of one of the big bridges of project known as Zal bridge at the non-flat intersection with the old road of Khorramabad - Andimeshk and it extends toward Andimeshk. The length of this freeway is about 45 km but according to the particular and mountainous situation of the region, this freeway passes over valleys with depth of over 40 meters. This road has been paved and flatted by construction of three large bridges up to 40 m and lengths of over 200 m. Determining the contractor's tender was conducted in 2005 in which Rahan Pars Company win the tender. On January 2006, a Memorandum of Understanding was exchanged between the Ministry of Roads (company of construction and development

of transport infrastructures in the country) and Rahan Pars Company. Then, by the proposal of the High Authority of the Ministry, the Council of Ministers announced the license of contract between mentioned ministry (Construction Company) and Zal – Andymshk Bridge Freeway Company in April month of 2007. Exploiting this project, while eliminating bottlenecks and dangerous curves and enhancing geometric characteristics, time travel and safety of travel increase significantly.

#### **Technical specifications of project**

- The length of freeway: 49 km
- width: 10.26 km
- Number of lanes: 4 lines
- excavation: 7300000 m<sup>3</sup>
- embankment: 3800000 m<sup>3</sup>
- concreting: 150,000 m<sup>3</sup>
- under foundation: 435000 m<sup>3</sup>
- foundation: 210000 cubic meters
- Asphalt: 495000 tons
- number of special and big bridge: 10
- number of small bridges: 16

#### **Tools to collect data**

In this section, we tried to identify the most important parameters influencing the success of value engineering studies. It seems that one of the serious obstacles to use of these factors practically inappropriate knowledge of value engineering in the engineering

community and universities of country, hence, due to approach used in this paper to identify and classify parameters, interviews were carried out with experts that will be discussed later. The focus of questions in these interviews focused was on several key factors, which are divided into 4 groups:

- first group: preliminary evaluation factors
- second group: supportive factors
- third group: technical evaluation factors
- fourth group: factors related to the life cycle of the project (after design)

First group: Preliminary and initial assessment factors

1- Stepwise and complete implementation value engineering schedule is one of the most effective in success of value engineering studies that by ignoring and unplanned implementation of some steps, output of studies has been largely reduced. Degree of attention to each step may vary depending on the type of project.

2-Care must be taken in selecting members of the value engineering group members, in value engineering workshops it has been ignored that due to short time in workshop, much time was spent to justify individuals and to follow opinions that were not considered a good value

3- Training related to value engineering is recommended to design consultants and

employers, development of value engineering will also be valuable from management perspective and technically.

4- Procedure applied in tenders for selection of contractors through offering the lowest price makes that selected contractor requests contract extension and uses adjustment in time through offering new prices by referring to issues that are in the design and implementation. However, through new engineering, contractor can provide a method leads to efficiency and profitability of project and guarantee his profit in this regard, using a systematic approach and creating creativity space.

5-Implementation of plan in light of human relations and collective efforts, cooperation and active participation of several people brings the most effective results, group participation plays a key role and shows that outcomes of a 5-member group are higher than sum of individual efforts of 5 people.

Second group: supportive factors

6- participation of eligible employers, as members of the group, not only offers promising prospects, but also through information obtained by the proposed facilities in value engineering process will provide long-term benefits for users.

7- one of the effective factors in the success of value engineering studies is to answer the

"why and how" questions. Humans are willing to answer how questions since they are looking for specialized solutions, but in answer to the why question, people do not have good feeling and they are usually distressed. In answer to this question, it is likely that people feel that their decisions have been challenged.

8- In order to prevent a decrease in design consulting fees and therefore consultant position, it is needed that after value engineering studies because of the reduced cost estimate, after redesigning, the changes made to be given for consultant through fair and rational fee. So many myths consultant with such action disappears.

Third group: technical assessment factors

14-The proposed changes should not be ignored one of the basic criteria or initial requirements engineering, the design consultant also should fade.

15-Factors that cause increased implementation time, rising costs and reduced value, possible at any project, must be clarified by designer and consultant so that contractor does not request termination of contract or its suspension (Article 48 and 49 of the general conditions of contract) in facing with contracting problems and in their demands in opposite front with monitoring device of contract extension request and

analysis of total sum of critical states. In many cases of implementation, it has been seen that the contractor has been faced with certain conditions that was not expected. In this case, consultant device provides new schedule and agenda and contractor usually enters to transaction arena with employer to confirm new prices by sending the analysis of new work price, that examination of these prices will increase the implementation time.

16- Change proposal can increase the contractor technical ability of contractor on one hand, and it increases executive knowledge of the consultant and employer on other hand. A creative change proposal cannot only eliminate mental frameworks exist in designing styles and methods, but also it can creates modern method.

Fourth group: factors related to life cycle of project (after designing)

17- Using value engineering after the designing stage increases the resistance by consultant and designer and at this time value engineering management must be such that it can provide its proposal to employer clearly and accurately so that employer accepts the proposal by its examination and increasing the project value.

18. The offered changes cannot be the basis for claims of contract by the contractor that is

why it can gives good value of capital for owner.

19. As value engineering studies are conducted earlier in the life cycle of project, the value, quality and schedule of the project will be improved, in addition, delay in implementation of project also will be lower (In case of inappropriate planning, these things happen).

### **Population of study**

Among 63 questionnaires sent to experts, Abadrahan Pars Company management staff, "construction-exploitation-transfer" contracts experts, and university professors, 73% of questionnaires could be examined.

Each questionnaire assessed the effect value engineering factors on time, cost and quality. As will be seen by observing tables and figures, using value engineering principles was more important in the early stages of the project, that is, zero and one phases, and they had the greatest impact on time, cost and quality of the project. However, as we go to final stages of project, the effectiveness of principles of value engineering will be declined on time, cost and quality of the project so that value engineering loses its efficiency in the final phase.

the mean impact of initial assessment factors on the quality of the project

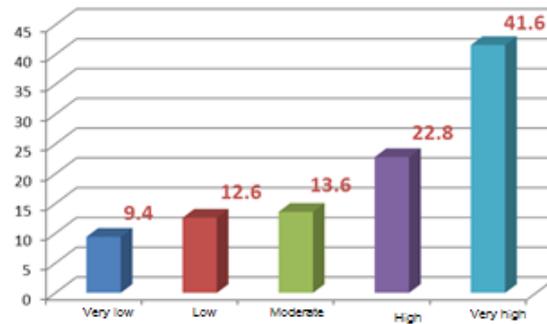


Figure 1: the mean impact of initial assessment factors on the quality of the project

mean impact of protective factors on the quality of the project

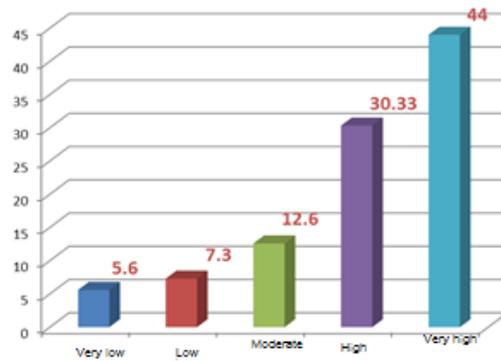


Figure 2: The mean impact of protective factors on the quality of the project

mean impact of technological assessment factors on quality of project

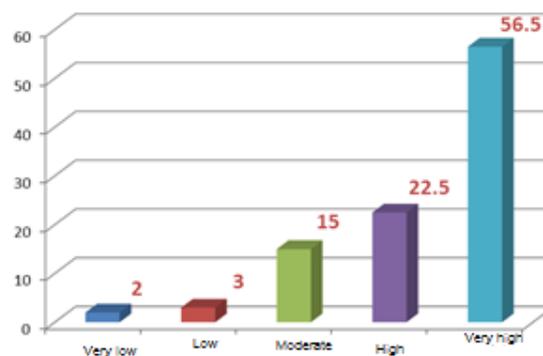


Figure 3: the mean impact of technological assessment factors on quality of project

mean impact of life factors on quality of project

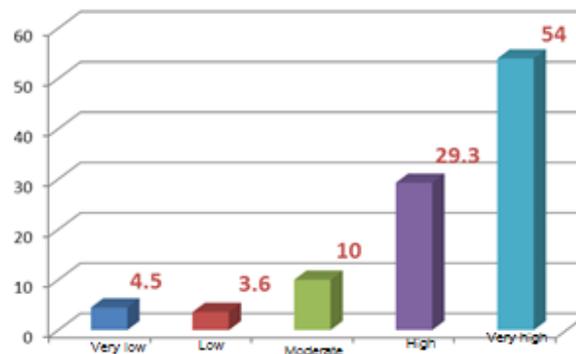


Figure 4: the mean impact of life factors on quality of project

### Analysis of the results of value engineering questionnaires

What obtained by analyzing the questionnaires results are as follows:

1. Using value engineering principles in the early stages "construction-exploitation-transfer" projects has particular importance. Its importance is due to specific requirements of contractors and large capital investors in these types of contracts in which investors are looking for lower cost and completion of project, as soon as possible, and its investment return.
2. Statistical analysis of costs showed that the highest potential cost reduction in the projects of "build-operate-transfer" "construction-exploitation-transfer" is in the soil operations with machine. In addition, by reducing the duration of the project, we can substantially reduce costs. Regarding cost of

other items, total cost of construction can be reduced by using value engineering methods.

3-Value Engineering can solve many problems in the complexities of BOT contracts, provided that it is controlled by coherent and integrated supported by transparent documentation.

4-As "construction-exploitation-transfer" contracts has recently been used in country, or in other words, their number is limited, thus, the number of experts who can manage such contracts is limited, so technical factor will have significant impact on the project.

5-What is clear is that value engineering is group working (its importance is discussed in the supportive factors), and lack of participation and interaction of contractor and the employer will have negative impact on appropriate performance of value engineering principles on time of project.

6- One of the most important factors in lack of success of value engineering in some projects is not mutual understanding between the employer and the contractor leading to confusion of both institutions.

7- one of the basic principles of value engineering is to create a new activity or change the usual procedure in road construction workshops. Appropriate flexibility of project consultant consultant and appropriate cooperation of consultant with executor of plan have positive impact on full implementation of value engineering and they will have positive impact on time, cost and quality.

8-care must be taken in the implementation of value engineering since the power of mentioned in imposing changes after the designing group will have significant impact on project.

#### Implications of study

According to the framework presented in this study and classification of value engineering using its major factors, these factors can be simply used in road construction projects of "construction-exploitation-transfer" leading to optimal management of the project. In this regard, investors of "construction-exploitation-transfer" contractors can reduce the additional costs and complete the project at the minimum time by forming a group of

expert people knowing about principles of value engineering, road construction projects management, and of "construction-exploitation-transfer" contracts by classifying the factors introduced in this study and knowing its impact on cost, time, and quality of project.

#### Recommendation for future studies

Given that issues related to project management and value engineering in Iran are new, what has been conducted in this study is overall review of value engineering in the of "construction-exploitation-transfer" road construction projects. As each of concepts of "construction-exploitation-transfer" and value engineering require development and localization in Iran's environmental conditions, especially in the road construction sector, known as infrastructure projects, following recommendations are provided:

- investigating and providing an optimal model in cooperation of government and contractors as investor
- investigating and providing an optimal model for the implementation of of "construction-exploitation-transfer" projects in Iran (especially in transportation sector)
- investigating the impact of risk engineering on time of road construction projects of

"construction-exploitation-transfer"

comprehensively

- investigating the integrated model of risk engineering and value engineering on road construction projects

- preparation of databases and documents related to road construction projects of Iran under various systems, especially "construction-exploitation-transfer" to document and record the experience

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