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Evaluation and Modulation of Value and Management Risk Engineering in ESP Projects: A Case Study in Hydroelectric Projects of Kohkilooyeh and Boyer Ahmad

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Abstract

In this research, we considered the issue of using value management in EPC projects to be able to make changes in implementation methods in major parts of the project. In addition to saving time and money, increasing and maintaining the quality and as a result enhancing the value indicators were the main reasons for doing the present study. In this applied research which is the hydroelectric power plant project of Kohkilooyeh and Boyer Ahmad and was conducted by EPC method, we wanted to find out whether we can improve the implementation process, reduce the costs and achieve a shorter time to conduct the project whether by applying the value engineering method in this project, along with improving or maintaining the quality. It is clearly stated that the value engineering has great ability in reducing the costs of completing the project. Since, it caused the 22% reduction of the cost of project value. On the other hand, it was determined that based on the results of chapter four of risk management, the results of value engineering were reliable, because regarding the mathematics hope and analysis done, the time of completing the project have not changed significantly by reducing 22% of the cost of project value. So, it can be claimed with certainty that results of value engineering have high reliability.

Keywords: Management Risk Engineering**,** EPC. Value engineering

Introduction

Value analysis as a special technical method was performed for years after World War II. The work on design and planning of this method started on Henry Erliture order, the technical assistant of the purchase department of General Electric Company. He believed that some alternative materials and plans which were applied out of necessity and because of the limitations of the war time had better performance with lower costs. Risk management is known as a process to maintain properties and the power to earn money in the institute through the available resources in order to maintain the financial balance and operational power of organization after the occurrence of probable events. Value management is considered as an integral part of risk management.

Consolidation of value management and risk management leads to synergy. By the review of the literature and history related to risk and value managements, it is identified that researches were conducted about each one, however, at the global level related researches is seen about their joint performance. Among them, David Krack (1995) and Dallas (2006) can be referred to. In Iran, the evaluation of joint performance of risk management and value management were not conducted. In the research titled "the evaluation of applying value engineering in EPC contracts and the reliability of their results" they tried to consider Dallas model (2006) as a theoretical framework.

Statement of the problem

The term EPC is the abbreviation of the three words Engineering, Procurement, and Construction. The advantage of this contract over others is that the project is done continuously and all required activities to implement the project from planning and engineering to preparations and final construction is delegated to a contractor.

On the other hand, we know that value management is an organized attempt that is aimed at evaluation and analysis of all activities of a plan (from formation of primary thought to the planning and implementation stage and then launching and exploitation) with the contribution of all effective factors which are aware of the issue for the regular analysis of values and costs to improve value and performance of project and planning new methods or removing unnecessary costs in order to reduce total costs, conducting project in the shortest time possible, improvement of function and increasing the quality.

Integration of risk and value engineering is a process through which risk and value engineering is conducted jointly and under the supervision of a team in order to cover deficits of each one. Paying attention to risk and value engineering in the civil projects is essential. Value engineering leads to cases that value is recognized by the employer and is paid attention to. Risk management identifies factors that may interfere in implementation of project and plans for them.

Significance of the study

Ascertaining the final price and the definite date of the project completion and implementation of the projects as EPC which provides the ground for assurance of the finalized price of project and the time for completing is among the needs of today's market. The reason for the turning of this project to EPC is also the same project.

On the other hand, the most important aim in the project management is the completion of the project with minimum cost and in the specified time with observing the qualitative issues and without implementation difficulties. Since value engineering is a group work and have systematic method that by collecting views and evaluating it and finally choosing best idea can lead to reduction of costs with increase or at least maintenance of quality, so using a combination of value and risk engineering in EPC projects became necessary and identifying barriers to it and removing them becomes important which is the subject of this research. Now, if we could apply the EPC process in the hydroelectric power plant of Kohkilooyeh and Boyer Ahmad as a sample of civil project, we may see good results including easier implementation, reduction of costs, reducing time and increasing quality.

Managers of civil projects at different levels talk about the importance and necessity of value engineering and risk engineering, but it is less seen they use value engineering and risk engineering in their projects. In a few projects, either the value engineering or risk engineering is used. Conducting either of them as implementing it separately cause that each of them does not have the required efficiency. And in practice, the project managers pay less attention to them.

If a process could be used in which both value engineering and risk engineering could be included and this joint process, by a team is managed and implemented, not only the efficiency of each is increased but also it leads to more use in implementing projects.

Objectives of the study

In general, the aim of doing this research project is to analyze the results of using the value engineering project as a management tool in order to continuously optimize the projects either from the aspect of cost reduction, time reduction and, or increase the quality and other necessary indicators of implementation such as quality, feasibility, speed, and security so that, by using the results of this study, we can create an applied pattern to use in civil projects.

Capabilities of value management

Nowadays, value management is introduced as the best improvement method. Successful implementation of them in strategic planning, improvement of quality, management studies, production and civil projects is confirmed. Its capabilities in civil projects is in such a way that most experts believe that in choosing the project to do value engineering, exceptionally all have acceptable return potential (saving). For example, according to annual reports of Circle of America

Civil Engineering, value engineering in the following cases are done for projects under the management of that circle and the returned net profit is 20 times more than the costs related to value engineering (Qoli Pour and Beiraqi, 2004):

- ✓ Construction projects with costs more than 500000 dollars
- ✓ Non-construction projects (preparation and equipment) with cost more than 1000000 dollars.

The following table shows the applied percentage of value management in different industries of the world (Mostofi Darbani, 2005).

Table 1. The percentage of application of value engineering in different industries of the world

No.	Major	Percentage of application
1	Electrical and Electronics	79.9
2	Transportation (road traffic)	91.3
3	Production Equipment	90
4	Machine building and automobile production	84.5
5	Chemical Industry	50
6	Construction Industry	39
7	Food Industry	37.5

The time of applying value management

The scope of value engineering project depends on the size and complexity of the project. The highest level of return happens when we are at the first stage of project life. It can be said that in primary phase of planning, implementation of engineering is very valuable, because theories still exist in form of concepts. The employer and designer are more flexible in their decisions in this step and changes have less effect on the timing plan of the project. In this step, the employer and the counselor are analyzing the project budget, doing researches on value engineering can be effective in identification of the costly elements before ratification of the final budget. The studies of value engineering for construction project are performed when 30 percent of planning is done. In other words, incomplete planning should be value engineered. In general, it can be said that, before making important decisions in planning, the value engineering is advised and at that time has a greater influence (Kelly et. al, 2003). Two important factors which influence the choice of proper time to implement the value methodologies is the amount of savings, the profit obtained and also the degree of acceptance and agreement with change in different steps of the project. The following figure shows the capability of saving resulted from practicing value engineering during the planning time in a general state (Qoli Pour and Beiraqi, 2004). And the next figure shows the opportunity for change in the method and time of applying techniques in the project life time (Ravanshad Nia, 2005).

The reliability of the results of value engineering in EPC projects

In recent years, a large number of national plans, with the implemented design and construction plans or the implementation of this method, are represented in such way that nowadays this system is the dominated method in implementing massive civil projects. One of the most important advantages, which is mentioned in the design and construction system, is the reduction in the project implementation costs and the completion time (Molenaar et. al, 1999). However, the results of design and construction projects experienced in the country, do not show significant conformation with theoretic presumptions (Bleasdals , Rodeny Curtis,1994). This caused a serious

uncertainty in project executive's views created about the efficiency of design and construction and purposes stated for it. One of the main tools proposed in form of studies (*Molenaar et. al, 1999* and *Gordon, 1994*). In order to reduce time and cost of projects in DB/EPC contracts, this system capability is increasing Constructability, designing and application of value engineering (Gordon, 1994). Despite the results of these studies, in Iran, there is not a long history of applying this advantage in implemented project in DB/EPC method. The aim of value engineering is to return most value for the costs of creative ideas. However, the experience of the workshops held show that sometimes the ideas proposed are themselves involved uncertainties that unlike the objectives of value engineering increase the project risk taking, and increase the necessary costs of controlling them. Because of the inefficiency of the value engineering tool in DB/EPC in Iran (as some tools such as qualitative control of contractor, certainty in budgeting and defining the project can also be added), the reduction of cost and time of project and as a result, developing DB/EPC projects among executives of civil projects of our country is questioned.

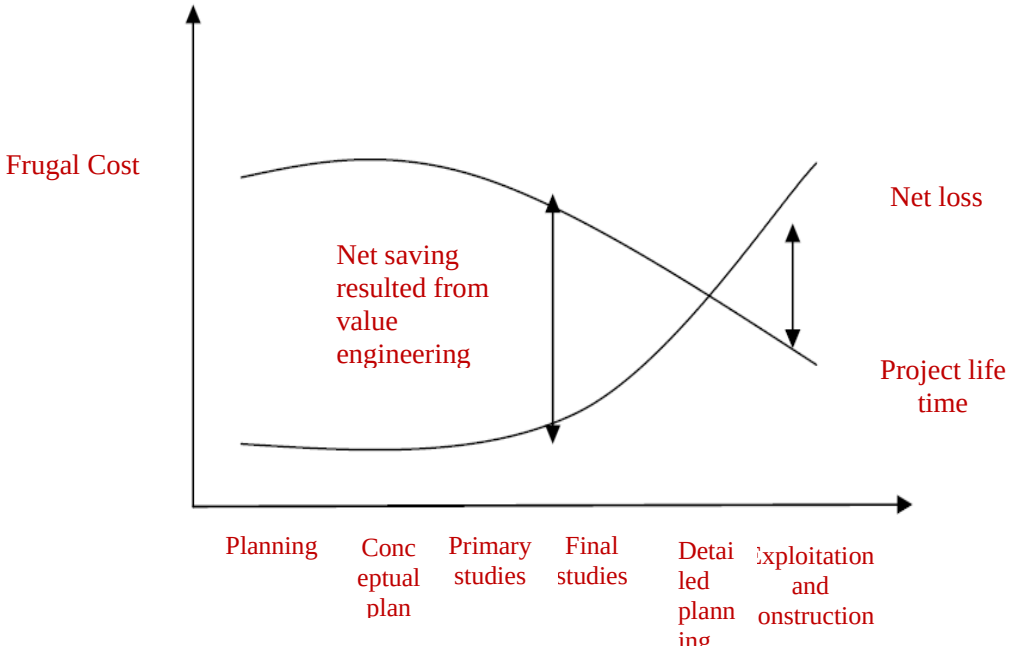

Figure 1: The capability of saving resulted from practicing value engineering during the plan lifetime

Thus, development of value management in a way that stable results with appropriate reliability can be obtained which involved capitals in a macro civil project, strong facilitator for the development of construction and planning system will be provided in civil projects. Here, the purpose is to develop a value engineering model in a way to do risk analysis on the suggestions from value workshop and the probable risks of implementation of each suggestion is identified. By having such model, the employers' trust to implement value engineering in projects can be obtained and achieve a model that in addition to having the required flexibility for the application of creativity and use of group contribution, has the capability of controlling and reducing project risks. However, application of two somehow contradicted models of risk management and value engineering, which the first is based on identification and removal of risk and the second one is founded on innovation and creativity, crates new challenges. Therefore, there is a need to provide a model for synergy of

these two models. Several studies have been conducted for the simultaneous application of risk management and value engineering (Ear S. S & Gebel Ameli and Mir Mohammad Sadeqi, 2001). However, most of these studies have focused on the manner of risk control after the implementation of value engineering suggestions and have seen risk evaluation out of the value circle and apart from the process of value engineering process. Development of risk evaluation method to the value circle in the way that workshop suggestion are assessed before presenting, leads to saving time and cost derived from evaluation of suggestions by a separate method and separate team. Before doing research aimed at completion of value circle, studies are conducted aimed at improving the evaluation process, for example, Nader Pour and Afshar (2001) by using fuzzy logic could improve the process of evaluation of value suggestions and practically it represented a hybrid model of this combination. By taking into account these experiences, in this section, an improved model of value engineering development was proposed that risk evaluation as a component of value circle was implemented, so that results of value engineering workshop get acceptable (or at least estimated) reliability systematically.

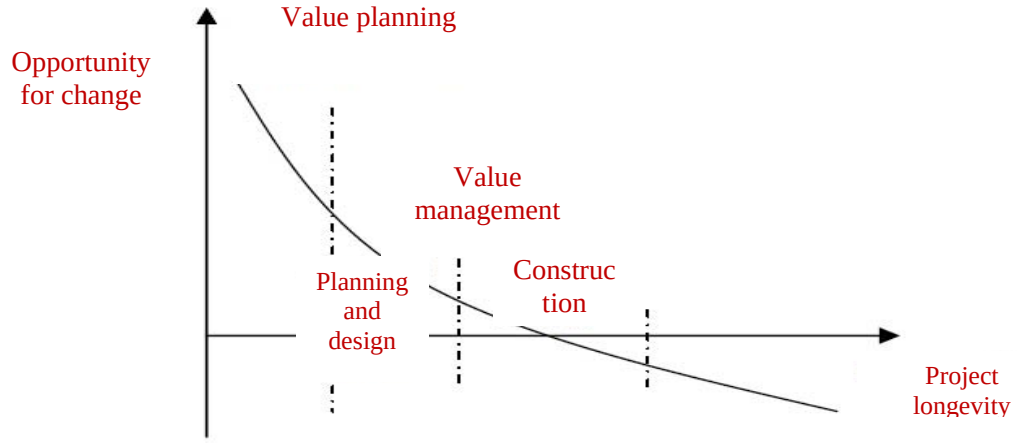

Figure 2: The opportunity for change in method and time of applying the value engineering technique

Risk management

Thus, a process should be created in order to analyze risks on the recommendations of value workshop in order to identify the probable risks of implementing each suggestion. This analysis is followed in a systematic process of management with recommendations for reducing the risks and to make preparations to deal with effects of occurrence of each risk (depending on the strategy which are applied to react to each) so that the risk level of project is placed in a reasonable level.

On the other hand, any risk for project includes costs. The risk cost equals to the amount of capital – that threatens an opportunity in case of occurrence (Khight, 199). This cost is Determined at the level of risk evaluation. During the implementation of risk management program if this risk is identified and a specified strategy is determined for its reaction, the cost of necessary actions should be estimated and then should be considered in the cost of risk (Chapman, 1991). Cost of risk management in this condition is replaced by the risk cost. Thus, in the process of conducting value management, in order to determine the value of implementing the recommendations of value workshop (which is not necessarily in form of value reduction) and prioritizing the

recommendations, the cost of risk and or the reaction cost to risk also should be taken into account so that the real value of project in this condition is determined. Lack of considering these measures, as it was common in workshops of value engineering, it caused an incorrect picture of costs of project value (Koga, Michael, 1996).

Comparison of features of value engineering and risk management

By comparing two classic models of value engineering and risk management, it can be seen that these two methods are different from each other and each have specific features that hardens the combination of these two methods. So, these features should first be compared with each other so that by identifying the limitations and applications of each, their combined application becomes possible. The objective of value engineering is to achieve higher value in the project and, in other words, increases the applicability; however, risk management intends to increase the security of project which means the reduction of risks that keeps the project away from reaching its goals. The process of value engineering is to produce and use creative ideas (Ear S. S & Gebel Ameli and Mir Mohammad Sadeqi, 2001). This project is conducted in risk management by applying the histories of the same projects and organizational experiences (Chan, Scott, 2002). However, value engineering concentrates on performances to increase the value of product by removing the sub-functions (Bleasdals , Rodeny Curtis ,1994). In risk management, it is concentrated on objective control and the possibility of access to them (Khight, 1991).

Table 2. Comparison of value engineering and risk management

Process features	**Value engineering**	**Risk management**
Final objective	Increase in project value	Reduction of available risks
Operation zone	Concentration on performance	Concentration on purpose
Method of identifying Critical points	Based on creativity	Experiencing the risks in previous similar projects
Impact range	Change in performance to achieve accepted objectives	the possibility of change in predicted objectives
Continuity in project	is done in project only once	Continuously during the implementation of project
Evaluation of results	By comparing the value obtained on price	By the level of security in achieving the objectives
Application of standard methods	Creative ideas out of standard frameworks	Applying secure experienced methods
The flexibility level	Flexibility	Flexibility
Main orientation	Maximum ideas	Conservative and minimum ideas
The members of teamwork	Members out of the project team	Project team or having experience in similar projects

Risk management is a long term process which is continuously practicing during the implementation of project, however, value engineering is organized in a temporary workshop and only once in the lifetime of the project. This workshop for the maximum application of people's creativity and entering innovative elements into conventional implementation and planning procedures is composed of people who do not have history in formation and implementation of project to not be able to prevent innovative ideas by their prejudgments (Ear S. S & Gebel Ameli and Mir Mohammad Sadeqi, 2001). However, on the other side, the risk management is basically

founded on the experiences obtained and in general, people are present in this procedure who were involved with problems of the project and do not necessarily have the related history in that project or the same projects. The value engineering tries to increase usability by applying creative ideas out of the recommended standard frameworks of planning and implementation (Koga, Michael, 1996). Formation of value workshop in general means the use of methods besides the common methods of the work; however, the risk management, on the opposite side, tries to test experienced methods that give a higher level of security to a project. For this reason, the risk management, unlike value engineering that is a maximum and supreme idea, have minimum and conservative idea (Chapman, 1991). In table 2, a summary of this idea is represented.

Combination of value engineering and risk management

Development of value engineering circle by using the risk management

Lack of attention to available risks in the project and the impact of these risks on the final performance of the project and, on the other hand, creation of serious risks for the projects derived from recommendations of value engineering and not taking into account the cost of reducing and controlling the impacts of risks in the cost of the product show the need to represent approaches to joint application of risk management. Basically, these created risks and the huge impact they have on the project, motivated employers to look with caution and suspicion at value engineering, because application of the same common methods, though have higher cost compared to recommendations of value engineering, because of numerous experiences had fewer risks and are basically more secure. Thus, the level of risk of each recommendation should be entered into the evaluation of the value circle in some way. So, in addition to evaluation of recommendation regarding their functionality, the amount of the risk that project in case of implementation of the recommendation of the value workshop will face it, is also estimated. Removing or reduction of risk effects that are identified in this stage and their level are estimated is assigned to risk management. Therefore, the value engineering model should be developed someway so that by getting help from risk management they find the ability to recognize and reduce risks that threaten the project as a result of implementation of recommendation. In the developed model of value engineering, the value circle is reformed as follows: after the stage of innovation and production of new ideas, in the evaluation stage, these ideas is studied regarding their implementation capability and are graded. The next step is the circle of management and risk analysis. In this circle first by the analysis of ideas which came out of evaluation stage, risks derived from the implementation of each suggestion are recognized.

The necessity of using value engineering in civil projects of Iran

The statistics published by the organization of management and programming indicates that the average years of launching national and capital plans in country at present is 8 years and 54% of the civil plans of the country have problems of planning, 27% of incomplete civil plans are completed and 28% of civil plans have problems in utilization. Increasing the implementation costs over time and financial limitations caused that in recent decades utilizing the plans is done with delay. Certainly, the return of capital in these massive projects is also absorbed with delay that itself face economic justification with serious problem. In general, this problem arises when the interval between the study and design expands in the implementation stage. On the other hand, due to some reasons, the designer counselor may have no access to all basic information to calculate and provide the plan for selecting the best design, therefore, at the implementation stage that reveals the different aspects of work, hidden and unknown side effects reveals the operation, problems and deficits of designing appears. So, the controlling leverage of the counseling system by utilizing the value engineering knowledge formed of several technical experts to review and analyze the components of

work are again mobilized and organized so that the complete implementation of the plan is realized by the lowest cost and time. On the other hand, what is specified as an executive problem in several cases slows the speed of implementation and weakens the project management in representing a work with a specified timing is the existence of local opponents that due to not being completely justified about profitability, increase in the job opportunity, economic development in the region and other benefits that will certainly be mentioned in studies, not only does not accompany the executive department regarding the usual issues, but also, frequently and with different motivations act in such a way that after several months of conflict, finally the project direction is changed and its result, besides the damages of suspicion period includes a severe financial burden on the plan. Here the innovation in the thought of a multiple expertise group like engineering can play important role in evaluation of information and the primary plan and solves the problem in a technical and appropriate way. Although lack of the credit of plan in facing the prolongation of the time of implementing includes particular problems and limitations, however, reconsideration in the components of the work related to the ever increasing technology and removing part of costs that do not affect the quality of the plan and from the implementation point of view are also considered as unnecessary, can compensate for lack of liquidity in the workshop and inject a new energy to the plan.

The results of value engineering workshops also endorse their efficiency. Experiences show that the capital return into the value engineering is 20.1 on average. In other words, per each Rial invested in the value engineering sector, 20 Rials saving in the whole project is seen. According to results obtained in US, in 90 percent of transformation and road making and 25% of construction projects of value engineering is used (Jalal Zadeh, 2002). The amount of saving in the primary investment and avoidance of costs of utilization period and maintenance in the plans studied during 1995 to 1999 in the United States Bureau of Reconciliation equals to 101.7 million dollars. As it can be seen, the proportion of saving to the order equals to 21.8. The other sample is the saving derived from doing value engineering in the federal bureau of US highways. According to the statistics published in years 1997 to 2000 the prices and proportion of saving equals to 106:1 – 540 and 117:1 – 769 and 113:1 – 769 and 145:1 – 1128. The saving derived from operating this technique in years 1994 to 1998 equals to 115, 126, 123, 133 and 150 million dollars respectively.

Also, in recent years in Iran by conducting engineering studies, remarkable savings have been achieved. Among them, there is an amount of almost 50 billion rials in operating the Boland Gavshan, about 20 billion rials in the large channels of bridge watering from the Karkheh watering network plan and about 120 billion rials in the watering network of Talvar, Zanjan can be mentioned (Haj Shir Mohammadi, 1999).

Chain power plants of Yasouj

History

Studies of chain project of Yasouj in year 2009 in the ministry of Jihad Sazandegi starts with the cooperation of China research institute (ECHIDI), in the primary researches, the existence of a storage dome was predicted that was removed because of the difficult situation of geometry and technical and executive problem and in the future studies several options were analyzed and finally the option 9 of chain power plants was approved by the employer and the complementary studies were carried out. The executive operations of six power plants that had economical priority started. Two power plants of Kreck 1 and Pol Kelo 1 came into operation in 1994 and 2004. The executive operation of two power plants of Kreck 2 and Kreck 3 were also finished in the march 2005 and entered into the circuit. Two power plants of Pol Kelo 2 and Kakhdan were also launched and tested in July 2007.

The study of value engineering of the project of hydroelectric power plants of Kohkiloyeh and Boyer Ahmad

The studies of value engineering include several activities that the success of the value engineering team depends on the quick and yet high quality conduction of these activities. This was achieved in studies of value engineering of the organization with proper cooperation of the team members and because of the suitability of the number of members (12 people mentioned below) and their sympathy occurred properly. At first, the pre-study step was performed in 2 months that included holding the information exchange sessions, the pre-study workshop and providing pre-study report. Following the six phases, the second step of value engineering was evaluated.

The steps of implementing the risk management system

System programming

Maybe, this step can be known as the most important step in implementing the risk management system because the general framework of the work is determined in this step and any carelessness or incorrect identification of the situation, this step can lead to the failure of the system in the implementation step. In fact, in this step, the plan of risk management system compared to designing the implied system considered with regard to effective factors like the contract type, the kind of available resources, condition of the company, the project life time, level of different project authorities' cooperation in implementing the risk management system, etc compared to the system planning and the way of implementing it. As we know, system has a completely mathematical nature that is independent from its operational environment. In designing the system, factors such as psychological features of the system executives should also be considered and finally design the system in a way that in the implementing stage the least problems and attrition occurs. In order to implement the first part of risk management system which is "planning", the following cases are considered as the input.

It is clear that, with regard to the planning time and the time of risk management system access to different documentaries would be possible but all together studying these documents looks necessary (Moien Zadeh, 2004):

Table 3. The process of system programming

Pre-input	Input	Operation	Outputs	Output
The contract office The technical organs The key organs The contract office The human resource office	The project contract The technical features and scope of the project The project Correspondence Contracts with contractors Organizational chart and	Sessions with authorities and experts of the project Referential standard Scientific	The plan of project management	Sub-process 2,3,4,5,6,7

The planning office	description of duties Reports of advancement in the job	resources		
The planning office	The system operation history Risk management in other projects			

Analysis of risks and opportunities

The necessity of doing analysis

As it was mentioned, one of the main objectives of this system is to achieve a technique to do the planning of the project in the probable condition. Probably, we concluded that prediction of no incident is definitively possible and any prediction which does not lead to a definite number is undoubtedly accompanied with a percentage of probability. Thus, although doing any calculation about predicting the time and cost of project with allocating certain numbers as the time and cost of performing and allocating certain numbers as the time and cost of implementing activities gives us definite answer, it has low credibility and do not pay attention to the likelihood of occurring this answer. However, considering the uncertain data and probable intervals as the time and cost of implementing the project activities gives us probable answer but has more credit because it conforms more with reality and provides a more clear view of the project future, since it reveals the percentage of the likelihood of the time and cost of the project or the calculations' validity. You, as the project manager, which one of the following answers do you prefer after asking about the cost of performing the project?

The first answer: the total cost of project equals to 100 units.

Second answer: the probability of completing the project with 75 tomans is 10 percent and the likelihood of completing it with 110 tomans is 50 percent and the likelihood of completing it with 150 tomans is 90 percent.

Finally, it should be mentioned that based on the results obtained from chapter three of this research, it is clearly determined that value engineering has great capability in reducing the costs of completing the project since its reason for the reduction of 22% of costs is the value of project. On the other hand, it is clear that, based on the results obtained from chapter four of risk management, the results of risk management is reliable because regarding the hopes to statistical analysis performed, it can be firmly stated that the results of value engineering have great capability.

Maybe the first answer seems more certain and exact because the logic that is dominant on the sentence is the certainly logic but if we want to have a clear vision of the future of the project and as a result, have a better decision during the implementation of the project, we prefer the second answer because first we accepted the truth that prediction of no event is absolutely possible. Second, after hearing the second answer, the first thing that comes to our mind is that why 75 units and why 150 units? What cause the increase in cost from 75 to 150 units? And, the answer to this question

cause losing risks and planning and finally reduce costs and the time to implement the project. Then, a successful and informed project manager certainly prefers the second question and avoids the blind motion.

The following example can properly reveal the deficits of predicting in the certain state. As predicting the condition of the project with the method of critical direction and the CPM network is based on the prediction in the certain state. The simple network includes two parallel directions.

Table 4. Example of predicted deficits in the certain state

Time	Activity
5	A
7	B
4	C
6	D

The first state: the critical direction

In case of estimating the time of doing activities A and B and C and D and according to the above table, the network critical direction concerned is SABF according to which the time for completing the project is 12 units. Now, if with a more clear and realistic vision, we consider the probable states of activities leads to the following table.

Table 5. Estimation of time

Activity	Optimistic time	Probable time	Pessimistic time
A	4	5	6
B	4	7	8
C	3	4	8
D	5	6	9

With regard to the times referred in the previous table and by taking into account the probability of occurrence of each of the data of the referred interval, each of the following states may occur after the real implementation of activities, the above issue is mentioned in the following table.

Table 6. Process direction by considering the probability of occurrence

Activity	First state	Second state	Third state	Fourth state
A	4	5	4	5
B	4	7	7	7
C	3	4	8	8
D	5	6	9	6

If the first state happens, the project critical direction of both **SCDF** and **SABF** directions are:

If the second state happens, the project critical direction is **SABF** direction.

If the third state happens, the project critical direction is **SCDF** direction

If the fourth state happens, the project critical direction is **SCDF** direction.

So, we cannot consider one of the directions as a critical direction with certainty and concentrates on it to do network calculations and by such a viewpoint the calculations of critical direction and CPM network is challenged.

Data analysis method

In this section, the method of qualitative and quantitative analysis is studied, in order to finally create a system for the calculation of the qualitative and quantitative risks and opportunities on the objectives of the project and as a result the time and cost of completing the project in the possible state

The first step of analysis

Up to here, opportunities and risks are determined. What should be done in this step is to find the effect of each of opportunities and risks and the possibility of their occurrence. The first point that should be taken into account is the project objectives. The final output of the project at the time of making the contract of the project is determined and titled as the SCOPE domain of the project. However, the SCOPE which is the tangible and physical realities should be presented with specific quality. So, the quality also can be one of the objectives of the project. Other cases that should be referred to at the time of making the contract and can be taken into account as the project objective are the time, quality, domain and cost. In this step of the process of risk management, the level of the impact of each opportunity and risk on the project objective should be determined. In the first step, the level of impact on project objectives zone and are determined in tripartite categories of low, medium & high or five categories (very low, low, medium, high & very high). In order to determine the impact level of each opportunity and risk on the project objectives and their contract in each of specified category, the proximity of these categories should be defined.

Table 7. Definition of category zone

	Very Low	**Low**	**Medium**	**High**	**Very High**
Time	Influence the time of some activities but does not change the completion time of the project or has no impact on the time	affect the completion time of the project Less than 2 percent	affects the completion time of the project between 2 to 4 percent	Affect the completion time of the project between 4 to 6 percent	Affects the completion of project more than 6 percent
Cost	leaves no impact on the cost	Less than 2 percent affect the cost of project	Between 2 to 4 percent affects the cost of the project	Between 4 to 6 percent does not leave impact on the project cost	Affects the project cost more than 6 percent
Domain of quality (performance)	Does not have significant influence on the quality of domain	The quality of some part of the project domain is reduced	The quality of final of project output is reduced	Some part of project domain does not answer but the project remained uncompleted	Project uncompleted

It should be noted that if the accuracy of the data that is given to the risk executive is low, it is suggested to use tripartite categories of low, medium & high, otherwise the use of five categories would not be useful.

Such determination of project objectives (time, cost, domain and quality) depending on factors such as kind of the project, kind of the project contract, kind of identified opportunities and risks, kind of executive expectation from the process of risk management, etc a little different. For example, maybe if the exact tripartite or five categorized definition of the domain and quality separately, all are considered in a category titled the operation. The definition of categories zone can be as inserted in table 7.

Definition of categories boundaries can be influenced from different factors, including the amount of attention to opportunities and threats. If the intention of risk executive is to identify risks and general opportunities, he can consider the boundaries in a more general way for example, instead of putting more than 6 percent in the High category, more 20 percent is inserted in High category or…

One of the other factors that is studied in this part of analysis is the possibility of the occurrence of opportunities and threats that it is also like the effect of opportunities and threats in three or five categorization that is shown in the following table.

Table 8. Categorization of the probability of opportunity occurrence

Very Low	Low	Medium	High	Very High
Less than 20%	Between 21 – 40%	Between 41-60%	Between 61-80%	More than 81%

The nature of the act of calculating the possibility of each risk or opportunity is based on calculating the probabilities and the precondition for calculating the probabilities in order to calculate the probability of occurrence of an incident, the history of available data and resulted from the previous realities about that incident. It means that in order to determine the probability of occurrence of an incident, the related random sample should be provided so that the possibility of calculating the probability is provided. Now, if the required data is not sufficiently available to form the random variable, one should refer to experts that do the above operations repeatedly so that finally the probability of the occurrence of an accident is found.

Two factors about the opportunity or risk are analyzed:

- ✓ The level of impact on the project objectives
- ✓ The probability of occurrence

Now regarding these two factors we can find about the degree of importance of each of opportunities and risks, the following table shows the above issue.

Table 9. Determining the degree of five importance

	Probability				
Impact	**Very Low**	**Low**	**Medium**	**High**	**Very High**
Very high	M	H	H	VH	VH
High	L	M	H	H	VH
Medium	L	L	M	H	H
Low	VL	L	L	M	L
Very low	VL	VL	L	L	M

The output of first step of analysis is the degree of each opportunity or risk. It means in this step, each opportunity or risk identified in one of the five categories very low, low, Medium, High and very High or the tripartite, Low, Medium and High. As the tripartite categories are considered the following table is used.

Table 10. Determining tripartite significance degree

	Probability		
Impact	Low	Medium	High
High	M	H	H
Medium	L	M	H
Low	L	L	M

As it is observed, the output of this stage does not include the exact time and cost of conducting project and gives the only categorization of opportunities and threats with regard to the boundaries defined. Therefore, this step is usually called the qualitative analysis of opportunities and risks. One of the reasons for doing this step before starting the quantitative analysis can be saving the energy used to do quantitative calculations that needs less care and cost, by removing opportunities and risks are not important. Although it is possible that in some cases, the risk executive is just the first purpose of the risk management which follows controlling risks and proper use of opportunities and the second purpose i.e. no probable planning is considered, so conducting quantitative analysis is not necessary.

After finishing this stage of risk management process, a column is added to information bank of risk that includes the degree or level of each opportunity or risk. Of course, columns such as degree or amount of time, cost, functional (quality domain) effect, can also be added to the bank. The issue is shown in the following table.

Reaction to risk and the result of study

Regarding the degrees of risk, concentration on reaction, are respectively as follows:

1. Lack of conformation of architecture plans with technology
2. Absence of enough contractors in the field
3. Propagations
4. Inability to buy equipment because of current prohibitions
5. Inability for leadership with this technology
6. Increase in the population because of immigration
7. Increase in population
8. Increase in price and inflation
9. Unsettlement
10. Inability to manage project in coordinating insignificant contractors

In order to calculate the final degree and total impact, by taking into account the weight of functional impact 0.3, the cost impact 0.35, the time impact 0.35 and the management capability 0.25, the probability 0.30, the total impact 0.45, figure 3 can be obtained.

Finally, the following actions should be taken into account in order to react to risks referred above:

In the first case i.e. the risk of inconformity architecture plans with the suggested technology of value by the team, the only possible approach is to study before starting the project. The team stated that in order to prevent the occurrence of this risk, it should be studied before deciding to

implement the risk by the engineering team. In the next step, in order to solve the second risk i.e. inexistence of enough contractors, the team suggested the same approach. By considering the study to find a contractor with the ability to do and deliver the project on time. In the next step, in order to solve the risk 8, i.e. inflation and price increase during the conduction of project, the team suggested the estimation of cost by the economic programs by considering the inflation rate and the possibility of delay in loan and bank payments and also use of a confidence coefficient about 1.2 to prevent the lack of budget to continue the project.

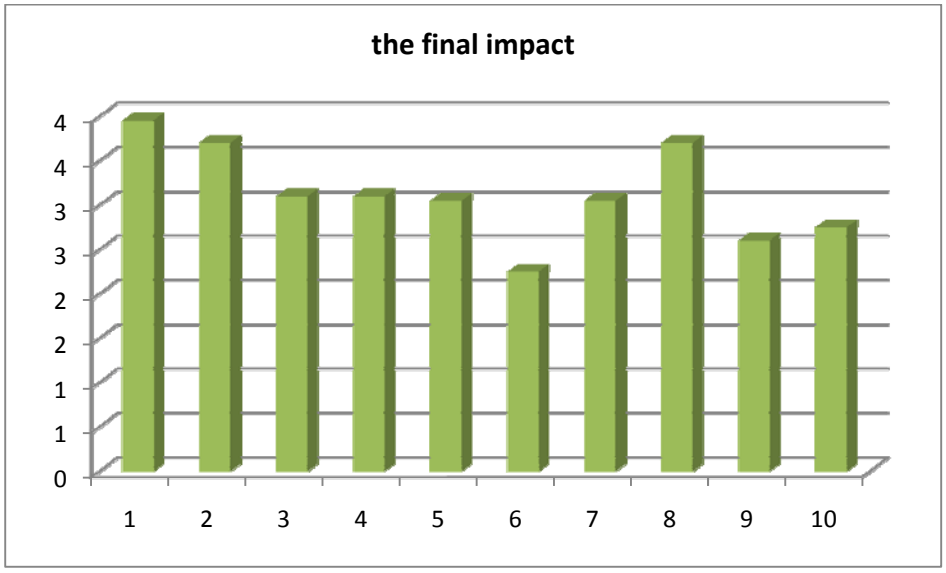

Figure 3: The curve of the degree of the final impact of identified risks

For the fourth risk, i.e. inability to buy equipment for the current boundaries, the team suggested that the international firms that produce accessories because of the current boundaries, the team suggested that by the international firms of accessories production, one should try to round the boundaries exerted.

In order to elevate the risk 9 that is unsettlement, two suggestions are recommended. First, the transferring service and then providing a temporary settlement.

In order to remove the risk 10, i.e. inability to manage project in coordinating small contractors, it was suggested that a special team composed of managers and deputies of different organs hold weekly or monthly justification sessions according to needs, in order to coordinate the organs with each other.

Conclusion

In general, the study of change from the value engineering viewpoint is composed of three parts: pre-study stage, principle study stage , and the over-study stage. In all three sections, the present research was performed by the presence of three value engineering teams including 12 authorities of the organization. In the pre-study stage, the required information was collected. The principle study stage included identifying the available plan, functions of the plan, giving idea, evaluation of idea, developing ideas and investigating the cost and in the over-study stage, the results of study was presented to the master of the plan.

The value study team after presenting 110 ideas for this project, in the evaluation step based grading and ranking, 10 ideas were elected and for these values and with regard to the current data

the pre-proposal was written that is presented at the end of this research as appendix. The important point is the results from implementing the values.

Accordingly, what is seen in implementing these values, one can save up to 22% of the primary costs of this project. One should pay attention to the fact that these values are risky that they may be created based on implementing each, therefore, implementing the named values necessitates the study of probable risks of each one that in the fourth chapter, the related risks are studied and for each, an approach was represented.

Finally, it should be said that based on the results of this study, it is clearly stated that the value engineering has great ability in reducing the costs of completing the project. Since, it caused the 22% reduction of the cost of project value. On the other hand, it was determined that based on the results of chapter four of risk management, the results of value engineering were reliable, because regarding the mathematics hope and analysis done, the time of completing the project have not changed significantly by reducing 22% of the cost of project value. So, it can be claimed with certainty that results of value engineering have high reliability.