Quantitative Risk Analysis and Integration of Value Engineering to Increase the Efficiency of Project Management Case Study: Sattar Khan Commercial Centre - Flour Parking - Tehran

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Abstract

Major organizations and large construction companies in the world are always looking for removing challenges of the project environment through risk areas. Potential risks that sometimes emerge at the beginning, middle and late stages of a project, and in case of improper dealing with it and not getting appropriate response and approach sometimes will lead to failure in the project-based organizations. But providing systemic solutions for transforming risk into opportunity and finding knowledge based on more accurate understanding of qualitative and quantitative risk analysis methods in the early stages of the project is an issue that since the past has attracted risk managers and experts' mind and is considered as the necessity of this research. A distinct use of the two approaches, risk management and value engineering in projects has long been done, therefore the combination and integration of these two techniques is an issue that during recent years has been highly regarded by the researchers and managers. Research framework contains a brief description and introduction of tools and quantitative risk analysis techniques, reasons and benefits of integrating risk management with value engineering and then description of case study. This research has provided a new way for planning and forecasting future performance of the final cost projections.

Keywords: *Risk management, Quantitative Risk Analysis, Value Engineering, Improve project performance*

1. Introduction

Many managers become confused because of uncertainty about the rate of risk of project activities (probability of occurrence and severity of the risk effect) and cannot find high-stakes risks and prioritize it in order to respond appropriately and in time, so a thorough and comprehensive study on the quantitative risk analysis tools and take advantage of the selected tools lead to elimination of the above problems.

In this study, after identifying project risks and introduction of tools and techniques of quantitative risk analysis, value engineering is introduced and an integrated approach to risk management and value engineering will be implementation and it has been dealt with the implementation of an integrated approach in risk management-value engineering in Sattar Khan flour parking commercial center project. The method is as follows: after the introduction of Sattar Khan project, the project risks are identified and classified, and it is determined that each one of the risks will be in which phase of the project lifecycle.

Since the assessment of risk occurrence probability and the impact of risk based on the qualitative criteria is an inaccurate process and a real comparison of the options is largely unknown in practice, the decision-maker or senior managers should certainly use the method of fuzzy numbers sets. By dividing the cost of activity with risks to the alternative performance cost, the index value will be achieved and the difference between the current costs and the cost of alternative performance using value engineering is the saving rate in any activity that is achieved using value engineering in risky activity.

2. Literature Review

2.1 Methods and tools Quantitative Risk Analysis and Quantitative Risk Analysis Application (Bodea & Purnus, 2010)

Quantitative Risk Analysis techniques such as probability distributions, Interviews, Monte Carlo simulation with discrete variables, Monte Carlo simulations of potential variable trail, Three scenarios approach, The probability distribution curve, Estimated triangular, Expert judgment, A sensitivity analysis, Tornado charts used in Quantitative Risk Analysis, Various methods Multiple Attribute Decision Making, Fuzzy set theory, Topsis, noted.

2.2 Value Engineering Methodology

2.2.1 Pre-study phase

By holding a brainstorming session in pre- study phase of the value engineering, the existing risks are preliminary identified in the scope of value engineering studies. The group facilitator is responsible to collect and formulate these risks in an open-ended questionnaire. The aim of formulating this questionnaire is to achieve both factors of the impact intensity and probability of the existing risks occurrence in the scope of value engineering studies with rely on the experience of experts present in the workshop of integrated approach for risk management -value Engineering.

2.2.2 Study phase

In this section, the work design will be followed. Designing of the work will lead study and examination on the sectors with high costs and low value and consists of six phases shown in Figure 1.

2.2.3 Post- study phase

The purpose of this section that sometimes is also called run is to implement the recommendations that have been approved as value engineering and are considered in the final design.

2.3 Workshop of an integrated approach for Risk Management- Value Engineering

In the process of value engineering, design and each one of its components are reviewed systematically and uniformly. Value Engineering creates ideas and offer multiple options for operating architectural projects by using intellectual creativity and collaborative effort. Assessment of the options resulted from the intellectual creativity in the process of value engineering is completed with qualified and skilful experts' review that in this study, experts were also used for polling.

At this stage, each member of the group adds to its efficiency, effectiveness and productivity by inviting a skilful and experienced expert in order to participate in this workshop. The group facilitator hands out a pre-developed questionnaire to all participants. The people are asked to add any other risks according to their own experiences in addition to the risks mentioned in the questionnaire in empty rows and then rate the probability of occurrence and impact the intensity of each risk. In this case, being aware of the risk characteristics helps the creation of productive ideas. In this step, value engineering workshops was conducted and the top ideas were identified and finally in the development phase of value engineering, value index of any top idea is calculated based on common relationship.

At last, in stage presentation, premier ideas were prioritized based on optimized value index resulted from an integrated approach "Risk Management - Value Engineering" and will be provided to the employer in its final report. Methodology of using value engineering phases is shown in Figure 1.

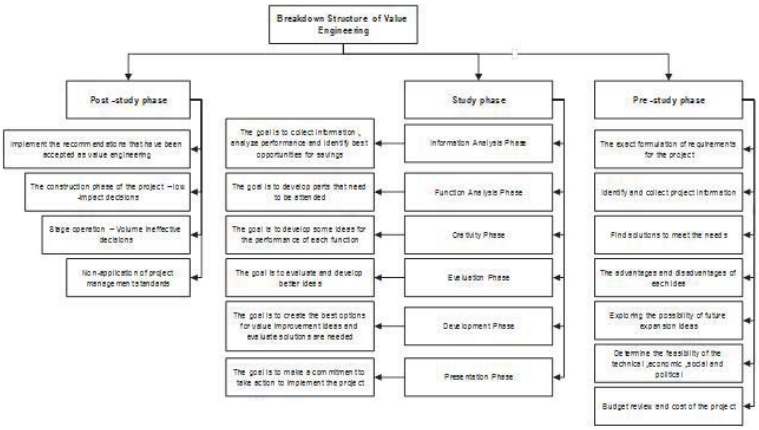

Figure 1. View of value engineering phases

2.4 Proper of time value engineering studies

The best time to conduct a study in the projects is in early stages of developing the projects because the recommendations of value engineering team is applicable with delay. In this regard, three time periods are recommended:

1. The planning phase for very large projects
2. After Preliminary design
3. During and after the design

According to the guidelines 100/215919 Management and Planning Organization of in Iran, Suitable time (mandatory and optional) for small projects (100- 20 billion), Medium (300-100 billion), Great (800-300 billion) and very large (more than 800 billion rials) are given in Table 1.

Table 1. The most suitable time and the importance of the projects value engineering workshop

The final feasibility study	The initial feasibility study	The size of the project
3-5day compulsory workshop	-	small
3-5day compulsory workshop	-	Medium
5day compulsory workshop	3day optional workshop	Great
5day compulsory workshop	3day compulsory workshop	very large

The methodology of this study, according to Figure 2.

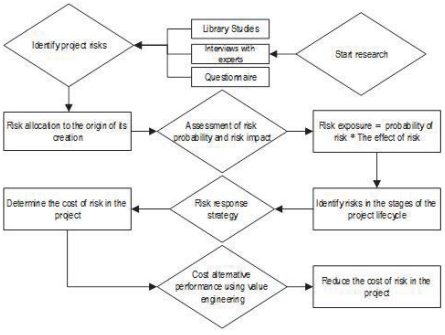

Figure 2. View of the overall structure research

3. Research Method

Statistical comprehensive taken from the opinions of experts which are involved in construction industry, but because of limited access to these experts, statistics is obtained by using non-random sampling and selection of homogenous. Hence, experts who meet the requirements for expertise and have at least 5 years relevant work experience were selected. According to the research, 100 experts attended in this comprehensive statistical which among them; it can be noted to the Project management experts, senior managers, contract managers, project managers, university professors and lawyers (Parchamijalal & Shahsavand, 2016).

Sample size for this research by Cochran's formula with acceptable error rate, i.e. 0.15 and confidence level of 1.96% was estimated to be 47 people. 47 people have participated in the research which indicates that the sample size is sufficient to generalize the results based on the formula that was used and its parameters that are as follows:

$$n = \frac{Nz^2pq}{Nd^2 + z^2pq} = \frac{100 \times (1.96)^2 \times 0.5 \times 0.5}{100 \times (0.15)^2 + (1.96)^2 \times 0.5 \times 0.5} = 47 \quad (1)$$

n statistical population
N sample size
P the estimated proportion of an attribute that is present in the population
q the estimated proportion of an attribute that is not present in the population
d level of precision
z desired confidence level

3.1 Data analysis method

To prioritize risk variables after collecting responses from the first questionnaire scores they were calculated based on the following formula and have been prioritized accordingly.

In this reaserch, to ranking of the factors affecting the risk, the views of 47 experts in the relative importance index is the used. In this method, respondents will be asked for a delay factor of 33, ranking the basis of that factor of 1 (Very Low important), 2 (Low important), 3 (Medium), 4 (High), 5 (Very High), allocate .The index calculation formula is as follows:

$$RII_j = \frac{\sum_{i=1}^{n} F_{i:1,\ldots,5} \times E_i}{x} \quad (2)$$

Where, RII is relative importance index of risk, Fi is frequency of any risk from 1 to 5, Ei is the impact of any risk from 1 to 5, X is sample contains a completes questionnaire (47 persons), i is the number of sample of 1 to 47 persons , j is the number of questions from 1 to 33. Then the percentage of the total points for each variable was calculated that is shown in Table 2.

4. Analysis

The procedure is as follows: in pre-study phase of the value engineering, studies and investigations and researches of a project are done and in this phase those issues such as: the exact formulation of the project requirements, environmental data collection and laws and regulations examination, study the advantages and disadvantages of each one of the designs and implementation side effects, explore the possibility of expanding the project in the future, social impacts and revenues of each project, study the feasibility of the project implementation from a technical, economic and political perspective, check the degree of appropriateness and cost of each project with its environment, statistical and geotechnical studies are being evaluated and in the main study phase, after finding data means and identifying the project risks and categorizing them in terms of source of risks and separating risks related to the factors involved in the project, by consultation with the project manager and the project engineers, the nature of the risk, and that the mentioned risk is placed at which stage of the project lifecycle has been identified,. To assess risk occurrence probability and risk impact intensity, the method of fuzzy numbers sets is used.

Table 2. Risk assessment activities and the use of value engineering project cost management in Sattar khan

Optimized Value Index)Value Index * Risk factors(	Risk factors related to value index (C/W)	The price of the alternative	The current cost of risk	Risk response strategy					risks in the stages of the project lifecycle			Intensity risk	The impact of risk (1 to	The probability of	Source of risk	Title of Risk	Row	Categories risks
				Use	Accept	Decrease	Transfer	Avoidance	Setting up	Performance	Planning	Feasibility						
17.8	13	1.37	80 million	110 million			*				*		12	4	3	Financial	Lack of timely financial payments	1	Risks related to employer
18.3	11	1.66	150 million	250 million					*			*	10	5	2	Economic-administrative	Lack of clarity in objectives and the technical and economic feasibility and environmental	2	
15.7	13	1.21	70	85				*				*	12	4	3	Economic - administrative	Lack of experts in the project and a lack of strategic vision	3	
18.5	11	1.68	95	160					*			*	10	5	2	Economic - administrative	Weakness in project definition and ultimate performance	4	
30.2	16	1.88	90	170					*			*	15	5	3	Management	Lack of risk management	5	
6.33	6	1.55	45	70		*						*	5	5	1	Unexpected	Lack of information about how to obtain special permits implementation of the project	6	
23.4	13	1.8	50	90					*			*	12	4	3	Management	Poor contracts	7	
28	21	1.33	60	80			*					*	20	4	5	The overall design	Defects in design trends	8	
23.1	17	1.36	55	75			*				*		16	4	4	Management	Changes in the schedule and scope of the project	9	
13.7	10	1.37	40	55		*						*	9	3	3	Environment	The lack of accurate and complete review of market conditions	10	
14.0	13	1.08	60	65			*					*	12	4	3	Economic-administrative	The delay in the delivery of land	11	
8.16	7	1.66	60	70			*					*	6	3	2	Financial	Inconsistencies in financing	12	
20.8	16	1.3	50	65					*			*	15	5	3	Management	Failure to make timely decisions	13	
31.2	26	1.2	75	90					*				25	5	5	ic-administrative	Roads leading to the site	14	
32.4	21	1.54	55	85			*					*	20	4	5	Detailed design	The absence of detailed maps	15	
15.6	13	1.2	50	60			*					*	12	4	3	Economic-administrative	Planning and scheduling improbable	16	
18.6	16	1.166	60	70			*			*			15	5	3	Technical	Special complexity of implementing and supporting structures compared to similar projects	17	Risks related to contractor
24.9	21	1.18	80	95				*			*		20	5	4	Safety	Non-compliance with HSE	18	
12.2	10	1.22	45	55					*				9	3	3	Financial	Buy expensive machines	19	
11.2	10	1.12	40	45		*					*		9	3	3	Administrative	Lack of timely delivery of materials to the contractor	20	
12.5	10	1.25	40	50			*				*		9	3	3	Administrative	Problems with transport to the project site		

5.38	5	1.07	65	70				*			*			4	2	2	Administrative	No guarantee of goods by suppliers	
14.2	10	1.42	35	50		*					*			9	3	3	Administrative	The imbalance between workload and team	21
12.1	11	1.1	50	55			*				*			10	5	2	Administrative	Contractors are not committed to their obligations	22
13.2	11	1.2	50	60			*				*			10	5	2	Administrative	Methods mistake	23
25.2	21	1.2	75	90			*				*			20	4	5	Technical	Inappropriate choice of machines and their maintenance problems	24
13.8	13	1.06	75	80			*				*			12	3	4	Technical	Lack of awareness of the efficiency of the machines	25
17.8	16	1.11	85	95			*							15	5	3	Administrative	Improper removal of workshop equipment and damage	26
24.7	21	1.17	85	100			*							20	5	4	Financial	Theft of equipment in the site	27
17.4	16	1.09	110	120		*				*				15	5	3	Administrative	Delivery delays and losses and poor quality projects	28
10.4	9	1.15	95	110			*			*				8	4	2	Administrative	Prolongation tests	29
33.3	21	1.11	135	150		*				*				20	5	4	Administrative	Problems setting up and operation	30
19.2	16	1.2	150	180	*								*	15	5	3	Unexpected	National macroeconomic risks, political, economic, social	31
12.4	9	1.38	65	90		*					*			8	4	2	Environmental	Strikes and riots	32
16.7	16	1.04	105	110		*					*			15	5	3	Environmental	Cases of force majeure	33

Risk related to external actors

5. Conclusion

The main objective of this research is to represent a model based on the combination of value engineering and risk management in order to improve project cost management process, with emphasis on the use and quantitative analysis of the existing risks in the intended project to improve the final cost of the project is to reform. For this purpose, firstly in Table 2, by providing a list of existing risks in the project and by knowing the finished cost of each activity and taking into account the risk factor and the value index and then the optimized value index, the difference between the costs of risk analysis method without using value engineering and by the method of implementing value engineering exercise, has been revealed and the standard deviation of costs criterion has been examined and it was found that how much it has been cost effective and efficient in the case of using value engineering in developing risk management in each one of 33 items of Sattar khan commercial centre - flour parking – in Tehran, and by comparing both factors of the current cost (c) and the cost of alternative performance (w) in Table 2, the issue of differences between the costs of the above project before and after applying value engineering is clearly evident and cost risk in this project is Rs 26 billion, USD 3255000000 due to the cost of project that by applying value engineering, this figure has been dropped to USD 2715000000.

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