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Presentation of a Conceptual Framework for Risk Management of Construction Projects Based on PMBOK Standard (With Case Study)

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Abstract: Designing and using a compiled system for managing and decreasing the available risks and expenses in the way of implementation of construction projects will have profitable results for successful finishing of project by paying attention to the cost, time and attracting the positive idea of project beneficial whit itself. It's a long time which this is the duty of risk management techniques but it's a short time that these techniques enter to the field of project management. The profitability and efficiency of projects risk we management system is confirmed by the majority of risk management experts. In this paper we will try to paying attention to the dimensions of construction projects risk management by considering the dimensions of risk management and available projects and intruding the system of projects risk management based on PMBOK[1] guideline. Then we will present the proposal frame work based on this standard. We also try to present some suitable operational solutions for recovering of time and expense simultaneously by using the framework of risk management for construction projects. We do that works also for evaluation of proposal system of the results of function before and after implementation of measured model which will have some desired results.

Key words: Project management · Project risk management · Construction project · Project management Body Of Knowledge Guideline (PMBOK) · Framework designing

INTRODUCTION

The intensity of changes in men's life and following that in projects has led to not accepting of absolute manners or zero and one and not accepting of try and error management because of restricted resources. This issue has caused to look at risk management one of the most important fields of project management which is used very organized and rule governed in some projects. Sufficient recognition of organizations and projects managers from this discussion has caused the efforts of this direction don't be useful and the other reason of that has been not having sufficient recognition of environmental and technical conditions.

It's presented different models for risk management through persons and institutions up to now but one of the most practical and well-known existed models is risk management based on PMBOK management which is practical in too many organizations and projects.

Some items of preference of this standard rather than the others are being practical in project management, consolidation with other project management process, clarifying of the ownership of risk in project, using process approach in methodology, registering in global standardizing organization, variety of techniques and instruments.

Consideration of Issue Literature: Primarily, in this part of paper, we define risk and then introduce the existed models for risk management and finally we compare the models.

Risk: Traditional view to risk is a negative view which is agent of damages, dangers and negative effects. Undoubtedly, usual concept and application of risk is lonely concerned of negative concept. This interpretation of risk has brought in the most of dictionaries and even technical texts and classic standards in project management.

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Statmen and Nigel define risk management as the high probability of defeat from management point of view [2]. British standard institute: risk is a combination of happening and results of a venture event [1]. Nigel defines risk like this: risk is said to the probability of happening of an unknown event, in such conditions which that event can be a reason for bringing out the problems. In the other words, risk depends on the situation in which the real result of a thing is probably influenced by an unknown event. This probability is while the probability and the effects of that event have been determinable exactly [2].

Currently, they have brought some of constructions and standards of risk positively or as an opportunity which by that they mean some risks with some profitable results on the project objectives.

KERZENR, defines risk as measuring the probability of don't achieve to definable objectives of project and generally risk equals not have the knowledge of an event in future. Usually the events related to good and desirable happens is called opportunity and some unfavorable events is called risk. The guide of the field of project management knowledge which is published by the project management institution knows risk as an event or conditions of uncertainty which if happens, will has some negative or positive impacts on the project objectives. Project risk consists of some threats for project goals and some opportunity for improving these goals [3].

Risk Management and its Models: Risk management is a dynamic and active method that response to the conditional questions whit if. In the other words, project management represents different conditions for each part of work, considers the impacts of happening an event and finally answers to the conditions logically. It does these works for positively impacting the projects objectives by that.

Up to now it's represented 13 models for risk management from 1991 till 2008:

- SHAMPU model: this model has been introduced by WARD and CHAPMAN in 1997and is famous by the name of SHAMPU. In this model, each phase of risk project is described with details. It consists of 11 phase [4].
- ALARM model: this model was represented by 3 English institutes which were considering risk project. It consists of 6 phase called: evaluation, analyzing, risk appearance, response to risk, review and purify the process of risk project. In this model each of these phases is divided to some subdivisions [5].
- PRMA model: this model was accepted formally in 2004.approach of this model is process based for risk project. It has 5 main phases called: risk concept development, risk recognition, risk analysis, risk examination and responding to risk and 2 supportive processes of purifying and revising and consultant relation [6].
- PRAM model: it was represented in 1997. It has 6 stages called: project defining, concentrating on PRAM, recognition, evaluation, planning and management [7].
- G.Sminth model: it was defined and represented in 2002 by Smith. Its phases are: risk realization, analysis, having priority, finding a way for responding, control and purification of risk [8].
- Leach model: it was represented in 2000. It has composed of 8 phases: realizing of risk intuitive events, estimating of risk probability, estimating of risk impact, recognizing the intuitive stimulators of risk, avoiding of risk event, planning for risk decrease, project insurance against risk, purifying the risk stimulators [9].
- Pritchard model: Pritchard represents his model in 1997 in 4 phases called: risk planning, evaluation, response development to risk and risk control [10].
- Max Wideman model: Max Wideman formulates a 4-phased process for project management which consists of risk realization, response to risk and making the risk well-documented.it will be described completely here [11].
- Boehm model: Boehm declares a 2-phased process for risk management. One of them is risk evaluation which consists of the stages of recognition, analysis and making priority. The second one is control which consists of planning for risk time, risk division, planning for purifying risk, trailing and reforming functions. It's represented in 1991 [12].
- Fairly model: Fairly represented his model in 1994. it includes 7 divided stages. They are realizing the risk factors, evaluating of probabilities and impacts of recognized risks, strategies development by purpose of risk decrease, purifying the risk factors, applying the event plans, crisis management and coverage against crisis [13].

- Software Engineering Institute model: This model is represented in 1996.it looks at the issue as a process with 5 phases. They are recognition, analysis, planning for responding to risk, trailing and control [14].
- Ludin, Kilem model: Ludin and Kilem represented 4-phased process (recognition, analysis, control and reporting) which equals the four phases of dynamic cycle [15].
- Risk management in PMBOK Guidline: project risk management consists of some phases which are in relationship with the guidance of risk management, dissolution, responding and supervising and controlling of that in project. These activities often make up dated along the project. The objectives of project risk management are, increasing the probability and impact of positive events and decreasing the probability and impact of unfavorable events on project. This model have 6 phases which are: risk management planning, risk recognition, risk qualitative dissolution, risk quantitative dissolution, planning for responding to risk, control and supervising on risk [3].

Comparison of Models: By brief considering of these models, it's obvious that model's stress to the purification phase is more during the years of 1991 till 1994. Researchers considered various phases for representing information from project situation and their risk.

Phases related to the methodology and completion was created from 2000 by a tendency to foundation of risk purification phases. And after that purification phase found a special place for itself among the other phases of risk management.

By looking at the recent models from 2000 to 2008 we can find some balances and coordination among recent years. In these models the number of phases and internal nature of them is determined and their rather place is determined. The only disagreement is for classification and division of phases to some smaller one. Phases like recognition, analysis and dissolution and examination are nearly declaring a unique concept and getting same information which declares some times by more division or some times by less division in the form of different models.

The comparison of models with each other shows that for considering the risks on a project, there are usually the same concepts of recognition, analysis and dissolution, examination and purification. These concepts are very expanded and general and their field and space of operation must be determined. Different models are created by paying attention to the type, characteristics and nature of projects. But generally, all the models have moved to one unique form during passage of time and have had the same changes and their similarities are very near to each other. These similarities have caused the models of after 2000 have some noticeable accordance with each other.

Proposal Framework of Risk Management Based on PMBOK Guideline: By paying attention to this issue which the nature of each standard is general, we can't expect of standard to represent a total, practical whit details framework for risk management. On the other hand, the distinction between standard and framework is just this point. Standard draws the total lines but framework should represent the practical solutions for arriving to the results from data.

The represented instruments in guide of explanation of project management knowledge have not been defined yet. The offered framework based on librarian studies has been defined in two levels. In the first level, framework has 5 stages which is introduced in the diagram of format 1. It consists of below stages:

- Make Structured and planning
- Risk recognition
- Risk qualitative Analysis
- Risk quantitative Analysis
- plannig for responding to risk

In the second level, we describe all these levels completely.

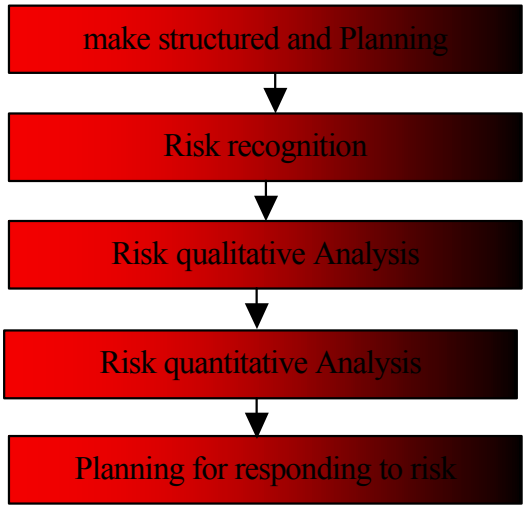

Fig. 1: First Level Of Framework

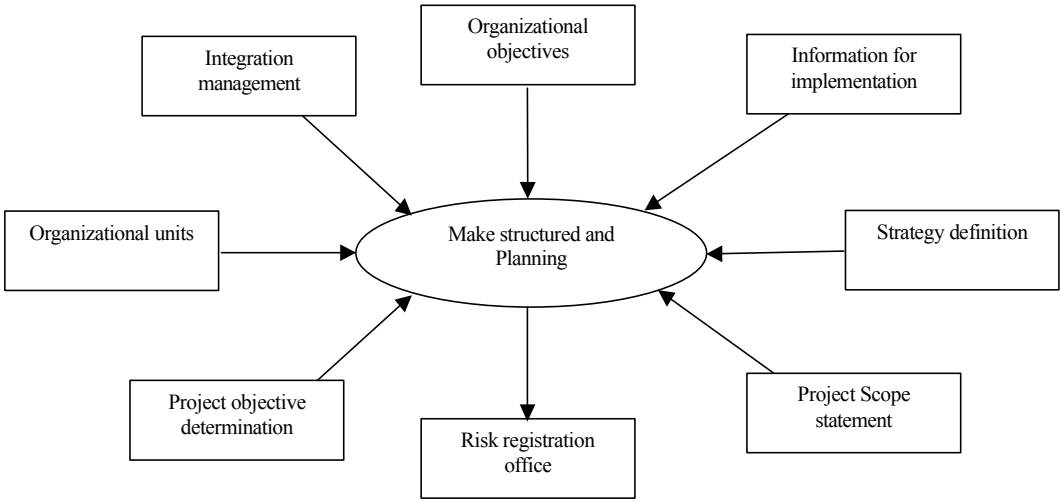

Fig. 2: Second Level Of Framework Make structured and Planning

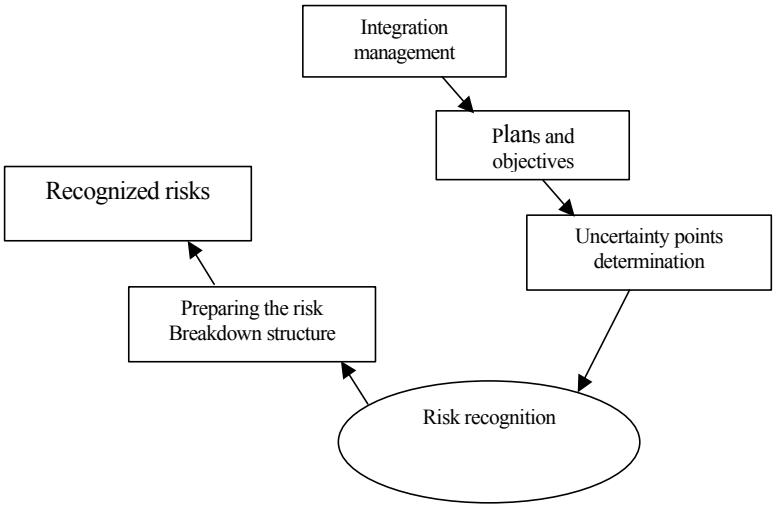

Fig. 3: Second Level Of Framework Risk recognition

Costruction a Planning: In this stage, by paying attention to organizational structure, project objectives, statement, mission and also the charter of the project of structure making and composing the team f project risk management have been done. One of the most important points which should be noticeable is the project scope statement. In this phase, there had been different meetings in the field of the way of framework implementation in 2 phase structure which is brought in shape 2. The outputs of this phase are registered in the book of risk registration.

The inputs of this phase are project objectives, project scope statement, organizational structure, methodology of operation implementation and project charter. Based on this issue they will have some meetings called project risk planning and making structure. Output of this phase is composing teamwork for managing the project risk by considering the organizational necessaries.

Risk Recognition: In risk recognition, the risks which can effect on project objectives are recognized. The used approach had been brainstorming meetings and also questioner.

The risks are recognized in this phase and the structure of risk defeat is got here. The framework of two phases of risk recognition has been brought in Fig. 3.

Integration Management.

The inputs of this phase are objectives, plans and determination the points of uncertainty and also Integration management. In this stage there have been some meetings with appearance of project beneficial with the team of project risk management.

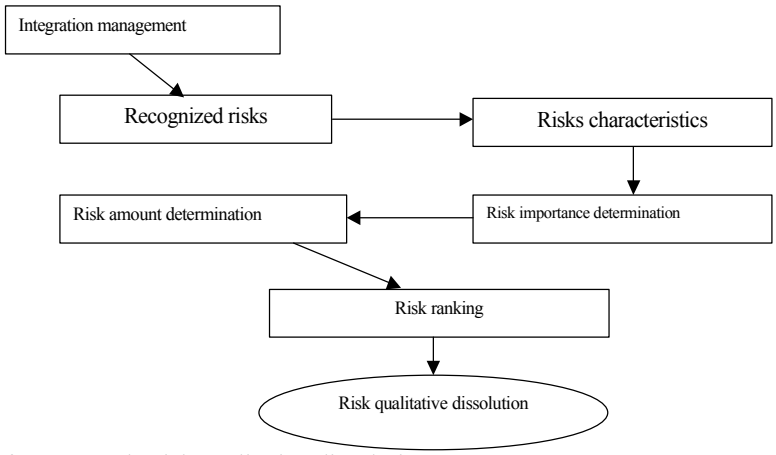

Fig. 4: Second Level Of Framework Risk qualitative dissolution

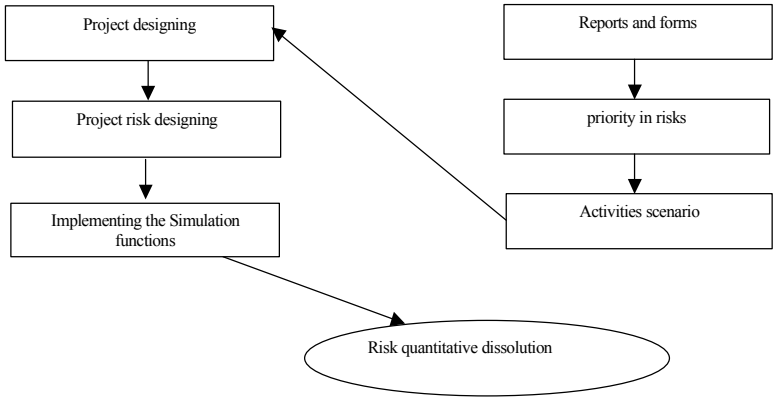

Fig. 5: Second Level Of Framework Risk quantitative dissolution

Risk Qualitative Dissolution: After editing the structure of project risk defeat, the level of risk qualitative analysis and making priority start. In this stage the amount of probability of happening of each event and also the amount of its effect on the function objective is determined. Risk qualitative dissolution is a process in which probability and effect of happening the recognized risks has been evaluated. This process ranks the risks based on the amount of its effects on project objectives. In this project by paying attention to the achieved average of results and the probability of happening risk and its impacts, method of matrix for the amount of happening and its impact has been chosen. Three below stages are noticeable and significant in the process of risk qualitative evaluation in the form of step by step for this phase of project risk management. They are as follow:

- We choose the expense of that factor which has the most impact on project, among the results of time factors.
- Calculation of amount of risk in the form of product of happening probability and the maximum of each risk impact.
- Ranking of the factors of risk based on the amount of risk

Framework in second level and the phase of project risk qualitative analysis are like shape 4. The inputs of this phase are: work division structure, risk characteristics, determination of risk importance and also determination of the amount of risk. This function is done by the questioner. The outputs of this stage are risk amount determination and risk ranking. In this stage, maximum tolerance of risk is determined by organization and the selected risks for entering to the phase of risk qualitative analysis are chosen.

Risk Quantitative Dissolution: The goal of risk qualitative dissolution is determination of the amount of achievement to project objectives. We use the soft ware of Excel and Primavera in risk quantitative dissolution. By helping of that soft ware we can do modeling and simulation by using the method of Monte Carlo. The framework of level 2 in risk quantitative dissolution likes Figure 5.

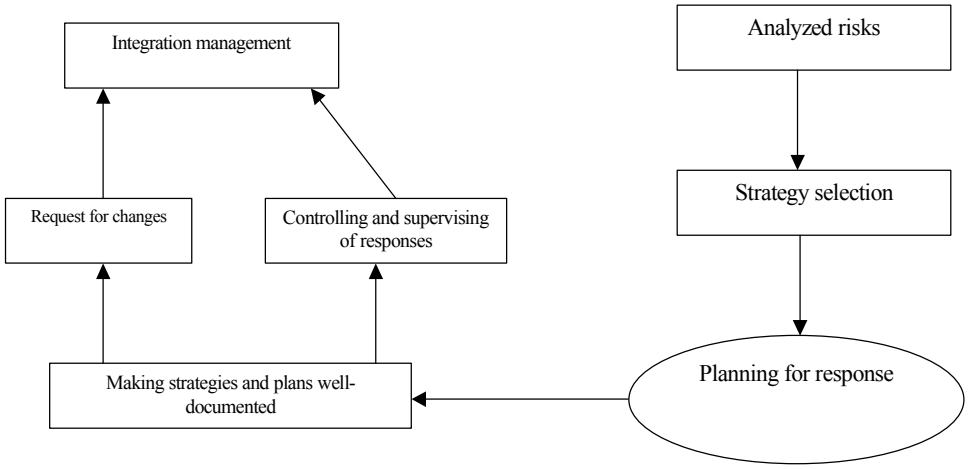

Fig. 6: Second Level Of Framework Risk quantitative dissolution

Inputs of this phase are forms and reports, risks with priority and determination the way of making scenario for time of activity. Usable distribution for time and cost of activities is a triangle one in which the all manners of optimistic, pessimistic and probability with the influential risks on the activities enter to Primavera Pert master and simulation functions. Outputs of this stage are the records related to the amount of probability of happening the activities by considering the activity time and also the considered costs for activities.

Planning for Responding to Risk: In the plan of responding to risk, the necessary functions for increasing opportunities and decreasing the probable threats for achieving the project objectives will be determined. Risk according to time happening is divided to 4 strategies: 1-avoidance 2-transfer 3-decrease 4-acceptance. Selection the strategy of responding to risk must be done by paying attention to the risk nature and the time of response representation. Framework in level 2 in the phase of risk response planning likes shape 6. Inputs of this phase are analyzed risks, choosing a suitable strategy and also operating the selected strategy. Outputs of this phase are determination of response strategies, making the strategies well-documented and determination of function plans and probable application of change in project united management.

Implemantation of Proposal Framework in Apart of Tehran-North Freeway Project: This framework has been implemented in the 4 part of Tehran-North freeway project and the steps related to the framework were implemented in this project. The called project was started in 2010/23/9 and its subject was way, tunnel and bridge. We were needed to implementing of time and cost management in project for observing the results of implementation of called model.

Objectives and priorities of project for beneficial were determined by having some meetings with project operators in the phase of risk planning and making constructed and team of management was composed.

Then, in the phase of risk recognition, the project risk makers factors and the project risk breakdown structure (RBS) was determined which is represented in Fig. 7.

In the phase of quantitative analysis, after risks exploitation and classifying them we used questioner for determining the mount of happening probability and risk effect on project objectives. This questioner was distributed among 45 persons from project beneficial. 41 questioners were gathered. They used from this digits (0.1-0.3-0.5-0.7-0.9) as the base of giving mark for determination of happening probability and (0.1-0.2-0.4-0.5-0.8) which is showed in Table 1.

Table 1: Weight factor

Impacting on time and cost	Less than 5%	More than5%-less than 10%	More than 10%-less than 20%	More than 20%-less than 30%	More than 30%
Measured numbers	0.1	0.2	0.4	0.5	0.8

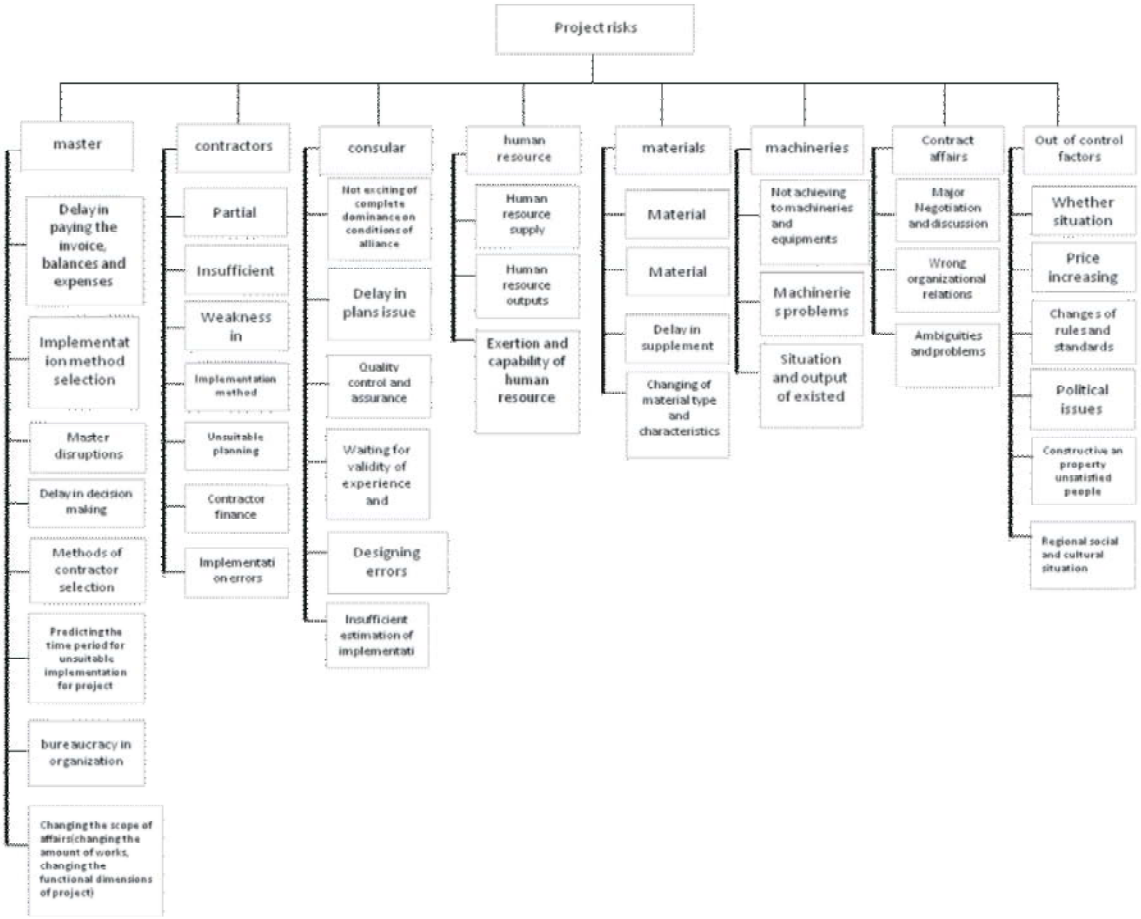

Fig. 7: Risk Breakdown Structure of Project

They did quantitative analaysis in accordance to the following stages:

- Selecting some factors which have the most impact on projects from the results of time and cost factors (risks list, figure 7)
- Calculation of risk amount in the form of product of happening probability and maximum effect of each risk
- Ranking of risk factor in the form of descending

After analyzing the questioner and project manager opinion and project beneficial, the coefficient of risks which are critical till 0, 25 were determined. On the other hand, project team knew the risks up to 0, 25 tolerable for themselves. Ranking of these risks is as follow:

- Inappropriate planning
- Insufficient estimation for cost of project implementation
- Predicting the time period for unsuitable implementation
- Unfavorable weather
- Weakness of workshop management
- Economic inflation and prices increasing
- Insufficient experience of contractor
- Delay in agenda
- Delay in material supply

In phase of quantitative analysis, the risks related to each activity by paying attention to done qualitative analysis in the previous stage, enter to soft ware, notice that this phase operates as a circle between risk qualitative and quantitative dissolution. Also for obeying of PMBOK methodology, triangle distribution is selected for activities statistically distribution. In This distribution, activities time period is used in 3 forms of optimistically, pessimistically, probable.

After complementation of project's premier plan, simulation functions were implemented by soft ware.

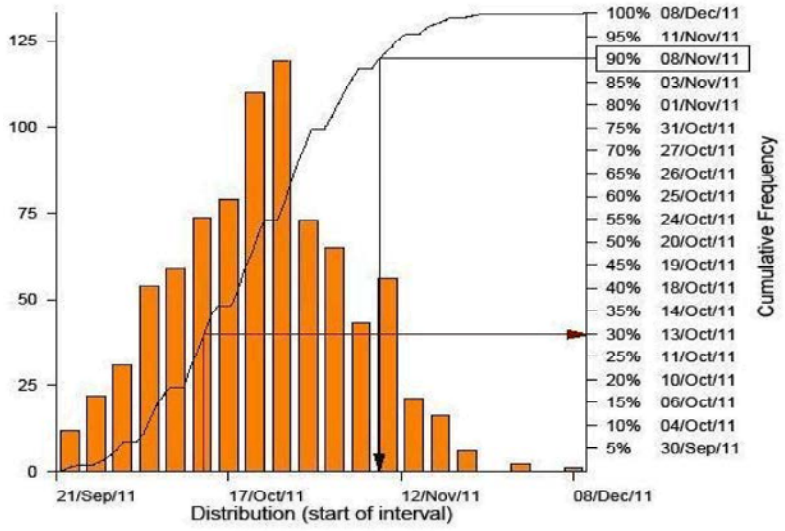

Fig. 8: Bar chart Estimate Finish date of project

Table 2: Respond to the priority risk

		Strategies for responding to risk			
Nom.	Risk factors group	avoidance	transfer	decrease	acceptance
1	Unsuitable planning	√			
2	Insufficient estimation for project implementation cost	√			
3	Predicting the time period for unsuitable implementation of project implementation	√			
4	Weakness of workshop manager	√			
5	Price increasing and economic inflation				√
6	Insufficient experience of contractor			√	
7	Delay in factors, invoices and other project payments	√			
8	Delay in material supply	√			
9	Unfavorable weather conditions			√	

Monte Carlo simulation functions are implemented on project by 1000 times repetition. Defined mechanism for simulating of Primavera Pert master soft ware is in accordance with Monte Carlo methodology. Considering the done simulation on project with coefficient of 90% in 1000 times repetition will be finished in 8th November 2011 which the premier time for ending the project according to first plan is 2011/15/5 which will be finished by 3 months delay and you can observe it in figure 8.

For interpreting the results of simulation and project's risk quantitative dissolution, we use bar chart. Bar chart is one of the most powerful graphically instrument in Primavera Pert Master soft ware which we use it in project.

For adopting suitable response for recognized risks with priority factors above 0, 25 which were mentioned in the part of risk recognition. For preparing Table 2, there was a meeting with appearance of Tehran-North Free way project operators and decisions were reflected in Table 2 after considering the discussed issues. As it's clear in Table 2, responding strategies to risk by paying attention to the proposal framework is divided to 4 groups which are: avoidance, transfer, decrease and acceptance.

Results of Framework Implementation in Tehran-North Free Way Project: This project, before implementing the proposal frame work had 16% physical development but in accordance with plan it must have 34% physical development. Its real expense was 52, 15 billion Rials in this period but it must have been 40, 08 billion Rials in accordance with plan. Cost performance index (CPI) is 0.5 and schedule performance index (SPI) equals 0.63 in this period.

Proposal framework has been implemented at the end of 2011/20/1 and the following results have been achieved:

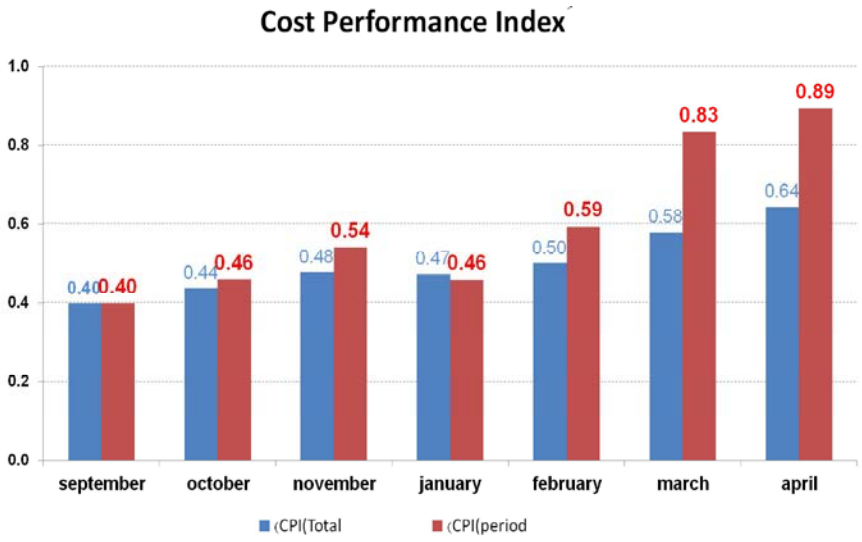

Fig. 9: CPI of the project Before and after Run the Framework

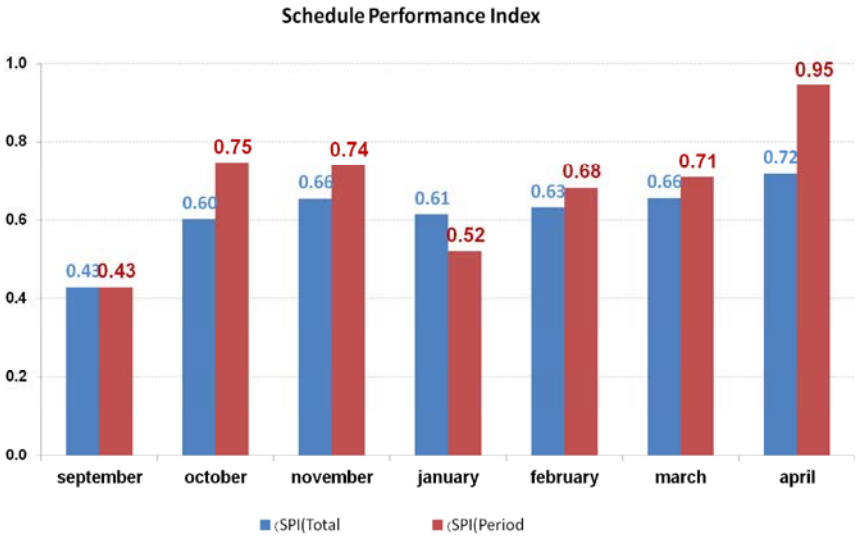

Fig. 10: SPI of the project Before and after Run the Framework

Percentage of development in 2011/20/1 was 4.17% that after its implementation, periodical development increased to 6.15% in February of 2011. Periodical cost index was 0.46 at the end of Day and increased to 0.59 at the end of February 2011. Project time index increased from 0.52 to 0.68 in the period of February.

It's considerable that whit Implementation of framework from the beginning of project and considering the united management in organization can achieve some more favorite results.

We can observe the results of schedule performance and project cost performance after and before of implementing the proposal framework in the figures 9 and 10.

CONCLUSION

Related studies in the field of this research clarified the necessaries of paying attention to constructive project risks more than before and the designed frame work based on PMBOK methodology prepared an edited, systematic, repeatable and practical frame work in the other constructive projects.

In this study, all the phases of risk management is implemented based on PMBOK standard and designed frame work operationally and in the form of case project and it has had some favorite results. Proposal mode and done method can be used as a general model among the constructive projects, by changing in risks defeat structure. Also we

can consider the qualitative and quantitative dissolutions as guide recourse for other constructive projects.

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