

The Importance and Use of Risk Management in Various Stages of Construction Projects Life Cycle (PLC)

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Abstract

Risk management is a step to make construction projects more efficient and practical such that uncertainties should be identified before occurring and changing into crisis and a balance should be made between threats and opportunities. Accordingly, construction industry is one of the most important and job creating industries in all countries. Compared to other economic-industrial sectors, construction management is highly influenced by the perception and employment of risk management concept. Additionally, there are abundant risks in such activities since Construction projects activities are very complex and various. Hence, it seems necessary to evaluate the proper use of risk management in various stages of Construction projects life cycle. In this regard, the present study attempts to describe Construction projects life cycle step by step and analyze the way of using risk management from designing stage to reviewing and supporting stage. The final objective of the study is to describe the process of using project management and its tools to create an optimal status in terms of risk and return balance in order to reach main objectives in construction projects.

Keywords: risk management, construction projects, project life cycle (PLC), and construction management

1. Introduction

The success of a construction project is evaluated based on the results obtained based on project objectives in the form of determined time, cost and quality. Also, achieving desirable results depends on the way of managing risks the project face with. Most of construction projects managers start to work only with a vague view of project objectives and priorities. Each of risk management processes involves applying analysis, planning, control, and managerial techniques employment that require investment (Akintoye et al., 1997). Furthermore, to execute this process in organizations, necessary infrastructures such as technical, backup and computer infrastructures as well as information banks and processes should be provided. Awareness and perception about the importance of construction projects management should be clarified in project management decision makings. The natural structure of these decisions is construction projects life cycle (Tah et al., 2000).

Risk plays a significant role in success or failure of various industries, particularly construction. As a result of influencing cost, efficiency and time of project execution, risk appears as opportunity and threat. In construction projects, risk factors include climatic change, cultural differences, instability, the possibility of change in state's policies, and economic-financial problems (Zavadskas et al., 2009). Big construction projects involve many risk factors that influence project results; therefore, it should be properly managed. Project management association defined "risk" as uncertain event or conditions with positive or negative effects on project objectives if occurs. Project management association also defines risk management as the systematic process of identifying, analyzing, and controlling project risks to maximize positive results and minimize negative results (PMBOK, 2004). Even with the use of risk management tools in development projects can be used to optimize costs (Eskandari & Korouzhdeh, 2016).

The schematic of project life cycle is necessary to provide a framework to predict uncertainties resources untimely occurred and be informed about the changing time of risk management in project life cycle. To execute risk management process, establishing relation between risk management process and various steps of project lie

cycle can strongly increase the efficiency of the process. In the present paper, in addition to reviewing risk management changes and integrating risk management with construction projects life cycle, the importance of this process in various steps of life cycle is investigated based on different examples of risk. Also, risk management model in project life cycle is presented by considering the importance of managing different factors influencing project life cycle states. The risks of large-scale construction projects can be fuzzy Topsis are also used (Shaffiee et al., 2016).

2. Analyzing Risk Management Process in Construction Projects Life Cycle

Project life cycle is an appropriate method to explain general structure of construction projects in each period of time. Project life cycle structure is generally determined based on the nature of project. Most of uncertainty resources of project have been identified late due to not managing them in early states of the projects, leading to destructive effects on the project. Therefore, detailed structure of project life cycle can properly organize risk management. The opportunities of risk management execution during project life cycle are considerable. Risk management can effectively employed relying on different and separate bases in each stage of project life cycle, without executing risk management in previous or next step. On the other hand, late starting can be followed by limitations in reacting to cope with risk. The range and depth of analyses will be increased by moving towards execution stages (Tserng et al., 2009). Before starting any step of analyzing risk, at the first stage, movement path can be specified and risk is analyzed with more details by considering more detailed issues and various alternatives in next stages to effectively direct project management process. Risk management should be considered as a complement of construction project management in each step of project life cycle.

To analyze risk management process in construction projects life cycle, Figure 1 has been presented. In general, life cycle connects various stages of a construction project to each other from beginning to the end. Also, a single life cycle cannot be separated and employed in all projects some organizations adopt policies to standardize life cycle of all projects and some other assign project manager and project team the authority of determining various stages of life cycle based on each project demands. In each project, life cycle steps are determined with respect to the nature of project and the importance of inventories delivered in different stages of project.

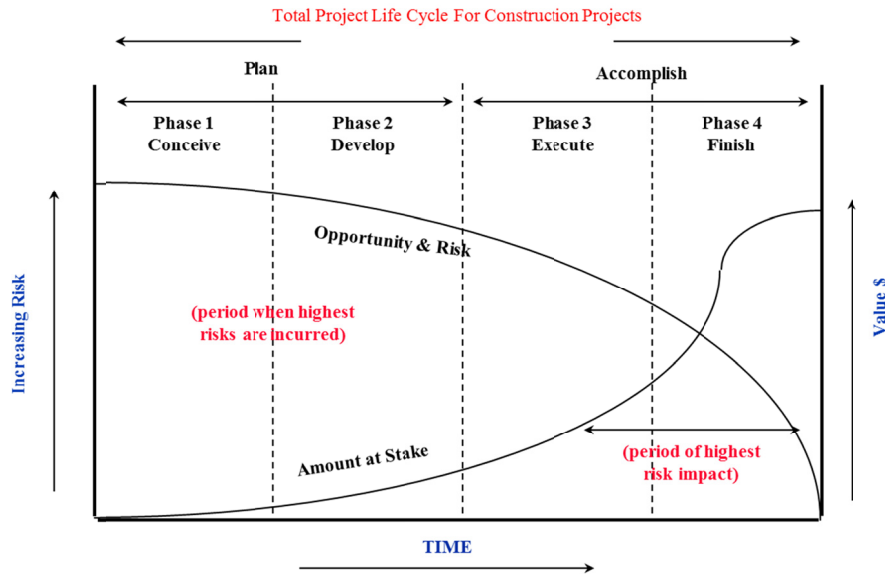


Figure 1. Project life cycle with respect to risk management in construction projects

Figure 1 show that risk management in early stages of the project life cycle to the end of designing stage is more difficult than execution stage and after that. It is due to the fact that in the early stages, project concepts are not accurately defined. In the early stages, risk management is usually strategic and creative and limited to focusing on identifying and exploiting opportunities. Also, there are few cases that are considered quantitatively, formal and at tactical-operational level. Formal risk management execution in an objective-profit-design structure requires risk management in the earliest possible time and at designing state preferably. At the stage of ideal developing in project life cycle, the most important problem is to exactly explain the main objectives of project and breaking them to determine the relation with each macro activities of the project. Late start of risk

management process in a project causes many problems. At the beginning of execution stage, with respect to the signed contracts, contractors in charge of supplying equipment's and execution are determined and the responsibility pertained to each project are also specified. Changing in risk management, compared to the stage of design, is very difficult and ineffective and it may create considerable additional cost in the project.

3. Risk Management Process at the Stage of Designing Construction Projects

The stage of designing is the best time of stating risk management process in construction projects and construction industry. It is due to the fact that in this stage, the macro objectives of the project, design of the project, and its time and cost are determined at strategic level and the time of investigating its related risks is at detailed levels. In this stage of life cycle, identifying all uncertainty resources and reactions related to life cycle steps, organizing and determining their relations, determining managerial and financial responsibilities related with each of risks, and their qualitative and quantitative analyses are performed (Lyons et al., 2004). In fact, at the end of designing stage, all project risks and their individual and combinational effects on the project are determined and prioritized. After the stage of designing, risk management process will control the obtained results, and apply reactions determined in considered step, reviewing identification, organization and analyses, if necessary. If risk management is started after the stage of designing, all the next stages of risk management will be executed in the project. The only difference between them is in applicable reactions imitation due to passing time of the project, spending cost and time to compensate unpredicted risk occurrence or the impossibility of compensating works done in the project. In designing stage, risk management process is as following:

3.1 The Definition of Project: the First Step of Risk Management in Construction Projects Design Stage

Independent from the fact that risk management process starts in which steps of construction projects life cycle, all project beneficiaries and their expectations as well as macro objectives of project should be identified through available documents and precise study of the project history. Exactly identifying beneficiaries and objectives of project can be highly effective in the effectiveness of risk management process and probable selective reactions to cope with various risks in project. In other words, not identifying beneficiaries and macro objectives of project can change them into important uncertainties in the process of project execution.

▪ Identifying beneficiary factors in project:

It is necessary to have a wide and safe view of all beneficiary factors of project and deep view to identify the expectations of each of them can considerably influence affect the project. Beneficiary factors are discussed in two preliminary and secondary classes. Preliminary beneficiary factors include individuals or organizations related to project through legal contracts. This class is associated with employer, investors, suppliers, work groups, customers, project management team, organizations partners. They can directly influence the project. This class is superior in terms of decision making and all their opinions and commands should be confirmed. The secondary beneficiary factors include individuals or organizations that are indirectly influenced by project effects. This class is legally involved in the project and its activities and they are not necessary to continue project life. This class includes municipalities, citizens, environments' advocate, different organizations, publications, media, etc. These can indirectly influence the project execution and enter very important uncertainty resources in the project.

Beneficiary factors of the project can create risk cases influencing project execution. Basic changes in the project design require adopting all key members including preliminary beneficiary factors of the project. If preliminary beneficiary factors regarding project changes are not justified, the process of management decision making regarding this change in the design can be changed into crisis management instead of risk management. In some projects, beneficiary factors influence the project in larger scale. For example, different technical needs, different comments regarding scheduling and budget design, different contractual systems among factors and contractors can highly influence the project execution and change the path of the project sometimes. If separate objectives of each of beneficiary factors of the project are met in the project, it is impossible to determine macro objectives of the project to cover all partial objectives. To manage uncertainty resources and risks related to beneficiary factors, it is highly important to identify all these factors, their reactions in different steps of life cycle and during the project execution and the effect of these reactions on the project execution. In this regard, the reactions related to the expectations of each of beneficiary factors with the parties' agreement should be determined before the end of designing to prevent problems in the next steps and particularly execution.

▪ Identifying weighting macro objectives of project:

Identifying the project objectives is highly important for the project. This fact will be also important in terms of risk analyses structure formation through the project objectives structure. To actualize this fact, it is needed to

identify the nature of the project objectives, their important related items, the way of measuring them, and the relation between various objectives of the project (Pica & Massimo, 2016). For instance, project managers should consider the priorities related to cost, time and quality with respect to their relations and mutual effects of these three executive criteria. If this act is not actualized, each of project team members may individually adopt improper decisions regarding various projects, leading to the deception and lack of concentration of the project organization. Given to the priorities and uncertainties resources, different project objectives and their related efforts can be explicitly recorded in an analytical structure and used in the next risk management stages in the future steps.

3.2 The Main Focus on Risk Management in Construction Projects

This stage includes the following two main processes:

1. Determining risk management range of the project involves responding to some questions regarding the cause and advantages of risk management execution, uncertainties resources related to the project at strategic level that can lead to providing a precise and detailed structure of project risk management.
2. Providing risk management process design involves appropriate structure regarding detailed analyses levels, models, software, and other resources in risk management process in certain time and finally, providing executive program of risk management to execute it. Directly, the output of this stage is related to the way of executing risk management that include project organization structure, risk management team, uncertainties structure of the projects at macro level and risk analysis model.

3.3 Identifying Risks in Construction Projects

Identifying uncertainty resources of the project in all life cycle steps and its related probable reactions as well as identifying uncertainty resources chain and subsequent reactions imposed on the project due to applying preliminary reactions are widely performed in this step. The important thing is to identify all these cases by considering their relations and managing them. Given that available strategic documents about previous steps, all risks related to the project beneficiary factors, the project design, the project scheduling, the project resources, contractual structure, and the project allocations, execution, setting up, submitting and backing up the identified project are prioritized based on their level of effect on the project. Also, the place of investigating and managing of them is specified with respect to reactions selected regarding their management. To organize the important relations between various identified uncertainty resources and the probable mutual effects between the reactions selected for each of them are extracted. Lack of organizing uncertainty resources, on the other hand, causes that the potential opportunities in the project cannot be changed into the advantage and benefit. In organizing, by relating uncertainty resources and determining the sequences and mutual effects of each of the resources with the preliminary reactions or resources chain and the subsequent reactions, it should be ensured to consider all risk factors in the project (Hakim, Amin & Hakin, 2005). This action can be led to identifying new uncertainty resources or alternative reactions. Also, in addition to creating the capability of detecting risks in each step of the cycle, the mentioned action is highly important for qualitative and quantitative analyses.

3.4 Determining Managerial and Financial Responsibility of Risks in Construction Projects

This part of the process occurred in designing step allocates risk managerial and financial responsibilities. One of the main causes is to not identifying some uncertainty resources in the early steps of the project life cycle that appear when entering into each step. Assigning managerial and financial responsibilities to individuals involved in the project or external organizations, it can be ensured that in charge managers identify newly advent resources and control them by determining the relation between various cases before the incidence of risks and damage. Moreover, this responsibility allocation causes that all financial or time losses due to risks occurrence are up to the determined responsible in case of inability in managing and controlling the project risks.

This part is so important that it can be viewed as a separate project since the cases related to the project responsibilities, particularly in projects with heavy investments are very complex and unclear responsibilities at the beginning of the work makes it difficult to determine the related responsible in case of any problem and damage. Using the result obtained from this stage, contractual strategy of the project and the way of allocating works to consultants, contractors, design management services, employer, various beneficiary factors, and the way of assigning risk can be specified. In addition, all the required contractual requirements will be specified in each sector with respect to the identified risks. In fact, the new two steps of planning and allocation using the results obtained from risk management are performed at the end of designing step.

3.5 Quantitatively Analysis to Estimate Risk in Construction Project

Identifying all risks with their prioritization in terms of their effect on the project, their relations and determining

their mutual effects, in fact, has been qualitative analysis of risks. Using the provided relationship charts and risks prioritization lists as well as quantitative analysis approaches including likelihood distribution functions, Mont Carlo analysis and sensitivity analysis can quantitatively prioritize projects' risk. Quantitative analyses, indeed, validate qualitative analyses and sometimes, lead to reviewing and modifying them. On the other hand, in these analyses, selecting a set of appropriate priorities, determining their relations and dependencies, integrating various cases, their final effect can be specified as a single or several scenarios and perspective reactions can be adopted. Executing this work is highly important in analyses since change in uncertainty resource can negatively or positively influence other resources. Integrative investigation of a change in all related cases and combining different cases with each other is critical to depict the effect of them altogether on the whole project (Salah et al., 2016).

By the end of all these steps, risks are prioritized in details and quantitatively and the prioritized set of their related reactions are also determined. The next steps of construction project life cycle are allocated to control and management with respect to the obtained results. In case of identifying new risky cases or changing project conditions in each step of life cycle, the performed works will be modified. Then, returning to identification and re-implementation, risk management process will be updated. Figure 2 shows the general quantitative analysis to estimate construction projects risk.

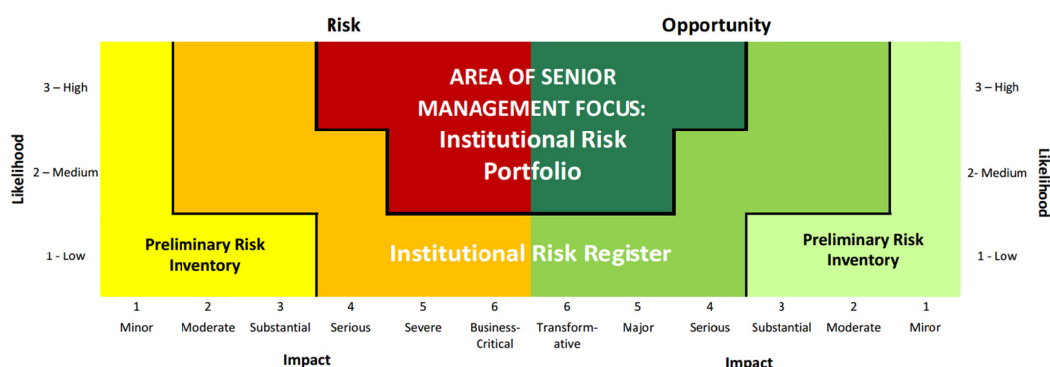


Figure 2. Quantitative analysis to estimate construction projects risk

3.6 Risk Management Process in Planning and Allocation Stage of Construction Projects

The control stage is executed in these two steps of project life cycle. In fact, the results obtained from the executed risk management in these two steps are used in the designing step to provide detailed execution programs and allocating work packages to different members. In planning step, operational and comprehensive programs and the provided risk management process results including partial controllable activities in the project. This program is one of the main tools of controlling risk and their reactions during execution, submission and backing up. In allocation step, all allocations required by the project are performed with respect to the risky items identified and strategies selected regarding transferring managerial and financial responsibilities to different members. Additionally, the contractual structure of the project and its subsequent responsibilities and appropriate executive design are determined to enter into execution step. Extraordinary designs provided as reactive proposals will be used in this stage (Aminbakhsh et al., 2013).

3.7 Risk Management Process in Execution and Submission of Construction Projects

During these steps, effective execution of risk management process is managed with respect to the results of risks identification and analyses stages and considering all risk items in the project execution. The main objectives of risk management in execution step include the following:

- Ensuring about the control over all risky items and their proper management
- Determining probable residual items for execution
- Determining items related to changes in design and planning
- Reviewing costs estimation by the end of the project
- Reviewing the time of concluding the project in execution step

The step of submission determines the acceptable accuracy of construction projects submission in terms of the performance expected by employer and comparing it with the performance expected in designing. This step is

only allocated to interpret adopted effective decisions from the beginning of the project life cycle since decision about the steps has been previously made and this step determine the success or failure of the project.

One of the most important items of risk management n submission step is to manage beneficiary factors expectations. In this step, different beneficiary factors may present new expectations or their expectations may not be properly identified. Of course, this work, in case of the necessity of basic changes in design or execution, can involve considerable heavy costs for construction projects.

3.8 Risk Management Process in Review and Backup Stage in Construction Projects

The step of review includes auditing construction projects documentation. This step is mainly performed for large and national construction projects after its submission. If risk management process is not properly performed, effective review of the project cannot be actualized. Of course, this step has no effect on the execution process; it is only performed to investigate risk management process performance in the project to obtain experience for future projects.

Backup step is the last step of project life cycle that includes project control work breakdown structure from the moment of setting up to the end of its life. The items related to project control work breakdown structure can derive from ideal design steps. The items related to the credit, maintainability and accessibility of project control work breakdown structure can be determined in design step; therefore, these items may be related to planning, allocation, and execution or submission steps. All these items in previous steps of project life cycle are regarded as uncertainty resources. These items can be managed in backup step as critical items in line with beneficiary factors expectation management.

4. Conclusion

Successful execution of effective risk management requires basic attention to various uncertainty resources and risks in different steps of project life cycle. It is very essential to know the best time of starting risk management; to know in which step risk management should be started, and to know what damages can be caused due to untimely start of this process. In the present work, it has been attempted to analyze the efforts related to risk management process in different steps of construction projects life cycle and specify the place of risk management process in construction projects life cycle. According to the research findings, it can be concluded that the following items should be executed for the success of each construction project:

- Creating an integrative mechanism to risk management process and project life cycle
- Analyzing different examples of various risks in various steps of project life cycle
- Considering effective factors in risk management in each step of life cycle and focusing on selected reactions regarding each of uncertainty resources related to life cycle steps
- Determining beneficiary factors and macro objectives of project as one of the most important factor in project execution. Not considering them in risk management process can appear as a basic uncertainty resource in various stages of project.

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