Risk Management and Life Cycle Costing of Infrastructure Project

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Abstract-- Risk management is a concept which becomes very popular in a number of businesses. Many companies often establish a risk management procedure in their projects for improving the performance and increase the profits. Projects undertaken in the construction sector are widely complex and have often significant budgets, and thus reducing risks associated should be a priority for each project manager. This paper presents an application of risk management in the early stage of a project life cycle of a construction project also a light is put on how the life cycle cost of a project is calculated and its importance on the project during its life phases. In order to examine how risk and risk management process is perceived a bridge project was undertaken. Moreover, based on the conducted interviews and simulation techniques, the research presents what are the risks involved and how risks change during a project life cycle. And its effects on the schedule of the project. All analyses are based on a theoretical background regarding risk, risk management process and project life cycle cost approach in the construction sector. Platform.

This paper highlights risks and risks management processes and life cycle costs of a bridge project during and after its construction

Index Terms— Risk; Risk management; Risk management process; Risk management methods; Project life cycle

I. INTRODUCTION

Risk management is the science which applies skills, tools and techniques to fulfill project activities in a way that the expectations and requirements of stake holders are fulfilled or exceeded. Project risk management is an integral part of process which aims at identifying the potential risk associated with a project and responding to those risks. It includes activities which aim to maximize the consequences associated with positive events and to minimize the impacts of negative events. It is believe generally that risk in an environment is a choice rather than fate, and the inherent uncertainty in the plans can affect the desired outcomes of achieving project and business goals. Risk is present in all activities in a project, it is only the amount which varies from one activity to another. Risks and uncertainties inherent in the construction industry are more than other industries. The process of planning, executing and maintaining all project activities is complex and time consuming. The whole process require huge number of people with diverse skill sets and the coordination of a vast amount of complex and interrelated activities. The situation is made complex by many external factors the track record of construction industry is very poor in coping with risks, resulting in the failure of many projects to meet time schedules, targets of budgets and sometimes even the scope of Work. The life cycle cost of an item is the sum of all funds expended in support of the item from its conception and fabrication through its operation to the end of its useful life A life cycle analysis of an infrastructure is a simple assessment of the condition of the infrastructure in the remaining life of the infrastructure without taking into account the estimated costs. Consideration of life-cycle costs is essential when evaluating civil infrastructure construction and rehabilitation alternatives. Unfortunately, most public funding decisions are often made on the basis of initial cost and without any consideration of life-cycle costs. Although the basic principles of life-cycle costing were developed more than 100 years ago, systematic Implementation began only 25–30 years ago. The lack of a rational method for estimating life-cycle costs of engineering structures as a major obstacle in life-cycle costing analysis.

II. OBJECTIVES AND NEED OF STUDY

Different risks occur at different times or stages in the project and no investment or even short-term production process can be planned without taking into account the associated risk during its lifecycle. In reality every project contains a component of risk which results in the necessity to assess and reduce the associated threats. On this premise, risk management is a continuous process which should be conducted at every stage of the project; from its emergence through to completion and operational use. It is important to eliminate risks as early as possible for instance at the stage of analysis of the project value and at the cost analysis stage during the project implementation. The main objective is to identify the problem as well as its significance together with any associated benefits with the risk management process. This identification can be documented as part of the risk plan.

Life cycle cost in construction projects is a process of

economic decision analysis, which helps taking decisions on investments in new construction. These decisions on investments are analyzed for the payback over the life of the investment. This method is also known as life cycle costing technique in construction industry.

III. RISK MANAGEMENT PROCESS

Risk management is a process which identifies the project risks, analyze them, and determine the actions to avert the threats on any project. All steps in the risk management process should be included to deal with risks, in order to implement the process of the project. Due to the nature of construction projects, risk management is a very important process.

Risk management is the process which consists of identification, assessment, response, control as shown in figure no. 1

Figure: 1 Risk Management Process

Risks can be either acceptable or unacceptable. An unacceptable risk is one which has a negative impact on the critical path of a project. Risks can either have short term or long term duration. In case of a short term risk, the impact is visible immediately, such as a requirement change in a deliverable. The impact of a long term risk is visible in the distant future, such as a product released without adequate testing.

Risks can also be viewed as manageable and unmanageable. A manageable risk can be accommodated, example being a small change in project requirements. An unmanageable risk, on the other hand, cannot be accommodated, such as turnover of critical team members. Finally, the risks can be characterized as internal or external. An internal risk is unique to a project and is caused by sources inherent in the project; example can be the inability of a product to function properly. Whereas, an external risk has origin in sources external to the project scope, such as cost cuts by senior management.

Risks associated with the construction industry can be broadly categorized into:

a) Technical risks:

- Inadequate site investigation
- Incomplete design
- Appropriateness of specifications
- Uncertainty over the source and availability of Materials

b) Logistical risks:

- Availability of sufficient transportation Facilities
- Availability of resources-particularly construction equipment spare parts, fuel and labor

c) Management related risks:

- Uncertain productivity of resources
- Industrial relations problems

d) Environmental risks:

- Weather and seasonal implications
- Natural disasters

e) Financial risks:

- Availability and fluctuation in foreign Exchange
- Delays in Payment
- Inflation
- Local taxes
- Repatriation of funds

f) Socio-political risks:

- Constraints on the availability and Employment of expatriate staff
- Customs and import restrictions and Procedures
- Difficulties in disposing of plant and Equipment
- Insistence on use of local firms and agents

g) Common sources of risk in construction projects:

The common sources of risks in construction industry are listed Below:

- Changes in project scope and requirements
- Design errors and omissions
- Inadequately defined roles and responsibilities
- Insufficiently skilled staff
- Subcontractors
- Inadequate contractor experience
- Uncertainty about the fundamental relationships between project participants
- New technology
- Unfamiliarity with local conditions
- Force majeure

Risk management process involves, risk identification, risk assessment, risk response planning, risk control.

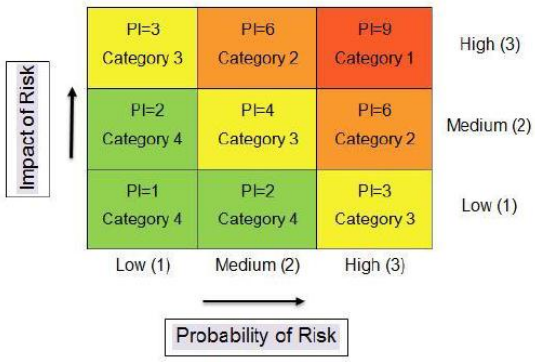
1. Risk Identification can be done by the following methods **Brainstorming:** This is one of the most popular techniques. Generally, it is used for idea generation, it is also very useful for risk identification. All relevant persons associated with project gather at one place. There is one facilitator who is briefing about various aspects with the participants and then after note down the factors. Before closing it the facilitator review the factors eliminate the unnecessary ones.

Delphi Technique: This technique is similar to brainstorming but the participants in this do not know each other and they are not at the same place. They will identify the factors without consulting other participants. The facilitator like in brainstorming, sums up the identified factors.

Interview/Expert Opinion: Experts or personnel with sufficient experience in a project can be a great help in avoiding/solving similar problems over and over again. All the participants or the relevant persons in the project can be interviewed for the identification of factors affecting risk. **Past Experience:** Past experience from the same kind of project, the analogy can be formed for identification of the factors. When comparing the characteristics of projects will provide insight about the common factors.

Checklists: These are simple but very useful predetermined lists of factors that are possible for the project. The check list which contains a list of the risks identified in projects undertaken in the past and the responses to those risks provides a head start in risk identification.

2. **Risk Assessment** can be done by the following methods:
Qualitative Method:
Risk Priority Number:
3. Risk Response Planning can be done by the following methods:



There are 4 categories defined in the above diagram. Category 1 - PI factor 9, which requires maximum attention Category 2 - PI Factor 6, which requires a good amount of attention Category

3 - PI Factor 3, which requires comparatively less attention to be paid Category

4 - PI Factors of 1 and 2, requires less attention to be paid

Quantitative methods Sensitivity Analysis:

This is carried out to identify the uncertain project components which will have maximum impact on the outcome of the project. After a risk model is made a sensitivity analysis is carried out to check the sensitivity of different elements of the model on project outcome. To do these the values of one variable at a time is changed and the impact of these changes is then seen on the project.

There is no single software tool that performs all functions listed above, although several are approaching. Most firms prefer to use an authoring tool that is best suited for their needs rather than to work with a totally integrated systems which is slower and less intuitive.

Scenario Analysis: Scenario analysis gives the impact of different scenario of the project or impact of different risk if that occurs simultaneously. A fair decision can be made after this analysis, the option which will give lesser loss or hazards that option can be opted.

Probabilistic Analysis (Monte Carlo Simulation): A project simulation is done using a model to show the potential impact of different level of uncertainties on project objectives. Monte Carlo Simulation is generally used for this analysis. It can quantify the effect of uncertainties and risks on project budget and schedule. It simulates the full system many times, each time randomly choosing a value for each factor from its probability distribution. It uses three point estimate like most likely, worst case and best case duration for each task in time management.

Decision Trees: This analysis is carried out by decision tree diagram. Decision trees are very helpful to both formulate the problem and evaluate options. In this analysis there are graphical models used to represent project and can clearly reflect the effects of each decision taken in the project.

Risk Avoidance: Risk can be warded off by removing the cause of the risk of executing the project in a different direction while still aiming to accomplish project objectives. Change project management plan to eliminate a threat, to isolate project objectives from the risk's impact, or to relax the project objective that is in jeopardy, such as extending schedule or reducing the scope.

Risk Transfer: Transferring risk involves finding some other party who is willing to accept responsibility for its management, and who will bear the liability of the risk should it occur. Transferring a threat does not eliminate it; the threat still exists however it is owned and managed by another party. Transferring risk can be an effective way to deal with financial risk exposure. The aim is to ensure that the risk is owned and managed by the party best able to deal with it effectively.

Risk Mitigation/Reduction: Risk mitigation reduces the probability and/or impact of an adverse risk event to an acceptable threshold. Taking early action to reduce the probability and/or impact of a risk is often more effective than attempting to repair the damage after the risk has passed.

Risk Exploit: This strategy seeks to eliminate the uncertainty associated with a particular upside risk by creating the opportunity definitely happens. Eliminate the uncertainty associated with a particular upside risk. An opportunity is defined as a risk event that if it occurs will have a positive effect on achievement of project objectives.

Risk Share: Allocate risk ownership of an opportunity to another party who is best able to maximize its probability of occurrence and increase the potential benefits if it does happen. Transferring threats and sharing opportunities are similar in that a third party is used, those to whom the threats are transferred take on the liability and those to whom opportunities are allocated should also be allowed to share in the potential benefits.

Risk Enhance: This response aims to alter the "size" of the positive risk. The opportunity is enhanced by increasing its probability and/or impact, thereby maximizing the benefits gained from the project. Seeking to facilitate or strengthen the cause of the opportunity, and proactively targeting and reinforcing its trigger conditions.

Risk Acceptance: Ultimately it is not possible to eliminate all threats or take advantage of all opportunities – we can document them and at least provide awareness that these exist and have been identified, some term this „passive acceptance.

This strategy is adopted when it is not possible or practical to respond to the risk by the other strategies, or a response is not justified by the grandness of the risk. When the project manager and the project team decide to accept a risk, they are agreeing to address the risk if and when it happens.

Contingency Plan: This involves the use of a fallback plan if a risk occurs. Contingencies can also be in the form of sometime kept in reserve to deal with unknown risks or in the form of costs to deal with unknown risks.

4. Risk Control: is the final step of the process. After we have implemented response actions, we must track and record their effectiveness and any changes to the project risk profile. Did the response actions have a positive or negative effect on achieving project objectives? Responses taken in risks should also be documented for future reference and project plans.

IV. LIFE CYCLE COSTING

Life cycle costing is a tool to determine the most cost-effective option among different competing alternatives to purchase, own, operate, maintain and, finally, dispose of an object or process, when each is equally appropriate to be implemented on technical grounds. In recent years, important progress has been made in life cycle Costing analysis of Infrastructures, e.g. for steel and concrete bridges. A life cycle analysis of an infrastructure is a simple assessment of the condition of the infrastructure in the remaining life of the infrastructure without taking into account the estimated costs. Consideration of life-cycle costs is essential when evaluating civil infrastructure construction and rehabilitation alternatives. Unfortunately, most public funding decisions are often made on the basis of initial cost and without any consideration of life-cycle costs. Although the basic principles of life-cycle costing were developed more than 100 years ago, systematic Implementation began only 25–30 years ago. The lack of a rational method for estimating life-cycle costs of engineering structures as a major obstacle in life-cycle costing analysis. The collection and analysis of existing data on total costs for all lifecycle phases of existing infrastructure, including bridges, roads, etc., and the use of realistic methods for calculating the probable useful life of these infrastructures the life cycle costing process in which assessment of cost is made by analyzing all the factors i.e. all the cost induced from the initiation phase to handover phase analyzing the cost in the early stages benefits everyone who all are involved in completion of project some of the benefits are mentioned below :

- It results in earlier actions to generate revenue or to lower costs than otherwise might be considered.
- It ensures better decision from a more accurate and realistic assessment of revenues and costs, at-least within a particular life cycle stage.
- It promotes long-term rewarding.
- It provides an overall framework for considering total incremental costs over the life span of the product.

Life Cycle Cost Analysis is an essential design process for controlling the initial and the future cost of building ownership. LCCA can be implemented at any level of the design process and can also be an effective tool for

evaluation of existing building systems. LCCA can be used to evaluate the cost of a full range of projects, from an entire site complex to a specific building system component.

Life cycle cost in construction projects is a process of economic decision analysis, which helps taking decisions on investments in new construction. These decisions on investments are analyzed for the payback over the life of the investment. This method is also known as life cycle costing technique in construction industry.

The life cycle costing technique helps to reduce the overall cost of a project by selecting best alternative designs and components to minimize the cost not only at the time of construction, but also the over the full life of the project. The life cycle costing simply does not considers the least cost of construction, but it considers a mechanism to determine which alternatives offer the largest economic advantage by considering costs and benefit that occur throughout the life of the project from initial concept of project to its construction and its useful life to the time it is ready for replacement. It helps the project designers to select the best alternative for the given project.

The aim for life cycle costing is to present owner of the project with maximum benefit when all the costs are accounted for by analysing the alternative designs and components. In this process, the costs are analysed with the benefit in the future. For example, how the cost of extra expenditure on a particular component can benefit in the project owner now or the investment shall be carried out only in future for that component. What will be the best alternative for that component now or in the future? This helps the analysts to compare and select from alternatives that have different spans and diverse cost and benefit profiles.

Life cycle cost analysis is a powerful tool that allows bridge owners or managers to consider the potential consequences of their decisions in present day monetary terms. The life cycle cost of a bridge is expressed by

LCC= CONC+ INSC +DESC+ FAIC+ RAMC

Where

- LCC is bridge life cycle cost.
- CONC is construction cost.
- INSC is inspection cost.
- DESC is design cost.
- FAIC is failure cost.
- RAMC is repair and maintenance cost.

V. CONCLUSION

An effective risk management process encourages the construction company to identify and quantify risks and to consider risk containment and risk reduction policies. Construction companies that manage risk effectively and efficiently enjoy financial savings, and greater productivity, improved success rates of new projects and better decision making. Risk management in the construction project management context is a comprehensive and systematic way of identifying, analyzing and responding to risks to achieve the project objectives. The research results show the risk management process in Construction Company. To manage the risk effectively and efficiently, each and every personnel must understand risk responsibilities, risk event conditions, risk preference, and risk management capabilities. Current Issues and Challenges the lack of experience makes it very difficult to change contractors' attitude towards risk management. Nevertheless, the construction companies need to include risk as an integral part of their project management. In our view, the use of risk management in the construction companies is low to moderate, with little differences between the types, sizes and risk tolerance of the organizations, and experience and risk tolerance of the individual respondents. Qualitative methods of risk assessment are used in construction companies most frequently, ahead of quantitative methods. In construction project risk management, risks may be compared by placing them on a matrix of risk impact against a probability. Mitigation options are then derived from predefined limits to ensure the risk tolerance and appetite of the construction company. The risk management framework for construction projects can be improved by combining qualitative and quantitative methodologies to risk analysis.

Life Cycle Cost analysis gives a broad idea about the projects current financial status it presents the owner the overall costs that is involved in the construction from conception to maintenance cost. The aim for life cycle costing is to present owner of the project with maximum benefit when all the costs are accounted for by analysing the alternative designs and components. In this process, the costs are analysed with the benefit in the future. Therefore these research shows importance of life cycle cost analysis and its importance and why it is important for any construction project.

VI. RECOMMENDATIONS

Majority of contractors and construction managers in construction industry are unaware of formal risk management techniques. In light of this finding, it is imperative to educate these professionals about risk management, and thus a formal and informal system of risk management training needs to be developed. Graduate level education in construction project management should be used to provide formal education on the topic. Informal education could be provided by career development programs and trainings, like risk management awareness programs. Such trainings can be organized by academic institutions or professional

organizations such as Indian Engineering Council, and Indian Institute of Engineers, public sector organizations and engineering universities. Providing such education will yield long term benefits and will be considered as a step in the right direction.

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