Comparative Risk Analysis of Construction Sectors: A Case Study

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Abstract

Construction project like Highways and Residential construction are basically service oriented and different activities are involved in completing the project. Hence this poses a severe challenge in coordinating so many activities and aligning them to deliver the project on time, high standards of quality and within the budget. In these circumstances implementing this model for risk analysis at the planning stage itself plays a pivotal role for the success of the project. This paper focuses more on risk analysis in construction sectors namely residential & highway project. The work is carried out by preparing the detail project report for the highway project & residential project which includes questionnaire survey, work breakdown structure, planning the activities, scheduling, risk analysis & risk mitigation. The schedule is prepared using PERT method in MicMSP and it is integrated in risky project software for implementing the quantitative risk analysis technique using Monte Carlo Simulation for the on-going project to predict the final cost and duration of the project

KeyWords: Risk Analysis, Monte Carlo Simulation (MCS), Risk Mitigation Strategies

1. INTRODUCTION

Construction industry is highly project-driven with a definitive start and end to the project in order to reap the full benefits of such investments. It is necessary for the project to complete on time within cost and meet quality norms

Planning and risk management are assumed to have greater importance and works hand in hand as the nature of the construction work involves many uncertainties outside the control of project manager. Anticipating risks and preparing mitigation plans plays a critical role in completing the project on time and within budget.

Risk management can be defined, as much about looking ahead for identification of future opportunities in order to minimize or avoid or mitigate losses [1]

The advantages of systematic risk identification and risk management are:

- Project planning leading to more realistic business
- Effective implementation of actions in time
- Attainment or achievement of goals and objectives of project with certainty in time
- Beneficial opportunities and being ready to exploit them
- Loss control can be improved
- Control over the project and business overhead costs can be improved
- Flexibility of project is increased, resulting understanding options and associated risks

Scheduling plays a major role in construction process, by completing the project on time with profit. Also it evaluates the delays at an early stage to entitle cost and time compensation. The primary aim of cost, time and quality is achieved by rearranging the resources and task in the project as an when the problems are encountered, which is foreseen by project managers due to Scheduling. Bar chart, CPM method and PERT methods are some of the general scheduling techniques used in the project management.

LauferA. and Cohenca D. [2]**:** this research paper mainly focuses on Measuring theoutcomes of planning based on the effects of uncertainties. and manager of system planning attitude. Questionnaire was developed and mailed to the 400 top companies in the United States. 72 companies responded. Uncertainty impact assessment is carried out by replying to evaluate companies.

Jamal F.A. and Crandall K. C. [1]**:** The Authors have explainedabout the effectiveness of systematic risk management approaches in construction work. The study concentrates on introducing Construction risk management system (CRMS) model to provide a systematic and logical approach towards identifying and evaluating the risks which may occur in the project. Monte Carlo simulation is used for the risk evaluation.

Boadi R. S. et al [3]This paper mainly focuses on risk analysis in transportation sector. The author mainly focusses on 2012 transportation bill, "Moving Ahead for Progress in the 21st Century", which emphasizes on implementation of risk management in decision making of transportation asset management. Research done by author gives a broad sense of literature on various risk identification methods and applications to define, identify and discuss some regular pitfalls—some of them are "communication failure"," monitoring failure", "proportionality", "involvement failure", "individual knowledge".

VilventhanA. and Kalidindi S. N. [4] :This research paper also focus on risk analysis in transportation sector. The author emphasizes on preliminary phase of the research leading to investigation and tries to assess the impact of approval risks in many possible ways on the outcome of transportation infrastructure projects. This paper focuses

on identification of approval risks in the development and implementation phase of the major transportation and infrastructure projects in India.

Skorupka D. [5]**:** this research paper explains about how the Polish construction markethas implemented the risk assessment strategies in their construction work. Questionnaires were prepared based on different types of risk indicators involved in the project and how much they may influence on the project. In this paper Author has included case studies for understanding the risk assessment process in the construction project

2. METHODOLOGY

The general data for this study mainly relies on the specifications provided by the firm and the questionnaire survey conducted with the project management team to identify the key areas relating to risks associated with the construction project and indicate the likelihood of occurrence of these risks which are classified into three categories- "High", "Medium", "Low" and the level of impact on each objective that would result in "High", "Medium", "Low".

The project specifications and data's were collected on two completed Construction Sectors which is residential project & highway project where data's were collected and all the aspects were looked onto it.

1. Highway project- a project to construct a highway in Tamilnadu. . It is the extension of 4 lane to 6 lanes with service roads. It is for up to 93kms. The highway is from EsselWlajapet to Poonamallee. The cost of the project is 89 crores.
2. Residential project- a project to construct a apartment of 9 floors of two wing. The cost of the project is around 30 crores.

Questionnaires were prepared based on the risks that may occur in the road works. Risks affecting the project were divided into five key risk factors such as Design Build Risks, Right-Of-Way risk, Force Majeure/Act Of God, Construction Risk & Environmental Risk.
Questions were formed based on every risk factor and Questionnaires were distributed to the Management team of the company. The results of questionnaires are used to identify the key risks associated with construction projects and indicate the likelihood of occurrence of these risks as very high, high, medium, low and very low and the level of outcome on each project objective that would result in as very high, high, medium, low and very low.

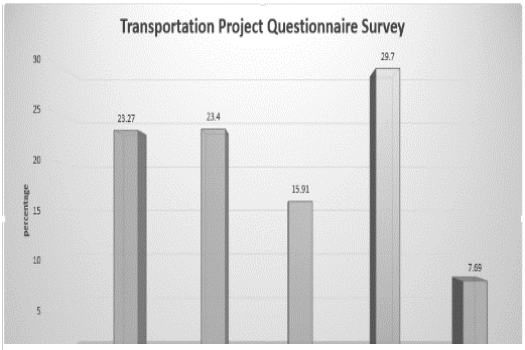

Fig. 1 Transportation Project Questionnaire Survey

Fifty samples of questionnaire survey for residential project was collected whereas twenty five samples of questionnaire survey for highway project was collected. [2]
The results of probability and outcome are calculated in percentage by taking average of results from every questionnaire

Figure 1 shows bar chart showing risk analysis of highway project. From the bar chart, we can see that construction risk is more as compared to other risks.

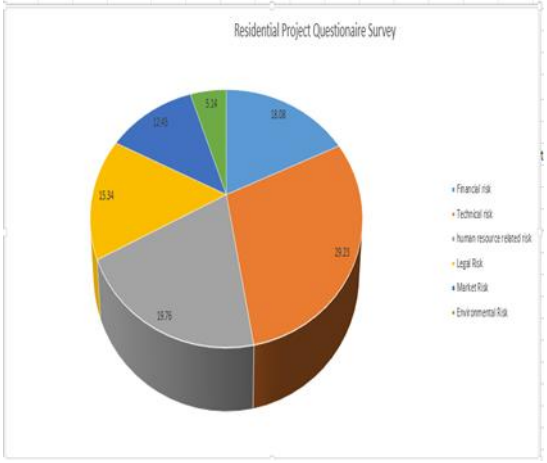

Fig. 2 Results of Risk Analysis of Residential Sector

Figure 2 shows the pie chart showing risk analysis of residential project. The pie chart indicates Technical risk is more as compared to other risks in residential project.

In planning & scheduling, a work breakdown structure for both residential & highway project were created. Scheduling of the project must be done using Microsoft project where all the resources are assigned to each activity. The identified risks using the output of questionnaire survey was used as input parameters for risky project tool in MS project.

Risk analysis is done to identify risks in project. In risk analysis, risk is assigned to every activity. Risk analysis is done using risky project software.

Risk mitigation is defined as taking steps to reduce adverse effects. There are four type of risk mitigation strategies namely risk acceptance, risk avoidance, risk limitation & risk transfer.

3. RESULTS AND DISCUSSIONS

A completed highway project & residential project is considered in this study shows the increase of cost and increase in the duration.
The risk which is more in highway project is construction risk and risk which is more in residential project is technical risk. If the project manager has considered realistic scheduling method instead of conventional CPM Technique then they would have easily predicted the project performance and end results. By considering all these issues realistic scheduling method is used for both highway & residential project to predict the cost and

time of the project by taking the risk factors into account.

The detailed results are presented below after using PERT and simulation scheduling techniques for predicting the project performance

Table 1. PERT and MCS Results

	Optimistic Duration	Most likely Duration	Pessimistic duration	Mean Duration
PERT Analysis	1185 days	1193 days	1220 days	1196.1 days
MCS Analysis	1243 days	1193 days	1312 days	1221.2 days

The table 1 shows comparison of highway project which is done through both Pert & MCS analysis. Pert Analysis shows mean duration of 1196.1 days whereas MCS analysis shows mean duration of 1221.2 days.

Table 2. Comparison of Residential Project

	Optimistic Duration	Most likely Duration	Pessimistic duration	Mean Duration
PERT Analysis	1805 days	1830 days	1853 days	1458.88 days
MCS Analysis	2595 days	1830 days	2014.39 days	1988.23 days

Table 2 shows comparison of residential project in both PERT & MCS analysis. Pert analysis shows mean duration of 1458.88 days where as MCS analysis shows 1988.23 days

Table 3. Cost Comparison (Highway Project)

	Cost estimated
PERT analysis(no risks)	₹ 868,929,400
Monte Carlo simulation (considering risks)	₹ 909,057,423

Table 3 shows cost comparison of highway project in PERT & MCS analysis. PERT analysis shows 86 crores whereas MCS analysis shows 90 crores.

Table 4. Cost Comparison (Residential Project)

	Cost estimated
PERT analysis(no risks)	₹ 293,412,740
Monte Carlo simulation (considering risks)	₹ 391,598,634

Table 4 shows the cost comparison of residential project in both PERT & MCS analysis. PERT analysis shows 29 crores whereas MCS analysis shows 39 crores.

Fig.3 Graph Indicating Comparison of Highway Project Cost with Risk and Without Risk

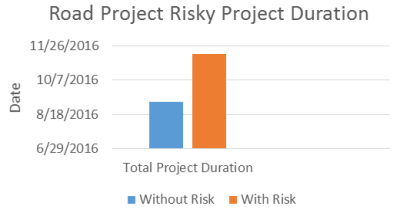

Fig.4 Graph Indicating Comparison of Highway Project Duration with Risk and Without Risk

Fig.5 Graph Indicating Comparison of Residential Project Cost with Risk and Without Risk

4. CONCLUSIONS

From the results obtained from risky project, we can clearly see if the risks are applied to activities then both duration & cost gets increased. For Road project, duration increases from 05/09/16 to 14/11/16(1193 days to 1243.6 days) whereas for residential project, duration increases from 18/05/15 to 13/02/17(1830.13 days to 2286 days). For road project, cost increases from 86 crores to 90 crores whereas in residential project, cost increases from 29 crores to 39 crores. It means that risk results in both delay of project & increase in cost of project

If risk mitigation is applied then the project duration will be completed early then the duration reduces from 14/11/16 to 28/10/16. The risk which is more in residential project is Technical Risk. The risk which is more in Transportation Project is Construction Risk. Comparing both PERT & MCS analysis, we can see duration of project is more in MCS analysis for both projects

REFERENCES

[1] Jamal F. Al-Bahar, Keith C. Crandall, (1990) Systematic Risk Management Approach for Construction Projects, *Journal of Construction Engineering And Management*, Vol. 116, No. 3

[2] Alexander Laufer, Dora Cohenca, (1990) Factors Affecting Construction Planning Outcomes, *Journal Of Construction Engineering And Management*, Vol. 116, No. 1

[3] Richard SarpongBoadi, AdjoAmekudzi Kennedy M.ASCE, Jay Couture (2015) Risk-Based Planning in Transportation Asset Management: Critical Pitfalls,*Journal of Transportation Engineering*, Volume 141, Issue 2

[4] Vilventhan, Aneetha and Kalidindi, Satyanarayana. (2012) Approval Risks in Transportation Infrastructure Projects in India,*Construction Research Congress 2012*.

[5] DariuszSkorupka (2008) Identification and Initial Risk Assessment of Construction Projects in Poland, *Journal of Management in Engineering*, Volume 24, Issue 3