A PROBABILITY ANALYSIS OF CONSTRUCTION PROJECT SCHEDULE USING RISK MANAGEMENT TOOL

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Abstract

The construction industry tumbled along with the other industry/sectors during the recent economic crash. Construction business could not regain thereafter and is still passing through a slowdown phase, resulting in time and cost overrun of many real estate as well as infrastructure projects. There are many theories, tool and techniques with software packages available in the market to analyze construction schedule. This study focuses on the construction project schedule and uncertainties associated with construction activities. The infrastructure construction project has been considered for the analysis of uncertainty on project activities affecting project duration and analysis is done using @RISK software. Different simulation results arising from three probability distribution functions are compiled. This study helps construction project managers to plan and prepare more realistic schedules for construction projects and document probable project completion date in the contract to avoid compensations or claims arising due to missing the planned schedule.

1. Introduction

Infrastructure construction in India has grown significantly. However, projects could not be delivered in the planned schedule and within estimated budget because of proper utilization of project management tools and techniques. The behavior of construction projects is haphazard. The attributes contributing to such behavior are research areas for the research scholars. By previous estimates, over 40% projects have reportedly been suffering from poor performance across the country (Iyer and Jha, 2005). Gunawan (2010) stated that the Indian construction projects are worst in time and schedule performance where average schedule overrun is the highest.

Assaf and Al-Hejji (2006) expressed that there are 73 attribute of delays recognized by all stakeholders of construction. In India, most of the infrastructure projects are delayed due to want of various approvals, land acquisition, various resources related delays and fund availability. Meena and Babu (2015) outlined an approach to find the causes and effects of delay on construction projects. Discussion on various delay analysis techniques, viz. Impacted-as-planned, time delay impact analysis, collapsed as-built, window analysis, as-planned vs. as-built have been done in the past to decide on the claim for the delays. Although many methods have been developed and adopted to analyze and measure construction schedule delays, no single method is accepted for all project participants and suitable for all delay situations (Yang and Kao 2009).

George F. Jergeas and Janaka Ruwanpura (2011) listed a number of reasons for cost and schedule overruns like; lack of realism in initial cost estimates, length and cost of delays are underestimated, Contingencies are set too low, Changes in scope are not sufficiently taken into account etc. Considering these uncertainties, which exist in construction project, three time estimates may provide better realistic time estimates of project activities.

Williams (2003) illustrated the advantages of Monte Carlo simulation over other methods of project analysis using uncertainty. These analytical methods often only provided certain moments of the project duration, instead of project duration distributions, which are much more useful in answering questions about the confidence level of project duration and statistically accounts for path convergence (or merge points). Most project overrun risk occurs at path

convergence points because projects can be delayed because a delay on any of the paths will delay the work and is riskier because either path can cause an overrun.

Application of Monte Carlo simulation for managing project schedule risks and uncertainties involved in the project is performed using @RISK software by iterative process. @RISK software is add-on module in Microsoft Excel software. In Monte Carlo simulation, the repeated trail approach, integrated with network logic and critical path method (CPM), offers an effective and established method for integrating assessment into project schedule risk analysis. @RISK can performs one to hundred simulation using more than 30 types (or families) of probability distributions with given number of iterations ranging from few to one lakh. In this study, the three probability distribution functions used are PERT, triangular and normal distribution with 100 numbers of iterations and 95% confidence on uncertainty.

2. Methodology and Data Analysis

Basic aim of this study was to fulfill the following objectives; 1) To calculate the planned duration of the construction project using various probability distribution functions using risk management tool, 2) To analyze the probability of project completion and comparison with base duration of the project and 3) To analyze the total impact on project finish date. This study is descriptive in nature and case study based approach has been adopted using Indian dam construction project. Dam project consists of main dam, saddle dam, diversions & drainage tunnels, spillways and stilling basins. Approximately 200 construction activities and sub activities were involved with appropriate resources. All activities are inter-linked using different types of linkages along with lead/lags based on method statement. Microsoft Project (MSP) professional 2013 version package is used to develop logical schedule network and estimate the project duration. Microsoft Project 2013 is management software that will provide its users the necessary tool to make sure that they plan, manage and organize their projects in a good and appealing way. Microsoft Project 2013 software is compatible with numerous other software in Microsoft office suite includes Excel, Exchange and Visio. Microsoft Project 2013 comes with a redesigned interface and is easily compatible with share point services. Microsoft Project 2013 management package helps in generating schedule of activities, work breakdown structure (WBS), milestones and resources of the project. In MSP all four types of relationships (finish to start, start to start, finish to finish and start to finish along with lag and lead features) can be used

for sequencing of activities based on the method statement of the project. Once the plan is prepared in MSP, baseline is saved for tracking the project. MSP software also helps in monitoring of the project during construction phase and retrieve data for the appropriate corrective measures to minimize project delays. Data regarding different activity durations of the dam construction are collected. Even though, activity durations are based on the scope of work and productivity of the allocated resources to complete the task, duration estimation is not an easy job. Construction activities do have backup of huge data of working under different conditions and situations so as to determine the productivity constants to workout plan duration and hence known as deterministic approach. Even with lot of site explorations and utmost care activity durations are estimated, still fails to meet the same during actual execution and results invariably in to delays. For considering the uncertainties @RISK software is used with input variables, output variables, and summary statistics with risk distribution functions. Input variable is taken from MSP 2013 package, project schedule of the dam project. The MSP dam project schedule is integrated with @RISK package using project feature available in the @RISK package. The uncertainty on each activity is given with PERT distribution, normal distribution and triangular distribution of the dam project. Three-time estimates are provided using parameter entry table i.e. Best/Worst /Most Likely time estimates. The parameter entry table feature of the @RISK helps to input the percentages in +/- as the user wish to incorporate in the data. As @RISK works on Monte Carlo simulation, it was necessary to decide number of iteration for each of the distribution to get results. To maintain the uniformity 100 iterations of simulation is considered across pert distribution, normal distribution and triangular distribution. The output variable was total duration of the project. Simulation in this study refers to a method whereby the distribution of possible outcomes is generated by worksheet repeatedly, each time using different randomly selected sets of values for the probability distributions. In effect, the simulation tried all valid combinations of the values of input variables to simulate all possible outcomes of the dam project data provided. Fig 1 shows simulation results using various distribution functions generated by @RISK package.
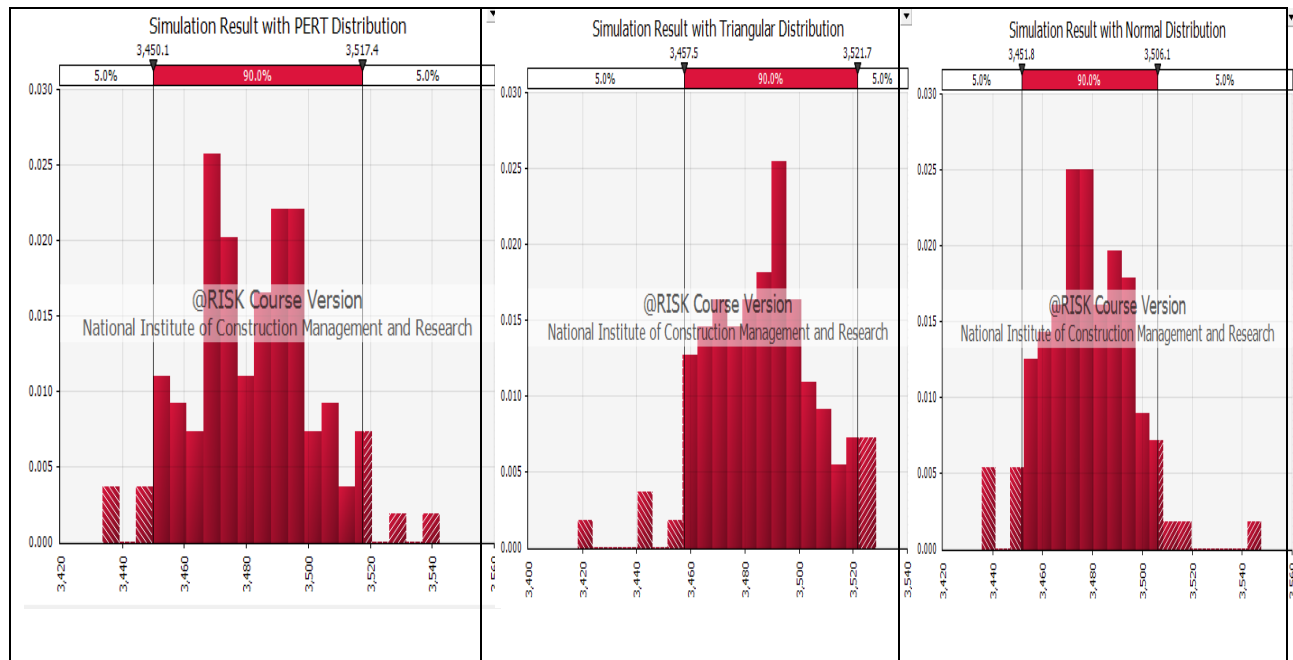
Figure 1: *Simulation Results using Various Distribution Functions*

3. Findings

Based on the above analysis following findings are listed:

1. The project duration estimated with the network logic using Microsoft project software is 3404.5 days. With 95% confidence on uncertain values of activity durations using PERT, triangular and normal distribution, the project duration calculated by @RISK are 3517.4, 3521.7 and 3506.1 days respectively.

2. The gap between the base planned duration and the probable duration calculated using PERT, triangular and normal distribution in @RISK are 112.9, 117.2 and 101.6 days respectively.

3. The project will finish 4 months 9 days later if calculations are done using PERT distribution, while it will finish 4 months 15 days or 4 months later, if calculations are done using triangular or normal distribution respectively.

4. Conclusion

From the empirical study and findings, it can be concluded that the construction project schedule has uncertainty due to many reasons. @RISK software provides facility to do probability analysis on project schedule by various distributions on individual activity or collectively project as a whole. @RISK performs the simulation as per the probability

distribution and give results from which one can interpret details about reserve schedule and the impact of risk events in project schedule. The study of probability distribution analysis for project scheduling can also be used for benefits like: finding out how likely the CPM completion date is, determining the contingency needed to reduce the overrun risk to an acceptable level, identifying the highest risk path for project risk management, and evaluating the effect of risk management actions. This forms a model for the project manager so that he can use to develop contingency scenario.

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