Risk Management using Monte carlo Simulation Technique

[1]A.M.Arun Mohan, [2]Dr.M.Lakshmi
[1]Research scholar,Civil Engineering Department,Himalayan University,
Arunachal Pradesh,India.

[2] Research Guide,Head of the department,Civil Engineering Department,Government Polytechnic College,
Madurai, Tamil Nadu, India

Abstract : The proactive management of risks throughout the software development lifecycle is important for project success.The risk management practice, which involves risk identification, analysis, prioritization, planning, mitigation, monitoring, and communication Software development risks that seem toreoccur in educational and industrial projects.A risk-driven process for selecting a software development model.To facilitate this type of risk monte carlo simulation technique can be used by software analysis.

IndexTerms - *Mitigation, development model, Monte carlo simulation.*

I. INTRODUCTION

Problems happen. Teams can choose to be reactive or proactive about these problems. Reactive teams fly into action to correct the problem rapidly in a crisis-driven, fire-fighting mode. Without proper planning, problems often occur late in the schedule. At this point, resolving any serious problems can require extensive modification, leading to big delays. Proactive teams begin thinking about risks even before technical work is initiated. Their objective is to be able to avoid risk whenever possible, to solve problems before they manifest themselves and to respond to problems that do happen in a controlled and effective manner. Generic and product-specific risks can be further divided into project, product, and business risks. Project risks are those that affect the project schedule or the resources (personnel or budgets) dedicated to the project. Product risks are those that affect the quality or performance of the software being developed. Finally, business risks are those that threaten the viability of the software, such as building an excellent product no one wants or building a product that no longer fits into the overall business strategy of the company.

II.LITERATURE REVIEW

Risk analysis and management in constructionInternational Journal of Project Management Volume 15,Issue I, February 1997, Pages 31-38

The paper describes, on the basis of a questionnaire survey of general contractors and project management practices, the construction industry's perception of risk associated with its activities and the extent to which the industry uses risk analysis and management techniques. It concludes that risk management is essential to construction activities in minimizing losses and enhancing profitability. Construction risk is generally perceived as events that influence project objectives of cost, time and quality. Risk analysis and management in construction depend mainly on intuition, judgement and experience. Formal risk analysis and management techniques are rarely used due to a lack of knowledge and to doubts on the suitability of these techniques for construction industry activities.

“Monte carlo method applied to comparison of tenders in construction projects” by Fernando G.Vaiderrama , Presto, Fernando, Vaiderrama 17th International Congress on Project Management and Engineering.

The comparison of tenders for the execution of works tendered within procurement systems based on unit contract prices, open to re-measurement, requires analysis tools capable of discriminating between proposals that having a similar overall amount may represent a very different final economic impact. The Monte Carlo method, though little known by construction professionals and Spanish companies, is easy to apply, having adequate tools. However, it must be based on assumptions and data that can be readily determined by those who wish to use it.

“Risk consideration and cost estimation in construction projects using Monte carlo simulation “by RADU A. Munteanu,Vasile Dorca,Claudius A. Peleskei.

Determination and quantification of risks and their impact on project costs within the construction industry is described to be one of the most difficult areas. It was found out that historical data could be used for a Monte Carlo simulation to give project manager an idea of the variation in costs.

“RII & IMPI effective techniques for finding delay in construction project” by Mamata Rajgor , Chauhan Paresh, Patel Dhruv ,Panchal chirag ,Bhavsar Dhrmesh Assistant Professor. Civil Engg. Babaria institute of Technology, varnama, Gujarat, India Student of final year BE Babaria institute of Technology, varnama, Gujarat.

To study the factors affecting delay and to identify the key factors and to evaluate the critical factors affecting delay, to minimize the effect of the delay by using RII technique.

III. ANALYZE OF RISK

After risks have been identified and enumerated, the next step is risk analysis. Through risk analysis, we transform the risks that were identified into decision-making information. In turn, each risk is considered and a judgment made about the probability and the seriousness of the risk.
For each risk, the team must do the following:
Assess the probability of a loss occurring. Some risks are very likely to occur. Others are very unlikely. Establish and utilize a scale that reflects the perceived likelihood of a risk. Depending upon the degree of detail desired and/or possible, the scale can be numeric, based on a percentage scale, such as “10 percent likely to lose a key team member” or based on categories, such as: very improbable, improbable, probable, or frequent. In the case that a categorical assignment is used, the team should establish a set numerical probability for each qualitative value .Assess the impact of the loss if the loss were to occur. Delineate the consequences of the risk, and estimate the impact of the risk on the project and the product. Similar to the probability discussion above, the team can choose to assign numerical monetary values to the magnitude of loss, such as $10,000 for a two-week delay in schedule.
Alternately, categories may be used and assigned values, such as 1=negligible, 2=marginal, 3=critical, or 4=catastrophic.
Determining the probability and the magnitude of the risk can be difficult and can seem to be arbitrarily chosen. One means of determining the risk probability is for each team member to estimate each of these values individually. Then, the input of individual team members is collected in a round robin fashion and reported to the group. Sometimes the collection and reporting is done anonymously. Team members debate the logic behind the submitted estimates. The individuals then re-estimate and iterate on the estimate until assessment of risk probability and impact begins to converge. This means of converging on the probability and estimate is called the Delphi Technique (Gupta and Clarke, 1996). The Delphi Technique is a group consensus method that is often used when the factors under consideration are subjective.

- Rank will be discussed .
- Risk is the description of the risk itself, preferably stated in CTC format.
- Probability is the likelihood of the risk occurring, using either a numeric or categorical scale, as discussed in the last section.
- Impact is the magnitude of the loss if the risk were to occur, using either a numeric or a categorical scale.

Rank last week and the number of weeks on list are documented so the team can monitor changes in priority, to determine if actions are being taken that cause changes in the stature of the risk

- Action documents what the team is doing to manage the risk, as will be discussed inspections.The action field is often not completed until the risks have been prioritized, as will be discussed in the next section.

Table 1: Risk Table Template

Rank	Risk	Probability	Impact	Rank Last	Action
				Week/	
				Weeks on	
				list	

Risk Management in Educational Projects

Sometimes the need for risk management can seem far off for students. After all, you don’t do anything close to buying insurance to reduce the risk for your class projects.However, consider that your success (your grade) in the class is at risk. In beginning computer science classes, your assignments were probably small, the requirements of these assignments crisp and defined, and you worked alone. Your chances of being successful were well within your own control. As you advance in your academic career, course projects will likely become quite a bit longer, you will be working with at least one other person, and the requirements will be more ambiguous and even changeable. All of a sudden, things aren’t nearly as under control. What can you do to improve your odds of getting a good grade? Employing risk management can help.All project teams completed the same project. A graduate student performed the role of customer for the students. You should consider whether your own projects could encounter these same risks.

Table 2: Risk Management technique

Risk Item	Risk Management Technique
Overriding other people’s work, not having the latest versions of code	Use a configuration management tool effectively.
Lack of exposure to and/or experience with technologies	Take time to learn tools and technologies, seek help from teaching staff.

Being overwhelmed by work in other classes	Have a project management plan with deadlines and ownership, update the project management plan frequently
Common meeting times	In the beginning of the project, determine all possible common times to meet based on class schedules and other commitments.
Requirements understanding	Meet with, e-mail, or phone customer.
Lack of communication	Set up a group Web page, group e-mail accounts, trade instant messaging IDs, meet regularly.
Project organization	Assign each team member a role, break down work in project management plan.
Loss of a team member	Assure files are uploaded and integrated consistently, use knowledge management strategies such as pair programming to understand each other's work.
Difficulty integrating work	Increase communication, integrate often.
Planning taking up too much time, not enough time to work on product	Don't get more detailed than necessary with the planning.

A sample student team risk management table from the class described above is shown below in Table 3; the team is in the fifth week of the project. Both the probability and the impact use categorical values, which is typical of a student project. Because of this, the student teams must use a group consensus technique to rank their risks. The method of using categories for risk analysis and group consensus for risk prioritization is also used in industry.

Table 3: Sample Student Risk Table

Rank	Risk	Probability	Impact	rank last week/ week on list
1	None of us knows how to use the technology.	frequent	Critical	1/5
2	Integration problems.	frequent	critical	2/5
3	Someone drops the class.	improbable	critical	4/5
4	Team members missing important team meetings.	improbable.	marginal	5/4
5	Overriding each other's work	improbable	marginal	3/5

Basically the estimated duration is calculated by Quantity of work divided by Outturn of the labour.

Estimated Duration = Total quantity of work / Outturn of the labors.

Two types of duration estimation are available

- Single point duration Estimate (CPM)
- Three point duration Estimate (PERT)

Table 4 Risk Analysis Questionnaire Survey Form with answer

No	**Group**	**Causes of cost overrun**	**4**	**3**	**2**	**1**
A.	**Design And Documentation Related Factors (DDF)**					
1.		Mistakes and discrepancies in design documents	32	5	1	-
2.		Delays in producing design documents	21	10	2	7
3.		Unclear and inadequate details in drawing	16	21	1	-

4.		Complexity of project design	5	25	8	-
5.		Insufficient data collection and survey before design	26	7	3	1
6.		Misunderstanding of owners requirements by design Engineer	10	11	17	-
B.	**Financial Management Related Factors (FIN)**					
1.		Cash flow and financial difficulties faced by contractors	27	9	2	-
2.		Poor financial control on site	18	12	8	-
3.		Financial difficulties of owner	13	12	13	-
4.		Delay in progress payment by owners	17	12	8	1
5.		Delay payment to supplier / subcontractors	22	10	6	-
6.		Contractual claims such as extension of time with cost claims	13	7	18	-
7.		Difficulties in financial project by contractor	15	10	13	-
C.	**Information And Communication Related Factors (ICT)**					
1.		Lack of coordination between parties	15	9	14	-
2.		Slow information flow between parties	23	10	5	-
3.		Lack of communication between parties	29	7	2	-
D.	**Material And Machinery Related Factors (MMF)**					
1.		Fluctuation of prices of materials	29	8	1	-
2.		Shortage of materials	20	13	3	2
3.		Late delivery of material and Equipment	8	14	7	9
4.		Equipment availability and frequent breakdown	10	8	7	13
5.		Changes in material type and specification during construction	11	10	6	11
6.		Damages of sorted material while they are needed urgently	14	9	5	10
7.		Low productivity and efficiency of Equipment	11	12	3	12
8.		Low level of equipment operators skill	17	12	4	5
9.		Equipment shortage	7	18	8	5
10		Poor quality of material and unreliable suppliers	7	17	10	4
11		Wastages on site	13	11	6	8
E.	**Human Resource Related Factors (Lab)**					
1.		Labour productivity	26	7	5	-
2.		Shortage of site workers	-	2	19	17

3.		Shortage of technical personnel	22	11	5	-
4.		Labour absenteeism	17	13	8	-
5.		High cost of labour	14	18	6	-
6.		Accident and injury during construction work at site	18	6	5	9
F.	**Project Management Related Factors (PMCA)**					
1.		Poor project management	17	16	5	-
2.		Change in the scope of the project	20	12	6	-
3.		Delays in decision making	21	11	6	-
4.		Inaccurate quantity take-off	9	13	16	-
5.		Legal disputes between parties	11	5	20	2
6.		Underestimate of project time and duration	24	5	7	2
7.		Lack of experience in some type of project	20	10	8	-
8.		Risk and uncertainty associated with projects	17	17	4	-
9.		Lack of proper training and experience of PM	11	19	4	4
10		Lack of appropriate software	12	11	7	8
G.	**Contractors Site Management Related Factors (CSM)**					
1.		Poor site management and supervision	32	3	1	2
2.		Incompetent subcontractors	24	13	1	-
3.		Schedule delay	34	4	-	4
4.		Inadequate planning and scheduling	28	4	10	-
5.		Lack of experience	29	5	4	-
6.		Mistakes during construction phase	27	11	-	-
		Inadequate monitoring and control of cost	27	9	2	-
1.		Inadequate time and cost estimates	29	8	1	-
H.	**External Factors (EF)**					
1.		Effects of subsurface condition(e.g.: soil, nearer to water table)	9	7	19	3
2.		Delay in obtaining permits from municipality	15	6	13	4
3.		Rain effect on construction activities	22	8	6	2
4.		Unavailability of utilities in site (e.g.: water, electricity)	9	8	18	3
5.		Effect of social andultural factors	4	7	13	14

6.		Traffic control and restriction at job site	6	10	7	15
7.		Changes in government regulation and laws	18	7	11	2
8.		Delay in providing services and utilities	10	9	10	9
9.		Natural disasters	2	25	10	1
10.		Land Acquisition	3	22	10	

Quite useful results for project statistics are obtainable by developing three-point estimates that can be used in equations to calculate expected value, variance, and standard deviation. The three points commonly used are:

- **Pessimistic duration** value that yet has some small probability of happening.
- **Optimistic duration** value that also has some small probability of happening.
- **Most likely duration** value for any single instance of the project. The most likely value is the mode of the distribution.

It is not uncommon that the optimistic and most likely values are much closer to each other than is the pessimistic value. Many things can go wrong that are drivers on the pessimistic estimate; usually, there are fewer things that could go right.

IV.MONTE CARLO SIMULATION

In a Monte Carlo simulation, a random value is selected for each of the tasks, based on the range of estimates. The model is calculated based on this random value. The result of the model is recorded, and the process is repeated. A typical Monte Carlo simulation calculates the model hundreds or thousands of times, each time using different randomly-selected values.When the simulation is complete, we have a large number of results from the model, each based on random input values. These results are used to describe the likelihood, or probability, of reaching various results in the model.

Risk AMP is a Monte Carlo simulation engine that works with Microsoft Excel®. The Risk AMP Add-in adds comprehensive probability simulation to spreadsheet models and Excel® applications.The Add-in includes 22 random distributions, 17 statistical analysis functions, and a wizard for creating charts and graphs, and VBA® support – all for a fraction of the price of competing packages.

Monte Carlo can take duration of activities with varying probability distribution patterns. The network model generally uses triangular distribution to analyze the project schedule with the object of understanding how uncertainly affects the project completion. With the each simulated run, the model generates random numbers and performs time analysis, indicating the critical path critical activities, mean duration and variance. After running a complete simulation (say 1000 runs), it evaluates the probability of each task on the critical path of the project and displays them in a histogram chart of the simulated values. Monte Carlo gives an unbiased estimate of the mean and variation of the project duration along with the degree of criticality of each activity. The analyzed model can be used to focus on the preventive measures to safeguard against delays and bottlenecks of these key drivers (critical tasks) to improve the outcome for the entire project completion on a given time schedule and to decide the acceptable risk level.

The procedure for the application of Monte Carlo technique for time scheduling of a project is outlined in subsequent examples using a simple network model drawn below. The examples with triangular activity duration distribution patterns are solved manually with 10 iterations to explain the technique. In practice over 1000 iterations be generated using computers can give an unbiased estimate.

The Monte Carlo simulation for estimation probable project completion follows the procedure given..

- Develop the network tabulated model on the work sheet using simulation software like @Risk.
- Assess the probability distribution (uniform, triangular, normal, or other) for the duration of each activity. Three-times triangular estimates is preferred.
- Enter probability distribution and mean value for each activity.
- Generate random numbers between intervals (0-1). Such data can be extracted from random table by computer. A random number is variable, which assumes different values conforming to the activity duration probability distribution, using precedence relationship.

- Run the random variant say at 1000 times in the worksheet. It determines critical activities and project completion time. Store this output data for further statistical analysis.
- View report on the process data to determine project probability distribution, its mean value and standard deviation and completion time corresponding to various confidence levels.

V.CONCLUSION

For the probability of completing the Sewage Treatment Plant (STP) within the due date, the simulation using @RISK software had shown that there is zero probability for the project to be completed within 88 days (most likely duration). This shows that the due date based on most likely durations that had been used by the construction management team was not significant in an uncertainty environment; it is unlikely to be achieved. The uncertainties lead the project management to risks and problems. The construction schedule should be revised regularly, and the changes of due date may occur repeatedly.

References

[1]Construction project management By K.K.Chitkara.
[2] PMBOK 5th Edition published by PMI (Project Management Institute).
[3] CPWD Schedule of Rates.
[4] IS 1200 - IS 7272 -2000 Labour output constant for construction management including safety in construction.
[5]IS 1200 – Method of Measurement of Building and Civil engineering works.
[6]Quantity Surveying –A.P.Arul Manickam, N.Murali Krishniah.