Volume 3, Issue 7, July 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Simulating the Probability of Risk During Project Completion

P.K. Suri *
Dean, Research and Development, Chairman CSE/IT/MCA, HCTM Kaithal, Haryana, India.

Kanchan Narula
Student, HCTM Kaithal, Haryana, India.

***Abstract*— The project schedule is the core of the project planning. Scheduling a project is extremely difficult task as the time needed to complete a project activity is hard to estimate. To identify the risk involvement during scheduling, various tools and techniques have been discovered. Simulation is an important technique for schedule risk analysis. This paper is aimed at implementing a simulator in C language which estimates the probability of risk during project completion.**

***Keywords*— Schedule, Risk analysis, Box Muller, Simulation, Probability**

I. Introduction

Project failures are the result of multiplicity of risks inherent in software project environment. Studies indicate that 15 to 35% of software projects are cancelled, and the remaining projects suffer from cost overruns, schedule slippage, or failure to meet their project goals [1]. Risk is a probability of occurrence of some unwanted and harmful event to the project. These events can result in delay, over budget, wrong functionality or termination of the project, degradation in product functionality & quality and high maintainability and reusability cost. Reference [2] defines risk as "In the context of software engineering and development, risk can be defined as the possibility of suffering a diminished level of success within a software dependent development program.

Boehm identified 10 software risk items to be addressed by software development projects:

- Personnel shortfalls
- Unrealistic schedules and budgets
- Developing the wrong functions and properties
- Developing the wrong user interface
- Gold plating (adding more functionality/features than is necessary)
- Continuing stream of requirements changes
- Shortfalls in externally furnished components
- Shortfalls in externally performed tasks
- Real-time performance shortfalls
- Straining computer-science capabilities [3].

II. Risk Management Process

The goal of risk management is to identify, analyze, prioritize, and mitigate potential problems with sufficient lead time to avoid crisis situations. The risk management process comprises all the activities required to identify the risk that might have a potential impact on the software project.

- **Risk Identification-** It is the process of specifying the threats to the project plan. It consists of listing all the risks that can adversely affect the successful execution of the software project.
- **Risk Analysis-** During the risk analysis step, each risk is assessed to determine:
  □□□Likelihood: the probability of hazard's occurring.
  □□□Impact: the effect that the resulting problem will have on the project.
  □□□Timeframe: when the risk needs to be addressed (i.e., risk associated with activities in the near future would have a higher priority than similar risks in later activities)
- **Risk Prioritization-** Risk Prioritization ranks risk factors by probability, impact, and/or the time frame. A priority scheme enables to devote limited resources only to the most threatening risks. Priorities are based on the risk exposure, which takes into account not only likely impact but also the probability of occurrence.

Risk Exposure = Risk Likelihood * Risk Impact

- **Risk Mitigation-** Risk Mitigation is concerned with developing and implementing strategies to handle risk factors. Mitigation is usually concerned with reducing either the probability of occurrence of a potential problem or reducing the impact of the potential problem. One way is to calculate and compare Risk Leverage Factors (RLF). RLF is calculated by calculating the risk exposure before mitigation, the risk exposure after mitigation, and dividing the difference by the cost of mitigation.

$$\textbf{RLF} = (\textbf{RE}_{\textbf{before}} - \textbf{RE}_{\textbf{after}}) / (\textbf{cost of mitigation})$$

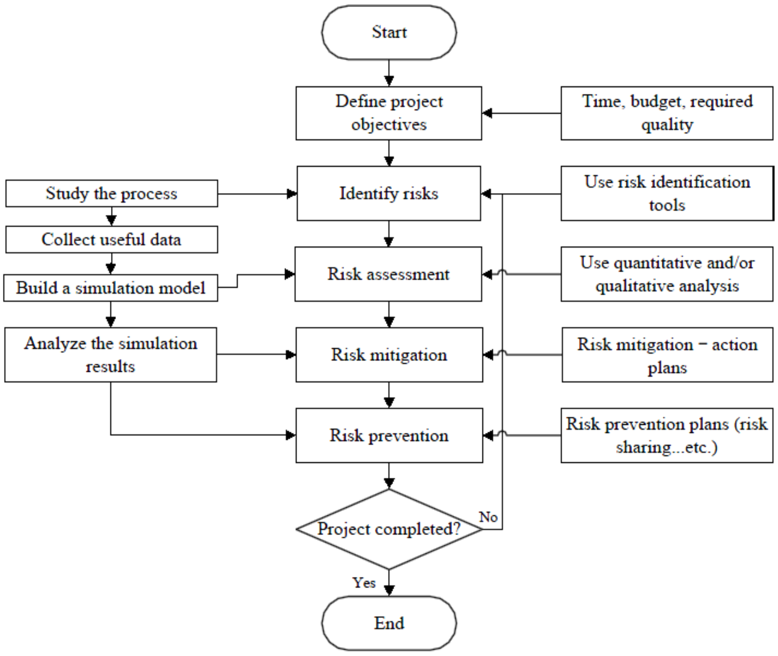

Fig. 1 Project Risk Management Process Map [4]

III. Risk Identification Techniques

The identification of risks requires a systematic review of the entire project during which the technical, cost, and schedule risks are evaluated. Some techniques for identifying risk factors are-

- **Checklists -** Checklists can be used to identify risk factors. They can be used by individuals, in group meetings. The risk taxonomy developed at SEI is one of the best checklists for risk identification.
- **Brainstorming -** Brainstorming is widely used technique for generating risk factors. It is quite easy for a group of individuals to generate long lists of risk factors in a one or two hour of brainstorming session.
- **Expert judgment -** Expert judgment relies on the expertise and past experiences of group of experts. The biases (both optimistic and pessimistic) of the experts should be taken into account while risk factors are discussed.
- **SWOT-** SWOT stands for Strengths, Weaknesses, Opportunities and Threats. Four lists are prepared, one for each of S, W, O, and T. A SWOT analysis can identify opportunities as well as risk factors.
- **Analysis of assumptions and constraints -** Assumptions and constraints for both the process and the product should be enumerated and examined for risk factors.
- **Lessons-learned files -** Lessons-learned files are prepared as a project termination activity for each project. Risk factors identified throughout the life cycle of the project should be included in the lessons-learned.
- **Effort, cost, and schedule estimation -** Effort, cost and schedule estimation models can be used in several ways to identify risk factors for the project.
- **Schedule analysis -** Analysis of the project's schedule network can be used to identify risk factors associated with the project.

IV. Simulation of The Project Schedule Activity Network

Each activity of the project schedule network is specified by its starting node, finishing node, and three time estimates- Optimistic, Most Likely, Pessimistic given by software development experts. Once the activities duration ranges and distributions have been determined, the schedule risk analysis can determine the risk during the project schedule. The most common method of determining schedule overrun risk is to simulate the project by iterating it hundreds or thousands of times on the computer. It was assumed that the duration of every activity (k) is normally distributed with mean μ_k and standard deviation σ_k. The sample time durations of each activity (k) of the project for different runs are drawn using Box- Muller transformation. During each run, it estimates the time duration t_k for each of the k_{th} activity with different sample of s during each run.

$$\mathbf{t_k = s * \sigma_k + \mu_k}$$

where σ_k and μ_k are the standard deviation and mean, respectively, for the k_{th} activity and s is the desired sample from the standardized normal distribution.

$$\mathbf{s = sqrt (- 2 \ln (rn1)) \cos(2 pi * rn2)}$$

Where (rn1, rn2) is a pair of random numbers in the range (0, 1). A sample of s is created by implementing a random number generator.

A. Algorithm

1. Read input data for activity network corresponding to given project consisting of n activities (topologically ordered) and m nodes, and number of simulation runs, mean time and variance for each activity.
2. Determine the critical path and critical activities through network.
(i) Perform the forward pass through the activity network.

(ii) Perform the backward pass through the activity network.
3. Initialize the simulation run counter.
4. Generate random input data (by invoking a random number generation routine) using the Box-Muller transformation to generate random samples of time for each of the k_{th} activity.
5. Compute probability of risk during project completion.
(i) Calculate the z value

$$z = \frac{\text{Scheduled time} - \sum \text{mean time of critical activities}}{\sqrt{\sum \text{variance of critical activities}}}$$

(ii) Convert z values to probability using standard normal probability table or graph..
6. Update the simulation run counter.
7. If the simulation run count is less than the number of simulation runs (as read in step1), then go to Step 4 for the next simulation run.
8. Print all risk indexes.

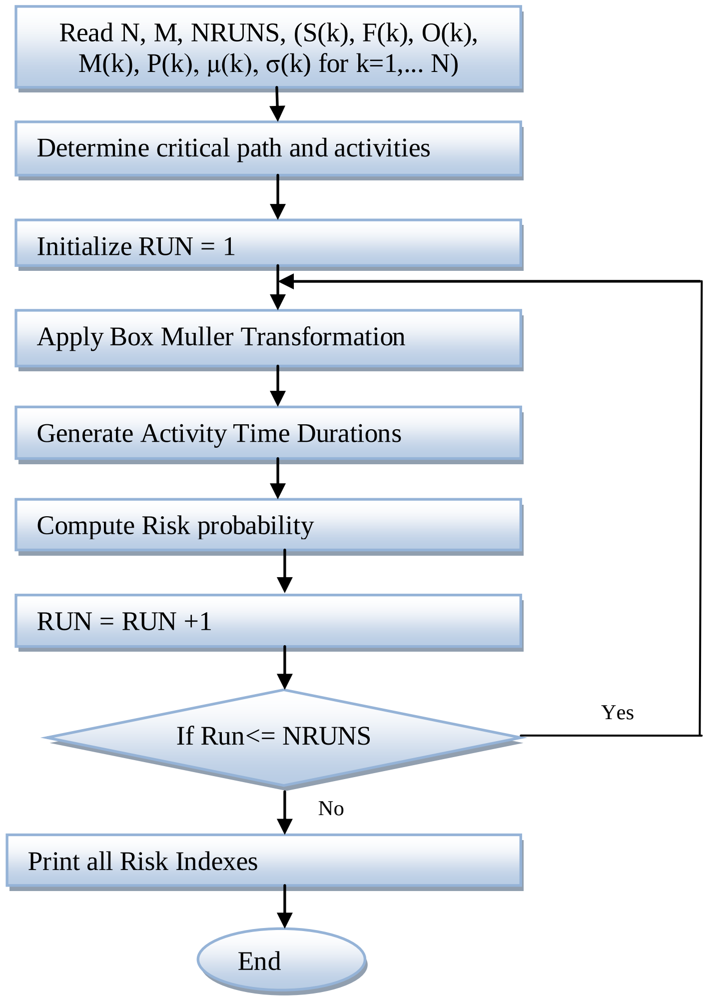

Fig. 2 Flowchart of the Proposed Work

V. RESULTS

Input: Read three time estimates, mean time and variance of each activity corresponding to the given activity network.

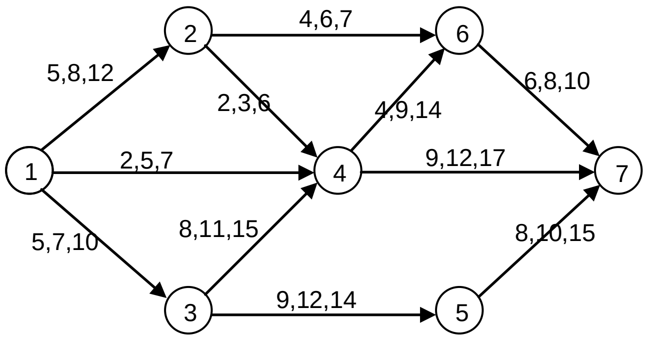

Fig. 3 Activity Network for Project

Table I shows three time estimates, mean time and variance of each activity for given project consisting of 7 nodes and 11 activities.

Table I
Three Time Estimates, Mean Time and Variance of Activities

Activity	**Optimistic Time**	**Most Likely Time**	**Pessimistic Time**	**Expected Time**	**Variance**
1-2	5	8	12	8.17	1.36
1-3	5	7	10	7.17	0.69
1-4	2	5	7	4.83	0.69
2-4	2	3	6	3.33	0.44
2-6	4	6	7	5.83	0.25
3-4	8	11	15	11.17	1.36
3-5	9	12	14	11.83	0.69
4-6	4	9	14	9.00	2.78
4-7	9	12	17	12.33	1.78
5-7	8	10	15	10.50	1.36
6-7	6	8	10	8.00	0.44

Output:

Table II shows generated time durations for each activity with different value of S during each run.

Table II
Generated Time Durations of Activities During Each Simulation Run

S → 0.93 0.72 0.62 1.77 1.54 1.62 0.66 0.19 1.36 1.83

Activity	**Generated Time Duration of Activities**									
1-2	9.25	9.01	8.89	10.23	9.96	10.06	8.94	8.39	9.75	10.30
1-3	7.94	7.77	7.68	8.64	8.45	8.52	7.72	7.33	8.30	8.69
1-4	5.60	5.44	5.35	6.30	6.11	6.18	5.38	4.99	5.96	6.36
2-4	3.95	3.81	3.74	4.51	4.36	4.41	3.77	3.46	4.24	4.55
2-6	6.29	6.19	6.14	6.71	6.60	6.64	6.16	5.93	6.51	6.75
3-4	12.25	12.01	11.89	13.23	12.96	13.06	11.94	11.39	12.75	13.30
3-5	12.60	12.44	12.35	13.30	13.11	13.18	12.38	11.99	12.96	13.36
4-6	10.55	10.21	10.04	11.95	11.56	11.70	10.10	9.33	11.26	12.05
4-7	13.57	13.30	13.16	14.69	14.38	14.49	13.21	12.59	14.14	14.77
5-7	11.58	11.35	11.22	12.56	12.29	12.39	11.27	10.73	12.08	12.64
6-7	8.62	8.48	8.41	9.18	9.02	9.08	8.44	8.13	8.90	9.22

Table III shows total project completion time, z value, risk probability for different value of S during each run.

Table III
Risk % for Different Values of S During Each Run

Project Completion Time	39.36	38.49	38.03	43	42.01	42.37	38.21	36.19	41.23	43.28
Z Value	0.27	0.65	0.85	-1.31	-0.87	-1.03	0.77	1.65	-0.53	-1.42
Risk Probability	0.39	0.26	0.2	0.9	0.81	0.85	0.22	0.05	0.7	0.92

Fig. 4 shows graph depicting the relationship between Z value and risk probability.

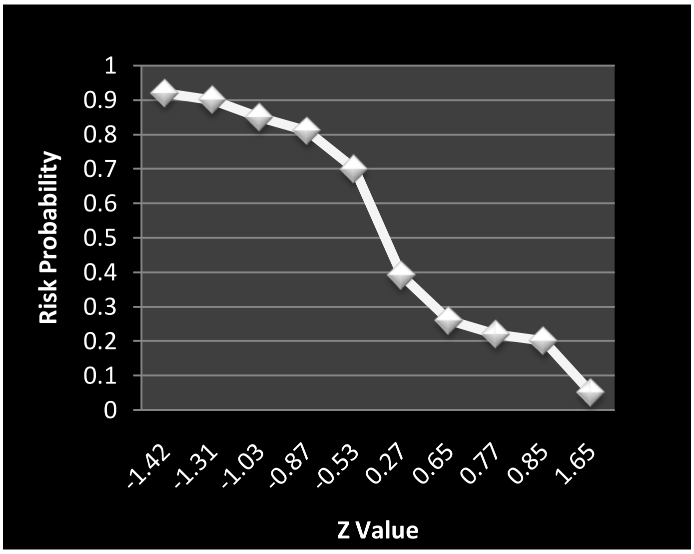

Fig. 4 Risk versus Z Value Graph

Fig. 5 shows graph depicting the relationship between total project completion time and risk probability.

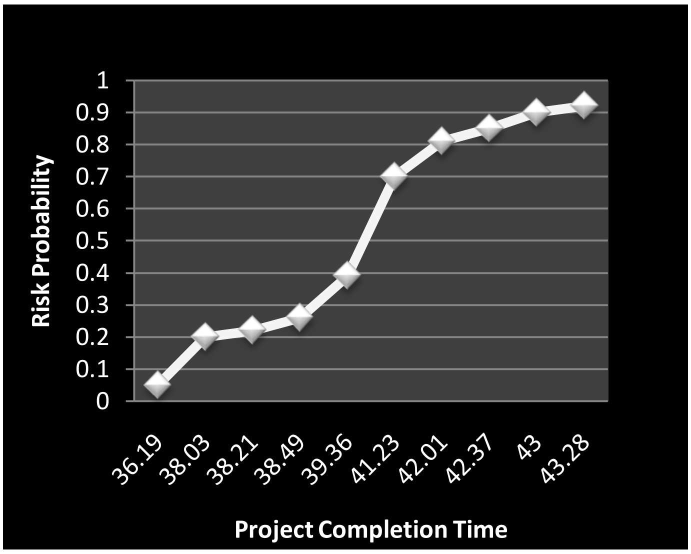

Fig. 5 Risk versus Project Completion Time Graph

VI. Conclusion and Future Work

The higher the time it takes to complete the project, the smaller is the z value and the greater is the risk involved in the project. As an alternative to this technique and to provide a greater degree of flexibility in specifying activity durations, we can use MONTE - CARLO SIMULATION technique to evaluate the risks of not achieving deadlines. It involves calculating activity times for a project network a large number of times, each time selecting activity times randomly from a set of estimates.

Acknowledgment

Sincere thanks to HCTM Technical Campus Management Kaithal- 136027, Haryana, India for their constant encouragement.

References

[1] Y.H. Kwak and J. Stoddard, *'Project risk management: lessons learned from software development environment'*, Technovation, 2004.

[2] M.S. ROJABANU and Dr. K. Alagarsamy, *'A Conceptual Model for the reduction of Time based risk in the Software Project Management'*, International Journal of Computer Applications (0975 – 8887) Volume 3 – No.5, 2010.

[3] Boehm, B.W., *'Software risk management principles and practices'*, IEEE Software 8 (1), 32–41, 1991.

[4] Undram Chinbat, Soemon Takakuwa, *'USING SIMULATION ANALYSIS FOR MINING PROJECT RISK MANAGEMENT'*, Proceedings of the Winter Simulation Conference, 2009.

[5] Abdullah Al Murad Chowdhury and Shamsul Arefeen, *'Software Risk Management: Importance and Practices'*, IJCIT, VOLUME 02, ISSUE 01, 2011.

[6] Aurangzeb Khan, Dr. Farooque Azam and Muhammad Shoaib Zafar: *'Managing Requirement Risks in Global Software Development'*, International Journal of Computer Applications (0975 – 8887) Volume 33– No.7, 2011.

[7] Ayse Kucuk Yilmaz and Triant Flouris: *'Managing corporate sustainability: Risk management process based perspective'*, African Journal of Business Management Vol.4 (2), pp. 162-171, 2010.

[8] Dhirendra Pandey, Ugrasen Suman and A. K. Ramani, *'Security Requirement Engineering Issues in Risk Management'*, International Journal of Computer Applications (0975 – 8887) Volume 17– No.5, 2011.

[9] Gluch, D. P., *'A Construct for Describing Software Development Risks'*, Software Engineering Institute, 1994.

[10] Haneen Hijazi, Thair Khdour and Abdulsalam Alarabeyyat, *'A Review of Risk Management in Different Software Development Methodologies'*, International Journal of Computer Applications (0975 – 8887) Volume 45– No.7, 2012.

[11] Hassan Mathkour, Ghazy Assassa, and A. Baihan, *'A Risk Management Tool for Extreme Programming'*, International Journal of Computer Science and Network Security, VOL.8 No.8, 2012.

[12] Iqbal Felani, *'Developing Objective-Quantitative Risk Management Information System'*, Proceedings of the World Congress on Engineering, 2012.

[13] Dr.-Ing. Tilo Nemuth, '*Practical Use of Monte Carlo Simulation for Risk Management within the International Construction Industry'*, Proceedings of the 6th International Probabilistic Workshop, Darmstadt, 2008.

[14] Jakub MILER and Janusz GÓRSKI, *'RISK IDENTIFICATION PATTERNS FOR SOFTWARE PROJECTS'*, Foundations of Computing and Decision Sciences Vol. 29, No. 1-2, pp. 115-13, 2004.

[15] James G. March and Zur Shapira , *'Managerial Perspectives On Risk and Risk Taking'*, Management Science Vol. 33, No. 11, 1987.

[16] James H. Lambed, Nicholas C. Matalas, Con Way Ling, Yacov Y. Haimes, and Duan Li, *'Selection of Probability Distributions in Characterizing Risk of Extreme Events'*, Risk Analysis, Vol. 14, No. 5, 1994.

[17] Karel de Bakker, Albert Boonstra, and Hans Wortmann, *'Does risk management contribute to IT project success? A meta-analysis of empirical +evidence'*, International Journal of Project Management, 2009.

[18] Kwan-Sik Na, James T. Simpson, Xiaotong Li, Tushar Singh, Ki-Yoon Kim, *'Software development risk and project performance measurement'*, The Journal of Systems and Software 80, 596–605, 2007.

[19] Lazaros Sarigiannidis, Prodromos D. Chatzoglou, *'Software Development Project Risk Management: A New Conceptual Framework'*, Journal of Software Engineering and Applications, 4, 293-305, 2011.

[20] Linda Westfall, *'SOFTWARE RISK MANAGEMENT'*, The Westfall Team PMB 383, 3000 Custer Road, Suite 270 Plano, TX 75075.

[21] Liu Jun, Wang Qiuzhen and Ma Qingguo, *'The effects of project uncertainty and risk management on IS development project performance: A vendor perspective'*, International Journal of Project Management, 923–933, 2011.

[22] Malaya Kumar Nayak, Sanghamitra Mohanty and Rachna Soni, *'People and Skills: A Potential Risk in ICT Infrastructure Management'*, International Journal of Software Engineering and Its Applications Vol. 5, No. 3, 2011.

[23] Ms Manisha.Ingle, Dr.Mohommad Atique, Prof. S. O. Dahad, *'RISK ANALYSIS USING FUZZY LOGIC'*, International Journal of Advanced Engineering Technology, Vol.II, Issue III, 96-99, 2011.

[24] P. K. Suri, Bharat Bhushan, and Ashish Jolly, *'Simulator for Risk Assessment of Software Project based on Performance Measurement'*, International Journal of Computer Science and Network Security, VOL.9 No.6, 2009.

[25] Dr P K Suri and Manoj Wadhwa, *'Identification and Assessment of Software Project's Risk'*, International Journal of Computer Science and Network Security, VOL.7 No.8, 2007.

[26] Rodrigues, A,*'The role of system dynamics in project management'*, International Journal of Project Management, Vol. 14, No. 4, pp. 213–220, 1996.

[27] Roger L. Van Scoy, *'Software Development Risk: Opportunity, not problem'*, Technical report, 1992.

[28] Severin V. Grabski., Stewart A. Leech., Bai Lu.: *'Risks and Controls in the Implementation of ERP Systems'*, The International Journal of Digital Accounting Research Vol. 1, No. 1, pp. 47-68.

[29] Sneh Prabha and R.L.Ujjawal, *'Software Risk Evaluation and Assessment using Hybrid Approach'*, Proceedings published in International Journal of Computer Applications, 2011.

[30] Vinay Kumar Nassa and Sri Krishan Yadav, *'Project Management Efficiency using Soft computing and Risk Analysis'*, International Journal of Computer Applications (0975 – 8887) Volume 50 – No.16, 2012.

[31] Young Hoon Kwak and Kenneth Scott LaPlace, *'Examining risk tolerance in project-driven organization'*, Technovation, 691–695, 2005.

