International Journal Of Business Management
Available at www.ijbm.co.in
ISSN NO. 2349-3402
VOL. 2(2),2015

Approaches for Estimating Threats to Project Schedule

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Abstract: Risk management is perilous to the success of any software project. The project schedule is the core of the project planning. In the process of software project development, risk scheduling is one of the most significant disciplines that cannot be grasped by anyone. So, evaluating risks to the schedule is complex. This paper presents different strategies for schedule risk analysis.

Keywords: Risk Analysis, Project Schedule, Simulation, PERT, Monte Carlo, Estimates.

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I. INTRODUCTION

If we say that there is a relationship between fault, error and failure .The answer will be yes as fault is a condition that causes the software to fail to perform its required function. Whereas error refers to difference between actual Output and expected output. and failure occurs when system or component is incapable to perform ,the required function according to the required specification. Risk is a probability of occurrence of some unwanted and harmful event to the project.

II. SOFTWARE RISK MANAGEMENT

Risk management is critical to the success of any software project. The objective of risk management is to avoid or minimize the adverse effects of unforeseen events by avoiding the risks or drawing up contingency plans for dealing with them. Boehm defines four major reasons for

Implementing software risk management [4]:

1. Evading software project disasters, including run away budgets and schedules, defected software products, and operational failures.
2. If avoiding rework caused by erroneous, missing, or unclear requirements, design or code, which typically consumes around 50% of the total cost of software development.

International Journal Of Business Management
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ISSN NO. 2349-3402
VOL. 2(2),2015

3. Avoiding heavy-handedness with detection and prevention techniques in areas of marginal or no risk.
4. To stimulate a win-win software solution where the customer receives the product they prerequisite and the vendor makes the profits they believe in.

The risk management process starts with the identification of risks. Each of the risks is then observed and

arrange according to the highest priority. A risk management plan is made that identifies containment actions to reduce the probability of the risk. The plan includes emergency actions that will be taken if the risk turns into a problem. The next step involves watching the status of known risks as well as the results of risk lessening actions.

A risk management plan is made that identifies containment actions to reduce the probability of the risk. The plan includes contingency actions that will be taken if the risk turns into a problem. The next step involves monitoring the status of known risks as well as the results of risk reduction actions.

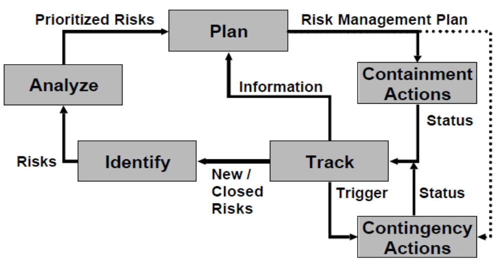

Fig 1. The Risk Management Process [25]

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.

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- **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. CURRENT TRENDS IN SOFTWARE RISK MANAGEMENT

1987, James G. March and Zur Shapira explores the relation between decision theoretic conceptions of risk and the conceptions held by executives [16].

1991, Boehm describes the emerging discipline of software risk management. Its objectives are to identify, address, and eliminate risk items before they become either threats to successful software operation or major sources of software rework [6].

1992, Roger L. Van Scoy reviews the fundamental concepts of risk and elaborate how these basic concepts apply to the development of large, software-intensive systems, develop strategy for seeing a systematic approach to risk management in software development [42].

1994, James H. Lambed, Nicholas C. Matalas, Con Way Ling, Yacov Y. Haimes, and Duan Lil makes the case that assessment of the tail of the distribution can be performed separately from assessment of the central values [17].

1996, Ronald P. Higuera, Yacov Y. Haimes presents a holistic vision of the risk-based methodologies for Software Risk Management (SRM) developed at the Software Engineering Institute (SEI) [37].

1996, Rodrigues, A. contrasts the characteristics of the two approaches and provides an overview of various areas of application of system dynamics in project management [36].

1997, Gemmer, A. describes a plan to elicit the behaviour “communicate risk more effectively” [9].

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1999, Jerry Banks Marietta, Georgia, introduced Modeling concepts in simulation based on the example and discussed the advantages and disadvantages of simulation [32].
2000, Jiang et al. examines the relationship between project risks and information systems project team performance [20].
2001, Jiang et al. proposes and tests a model based on literature that relates sources of risk to strategies and success [19].
2002, Yacoub and Ammar describe a heuristic risk assessment methodology that is based on dynamic metrics [40].
2004, Y.H. Kwak, J. Stoddard addresses lessons learned from implementing project risk management practices in software development environment [41].
2004, Kwan-Sik Na, Xiaotong Li, James T. Simpson, Ki-Yoon Kim conduct a comparative study to determine how risk management strategies impact software product and process performance in countries with dissimilar IT capabilities [22].
2004, Jakub MILER, Janusz GÓRSKI presents a systematic approach to software risk identification based on risk patterns, demonstrates how this approach can be applied using RUP as the reference model of software processes [15].
2005, Young Hoon Kwak, Kenneth Scott LaPlace defines that Risk tolerance is often misunderstood or overlooked by project managers [42].
2005, Dragan Milosevic, Peerasit Patanakul undertook an exploratory study into the impact of SPM on project performance in development projects in high-velocity industries [8].
2007, Dr P K Suri, Manoj Wadhwa provides a quantitative means to assess the risk associated with software development, by outlining the different factors which introduce the risk , assigning weightages to each factor [18].
2007, Kwan-Sik Na, James T. Simpson, Xiaotong Li, Tushar Singh, Ki-Yoon Kim investigate the impact of two alternative conceptualization of software development risk on both objective performance and
subjective performance [23].
2008, Gupta, D., Sadiq, M. proposed a software risk assessment and estimation model (SRAEM [11].
2008, Dr.Ing. Tilo Nemuth implement risk analysis tool for construction project evaluation in the tender phase based on Monte Carlo Simulation [14].
2009, Karel de Bakker, Albert Boonstra, Hans Wortmann presents a meta-analysis of the empirical evidence that either supports or opposes the claim that risk management contributes to IT project success [21].
2009, P. K. Suri, Bharat Bhushan, Ashish
Jolly design a simulator for analyzing the

International Journal Of Business Management
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performance measurement of Software Risk Assessment using Markov process [31].

2010, M.S. ROJABANU, Dr. K. Alagarsamy proposed a model for the Software Risk Management based on the Developer, Development process and the customer [30].

2010, Ayse Kucuk Yilmaz and Triant Flouris presents an integrative conceptual framework for sustainability risk management in enterprise-wide [3].

2011, Dhirendra Pandey, Ugrasen Suman, A. K. Ramani proposed a method to match requirement engineering approaches with risk assessments approaches [7].

2011, Liu Jun, Wang Qiuzhen, Ma Qingguo develops an integrative model to explore the moderating effects of uncertainty on the relationship between risk management and IS development project performance from a vendor perspective [26].

2011, Ms Manisha.Ingle, Dr.Mohommad Atique, Prof. S. O.
Dahad reports the methodology to solve risk analysis problems with the purpose of determining the project's attractiveness [28].

2011, Averill M. Law give a three-activity approach for choosing the theoretical distribution that best represents a set of observed data [2].

2011, Abdullah Al Murad Chowdhury and Shamsul Arefeen recognizes the increasing role of risk management in present software projects [1].

2011, Lazaros Sarigiannidis, Prodromos D. Chatzoglou investigates a wide range of relevant literature, proposes a new conceptual framework for managing risk in software development projects [24].

2012, Haneen Hijazi, Thair Khdour, Abdulsalam Alarabeyyat investigate the state of risk and risk management in the most popular software development process models [12].

2012, P.K. Suri, Pallavi Ranjan discussed several existing methods for software cost estimation and their aspects [33].

2012, Vinay Kumar Nassa, Sri Krishan Yadav present an approach for creating a robust risks classifications and measurement system [39].

2012, Iqbal Felani developed a risk management information system. This information system will be supported by some simple methods to reduce subjectivity and qualitative result [13].

2012, P.K. Suri, Pallavi Ranjan implement a simulator in C language which estimates the probability of a successful project completion [34].

2012, Malaya Kumar Nayak, Dr Sanghamitra Mohanty deals with the benefit of conducting schedule risk analysis on an ICT Infrastructure Project [27].

V. RISK ANALYSIS OF PROJECT SCHEDULE

The project schedule is the core of the project planning. As the time needed to complete a project activity is hard to estimate, scheduling a project is extremely difficult task. In the software project development process it is very obvious that risk scheduling is one of the most significant disciplines that cannot be mastered by anyone who normally has project risk scheduling responsibilities. So, evaluating risks to the schedule is complex. Once the activities duration ranges have been determined, the schedule risk analysis can determine the risk during the project schedule. Normal risk schedules are designed using single point approximations of activity durations. When the uncertainty of activity durations is taken into account, the duration of a schedule path is likely to differ from that computed. To identify the risk involvement during scheduling, various tools and techniques have been discovered. Simulation is an important technique for schedule risk analysis.

VI. STRATEGIES FOR SCHEDULE RISK ANALYSIS

Analysis of the project's schedule network can be used to identify risk factors associated with the project in the following ways –

- PERT
- Monte Carlo Simulation /Box Muller Simulation
- Simulation of PERT

A. *PERT*

PERT (Project Evaluation and Review Technique) was designed to look after the uncertainty of estimates of task durations. Instead of using a single estimate for the period of each job, for this PERT requires three estimates - Optimistic Time , Most Likely Time, Pessimistic Time.

- **Optimistic Time (t_o)**: The optimistic time is the shortest possible time in which the activity can be completed.
- **Most Likely Time (t_m)**: The most likely time is the normal amount of time the activity would take.
- **Pessimistic Time (t_p)**: The pessimistic time is the longest time the activity could take if everything goes wrong.

The objective of PERT is to find out the completion time for a particular event and to determine what are the chances of completing a job and the risk of not completing a job in time. In the network analysis, it is assumed that the time values are deterministic or variations in time are insignificant. It is difficult to get a reliable time estimate because the technology is changing rapidly. Time values are subject to chance variations [34].

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Each activity is specified by its starting node, finishing node, and three time estimates. The risk index for the activity network can be computed as -

1. Compute mean time (μ_k) and variance (σ_k^2) for each activity - Mean time and variance of each activity/ node is computed on basis of Optimistic, Most Likely, Pessimistic timings of completion of project estimated by software development experts. The mean time for every activity can be approximated using the weighted average given below:

Mean time = (Optimistic + 4 * Most likely + Pessimistic) / 6

$$\mu_k = (t_o + 4t_m + t_p)/6 \quad (1)$$

The variance is given by:

Variance = [(Pessimistic - Optimistic) / 6]²

$$\sigma_k^2 = ((t_p - t_o)/6)^2 \quad (2)$$

2. Determine the critical path and critical activities through network - Critical path is the longest path through the network. The whole project falls behind schedule if something falls behind schedule on the critical path. Critical activities are the activities that lie on the critical path.

3. Estimate the probability of risk during project completion - (i) Calculating the z values - Given a scheduled time (ST) for completing the project, the z value can be computed as -

$$z = \frac{\text{(Scheduled time - }\sum\text{mean time of critical activities)}}{\sqrt{\sum\text{variance of critical activities}}} \quad (3)$$

(ii) Converting z values to probabilities - The z value can be converted to probability of risk of not completing the project on time by using standard normal probability table or graph.

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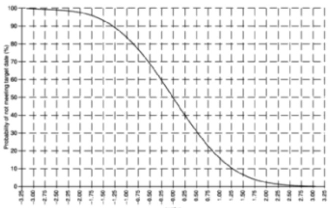

Fig 2. The probability of obtaining a value within Z standard deviations of the mean for a normal distribution

1) Benefits:

- PERT explicitly defines and makes visible dependencies (precedence relationships) between the activities of the schedule network.
- PERT facilitates identification of the critical activities and critical path.
- PERT provides for potentially reduced project duration due to better understanding of dependencies.

2) Limitations:

- There can be hundreds or thousands of activities and individual dependency relationships.
- When the PERT charts become unwieldy, they are no longer used to manage the project.

B. *Monte Carlo Simulation*

As an alternative to the PERT technique, and to provide flexibility in specifying activity durations, Monte Carlo simulation techniques can be used to evaluate the risks of not achieving deadlines. The basis of this technique is to calculate activity times for a project network a large number of times, each time selecting activity times randomly from a set of estimates. The Monte Carlo method thus produces range of estimates with associated probabilities.

For example, In the COCOMO II estimation model, equation that relates estimated schedule to estimated effort is of the form:

$$\mathbf{S = c * (E)^d} \quad (4)$$

Where E is estimated effort in staff-months, S is the estimated schedule in months, c and d are constants derived from historical data. The Monte Carlo technique can be used produce estimates of the probabilities of achieving various project milestones, including the completion milestone as depicted in Fig 3.

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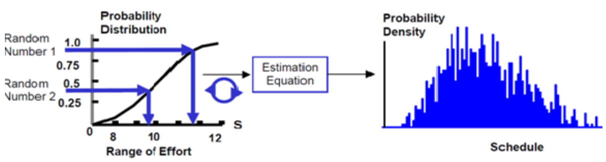

Fig 3. A depiction of Monte Carlo estimation [35]

C. *Simulation of PERT*

Mean time (μ_k) and standard deviation (σ_k) for each activity/node are evaluated on the basis of emperical data available (greater than 50) from different software development houses for a particular sector. For eg- banking sector. the timings for completion of each activity/node can be computed by using Box- Muller transformation.

$$\mathbf{t_k = s * \sigma_k + \mu_k} \quad (5)$$

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.

$$\mathbf{s = sqrt(- 2 \ln (rn1)) \cos (2\, pi * rn2)} \quad (6)$$

Where (rn1, rn2) is a pair of random numbers in the range (0, 1).

Using simulation of PERT, one can compute critical indexes for each activity/node and thus accordingly due importance can be given to that particular activity/node. this will minimize the risk factor involved in each and every activity and it will enable software development houses to develop the project in time.

VII. CONCLUSION

Project failures are the result of multiplicity of risks inherent in software project environment. When risks are not managed properly, they leave projects vulnerable to factors that can cause major rework, major cost or schedule over-runs. Risk scheduling is a difficult discipline. Analysis of the project's schedule network can be used to identify risk factors associated with the project. In this paper, we have reviewed different strategies for evaluating risks to the project schedule.

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