


Influence of Risks on Project Planning Decision

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Received on:1/11/2015 & Accepted on:4/2/2016

ABSTRACT

In this research, a "Project planning / Risk analysis" model that consists of four modules has been developed to aid the decision-maker in planning different types of projects and analyze the risks. These modules are: Planning, Decision-Making Process 1, Risk Analysis, and Decision-Making Process 2. The model can be used to generate different scenarios of project plan according to the decision-maker's opinion in choosing the type of probability distribution, changing the probability/impact of the risk occurrences and/or changing the input values (time/cost) into the probability distribution. These scenarios will be resulted by Monte Carlo simulation as well as the application of qualitative techniques to assess risks and combining their probability of occurrence and impact, and quantitative techniques to numerically analyze the effect of identified risks. Moreover, it gives the decision-maker the ability of avoiding unexpected events through providing a futuristic look of the most project risky activities by implementing risk ranking matrix using heat map. The developed model will go through interrelating three software; Microsoft Project, Microsoft Excel and @Risk from Palisade.

Keywords: Project Planning, Risk Analysis, Simulation, Heat map, Decision Making, Probability distribution

INTRODUCTION

Project management has been around for many years which become more defined and structured. All projects have a starting point and an endpoint. In order to transfer from a starting point to the endpoint, the project will consume time, effort and money, also there is risk involved. Therefore, a feasible plan that achieves best specifications and performance within the time-cost frame is needed. Therefore, this research produces an illustration of the design of a model that aims to plan the project and analyze the risks with the interference of the decision-maker. This will facilitate the updating of all activities relevant to the criteria of cost and scheduling time. Moreover risk analysis can be achieved according to the decision-makers opinion through multiple scenarios seen as crucial information. These scenarios will be activated by using Monte Carlo simulation as well as the risk analysis will go through the trial version of @Risk software from Palisade [1].

Problem Statement

The research problem indicates that most companies are experiencing considerable losses because of the encountered problems in the project planning scope. As well as the negligence of risk management causes negative affects in the outcome of the projects and could fail to achieve the project goals. Moreover, these companies are using traditional methods in managing and planning projects, which in turn increase the waste of both time and cost.

Literature Review

The most relative recent literatures are considered as follows:

He and Kang (2010) [2]: have proposed a study using bayesian network as a decision support system (DSS) technique in order to manage the risks. The results of this study prove the effectiveness of this technique in analyzing complex risks in order to enhance the project management processes. Moreover, it can not only evaluate risks of project but also update the risks, evaluate the results and effects according to sudden risks events. A study prepared by **Gajewska and Ropel (2011) [3]:** focuses on the early phase of a project life cycle of a construction project. This study based on the interviews and previous researches that present the nature of risk and its affect through the project life cycle. The success of this study was proven in a school project as a case study. A project scheduling approach has proposed by **Razaque, Bach, salama, and Alotaibi (2012) [4]** focuses on critical chain schedule and risk management. The critical chain schedule has been implemented for reliable scheduling within defined plan and schedule. The potential risks of project are critically analyzed using fuzzy failure mode and effect analysis method. In addition, Monte Carlo Simulation has been used in order to calculate the total time of project. **Baloi (2012) [5]:** has studied multiple risk analysis techniques and tools as well as their strengths and weaknesses in order to manage the risks. These techniques such as Probability Theory, Certainty Factors and Fuzzy Logic are explained with regard to their application to risk analysis in construction projects. The result of this study is to give a good suggestion on the most appropriate analysis tools and techniques depending on the risk nature. While **Swarna (2014) [6]:** uses Fault Tree method for analyzing the risks because of its significant impact on a construction project performance in terms of cost, time and quality. This research aims at gaining understanding of risk factors that could be for the building projects in various firms.

The Proposed Model Architecture

The developed "Project Planning/Risk Analysis" model can be characterized by four basic modules as shown in figure (1). These modules are:

- a. Planning Module
- b. Decision-Making Process 1 Module
- c. Risk Analysis Module
- d. Decision-Making Process 2 Module

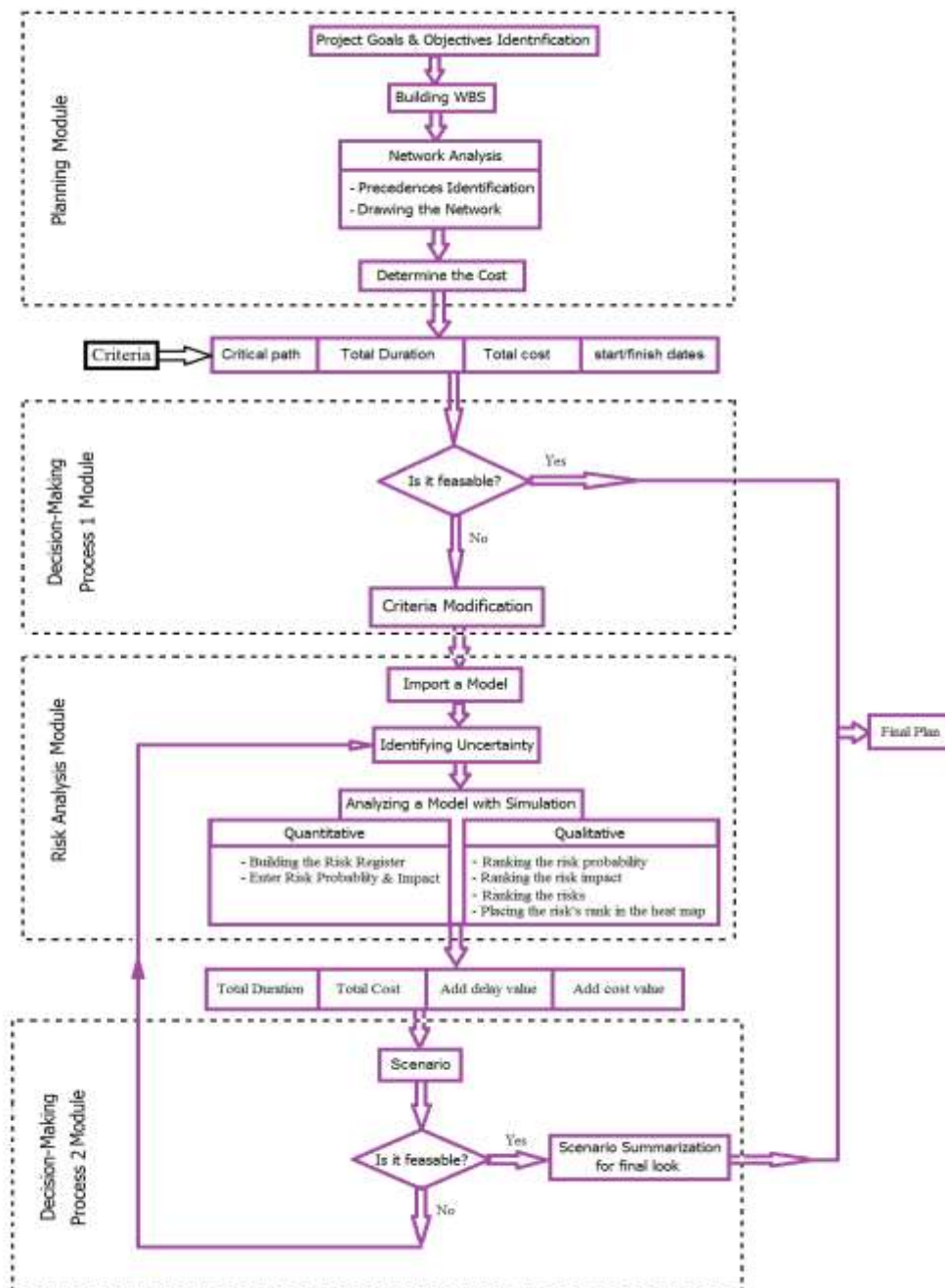
Planning Module

Starting the project with clearly defining the goals and objectives by setting up type of the construction project including the expected project duration and budget that are determined by the decision-maker. Moreover, all the tasks are needed to reach the identified goal are specified. Prioritized these tasks are achieved by building the project's Work Breakdown Structure (WBS). The network analyses will constraint on using Critical Path Method (CPM). The cost in this module represents the combination of both direct and indirect costs for each task. Collecting the costs of all the tasks will produce the total cost of the project.

The outcomes of the planning module consist of the following criteria:

- 1- The critical path
- 2- The total duration
- 3- The total cost, and
- 4- The start/finish dates

The current module uses Microsoft project (version 2007) for planning to have the same results but more efficient compared with by hand calculations.



Figure(1): The Framework of Project Planning/Risk Analysis model

Decision-Making Process 1 Module

The criteria from the planning module will interaction with the ideas of the decision-maker. If these criteria are accepted /feasible by the decision-maker then this plan will be set as the final plan. Otherwise, the decision-maker will modify all or any criteria.

Risk Analysis Module

The extracted criteria from the previous module assumes as uncertain values. Risks might happen through some or all these criteria causing lateness of completion of the project or overload budget. These risks will be analyzed by Monte Carlo simulation using quantitative and qualitative analysis techniques.

This module consists of three steps as follows:

1. Importing all the tasks that have been identified in the planning module into Excel worksheet.
2. Using the probability distributions to describe and summarize the risk by entering both minimum and maximum range of uncertain values (Time and Cost). The probability distributions will be determined by the decision-maker.
3. The risks can be analyzed by the following procedures:

a) Procedure 1 (Quantitative):

Building the risk register is to list all the identified risks including their probabilities and impacts that are estimated by the decision-maker, using Microsoft Excel as shown in figure (2).

Figure (2): The Risk Register in Microsoft Excel worksheet template

b) Procedure 2 (Qualitative):

Anticipating the risks probabilities and impacts using qualitative uncertainty analysis called "Risk probability-Impact Ranking Matrix technique" in order to rank and assess the degree of seriousness of the critical tasks. This technique determines four factors, these are:

First: Ranking the risk probability (from 1 to 5) according to the probability scale (%) that will be defined by the decision-maker which is related to the activated research. As shown in table (2).

Table (2): Probability Ranking of Identified Risks [7]

Probability of occurrences	Probability ranking
Rare (%)	1
Unlikely (%)	2
Possible (%)	3
Likely (%)	4
Almost Certain (%)	5

Second: Ranking the risk impact (from 1 to 5) of different categories. If the risk impacts affect more than two categories, the two highest impacting ranking categories will be chosen [7].

Third: Ranking the risks by specifying the risk consequence using the equation below [8]:

$$\text{Risk Consequence} = \text{Probability} \times (\text{Impact A} + \text{Impact B}) \dots\dots (1)$$

Forth: placing the risk's rank in the heat map to determine the most important (critical) risk activities that require further attention and treatment.

Probability	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
		Impact				

Figure (3): Risk Consequence(Probability-Impact Matrix heat map) [9]

As shown in figure (3) the located values in the heat map represent the risk consequence. The heat map is graded in four areas with different colors, red, orange, yellow and green, from top right to bottom left. The most significant area of the heat map is the top right corner, in red, where the risks have the highest probability and the highest potential impact. The risks plotted in red are critical and are considered to be in need of the most urgent attention.

Those in the orange area are significant risks that will also need constant management effort to manage them to an acceptable level while those in the yellow area are worthy of regular review and management updates.

The risks in the green area can be neglected because of the little or no impact; also there is no need for management actions in this area.

The primary reason for risk ranking is focusing the attention of management effort on those risks that exhibit the greatest potential to have a negative impact.

Run the Simulation

After applying the quantitative and qualitative techniques the Monte Carlo simulation will run. The results of the simulation will be considered of the outcome of this module. These results are:

- The total duration: represents the summation of project construction duration and the delay days.
- The total cost: represents the summation of project construction cost and the additional costs.
- Added delay value: represents the delay days that are added to the plan as the risk's impact.
- Added cost value: represents the additional costs that are added to the plan as the risk's impact.

Decision-Making Process 2 Module

In order to give the decision- maker the permissibility in the selection of the appropriate plan with preferable criteria, this module will present multi scenarios. Each scenario will concentrate on the total duration, total cost, add delay value and add cost value.

The outcomes of the previous module (the risk analysis module) can be considered as the first scenario, while the changes between one and another scenario will be described in the following steps:

- 1- Changing the type of probability distribution for some or all the durations and the costs of the critical tasks.
- 2- Changing the probability/impact of the risk occurring for some or all the critical tasks in the risk register worksheet.
- 3- Changing the minimum and/or the maximum range for some or all the input values and then enter them into the probability distribution.

After having multiple scenarios, they can be summarized in a table. The decision-maker will take a comprehensive overview at the generated results of each scenario then select the appropriate scenario as a final decision.

whether there isn't any scenario that pleases the decision-maker, then these scenarios must reanalyze starting from "identifying uncertainty" in the risk analysis module, thus this step will repeat continuously until there will be at least one scenario that satisfies the decision-maker.

CONCLUSIONS

This study has developed the "Project Planning/Risk Analysis" model, which can be applied in different types of projects. The model highlights the interference with the decision-maker through the project planning, risk analysis and to choose the preferable plan. The model offers a plan using CPM, which is proven method in saving both time and cost, however the previous studies didn't support this method with the risk analytical capabilities. Project implementation may experience unexpected risks; therefore the suggested model offers Monte Carlo simulation in order to analyze risks. Monte Carlo simulation will be achieved using qualitative and quantitative techniques as well as the application of @Risk, Microsoft Project and Microsoft Excel software. The model presents multi scenarios of the project plan according to the decision-makers opinion. Moreover summarize scenarios results to give the decision-makers permissivity in the selection of the most preferable plan. The model gives the decision-maker a futuristic look of the project's risky activities and highlights their probabilities and impacts through the implementation of Risk Ranking Matrix using heat map.

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