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The development of stochastic process modeling through risk analysis derived from scheduling of NPP project

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1. Introduction

There are so many different factors to consider when constructing a nuclear power plant successfully from planning to decommissioning. According to PMBOK, all projects have nine domains from a holistic project management perspective. They are equally important to all projects, however, this study focuses mostly on the processes required to manage timely completion of the project and conduct risk management. The overall objective of this study is to let you know what the risk analysis derived from scheduling of NPP project is, and understand how to implement the stochastic process modeling through risk management.

2. Methods and Results

In this section, some of the techniques which used to risk analysis and stochastic approach of scheduling model are described. And, input data applied to this application are based on construction of Shin-Wolsong NPP #1 which started commercial operation from 31 July 2012, but are a little bit restrictive.

2.1 General Concepts of Project Scheduling

PDM (Precedence Diagramming Method) is a kind of methods that used in Critical Path Method (CPM) for constructing a project schedule network diagram. This method that also called Activity-On-Node consists of two parts; boxes to represent activities and arrows to show the relationship or constraint between activities. Also, this includes four types of logical relationships as follows; finish-to-start (FS), finish-to-finish (FF), start-to-start (SS), and start-to-finish (SF). From these concepts as above, the Critical Path Method calculates the early start and finish dates, and late start and finish dates, and also measures the difference between early and late dates. The latter is termed "total float" that means the schedule flexibility. The critical path that is adjusted by duration, relationships, leads and lags and other schedule constraints, has a significant impact on whether or not project is way behind schedule.

2.2 Open Plan Program

Open Plan is a kind of project management systems that considerably helps to complete multiple projects on time. And, using this program, it's possible to calculate ES, EF, LS, LF, Total Floats, and other necessary data for project planning, and show the histogram, bar-chart and spreadsheet risk views. For scheduling analysis, twenty activities from input data were used in Open Plan program as shown in Table I.

Table I: Input data for Open Plan program

	Predecessor	Lead/Lag	Duration
Activity 1	Start FS		12
Activity 2	1 FS	-5	20
Activity 3	2 FS		26
Activity 4	2 FS	10	32
Activity 5	3, 4, 13 FS		16
Activity 6	3,5 FS		38
Activity 7	6 FS	-5	25
Activity 8	6 FS	5	15
Activity 9	6 SS	20	9
Activity 10	7, 8, 9 FS		30
Activity 11	10 FS	5	28
Activity 12	Start FS		12
Activity 13	12 FS	-5	18
Activity 14	13 SS	10	25
Activity 15	14 FS		15
Activity 16	11, 15 FS		33
Activity 17	16 FS		11
Activity 18	17 FS	-3	15
Activity 19	17 FS		17
Activity 20	18, 19 FS		25

The result, used in Open Plan program from input data as above, is as follows.

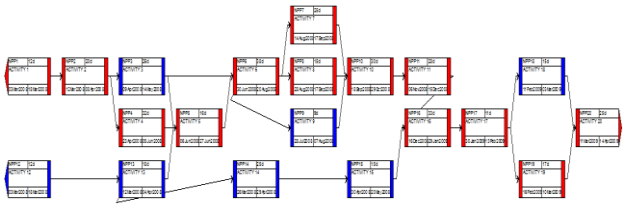

Fig. 1. Output of Activity Network Diagram based on input data using Open Plan program

From Figure 1 as above, 13 boxes with red color are critical paths that have a zero total float, so, that means they are longest path of logically related activities through the network which has the least total float.

2.3 Monte Carlo Program

The Monte Carlo method is commonly used for estimating project schedule uncertainty. Simulations that include uncertainty are often "Monte Carlo" simulations; Monte Carlo simulations involve the repetitive solution of the same set of equations based on different samples of the underlying probability

distributions. In order to get the results of Monte Carlo simulation, Crystal Ball program that enhances your excel model by allowing you to create probability distributions that describe the uncertainty surrounding specific input variables was applied to this simulation. Using twenty activities as shown in Table 1, the results after Crystal Ball simulation with 50,000 trials are as follows.

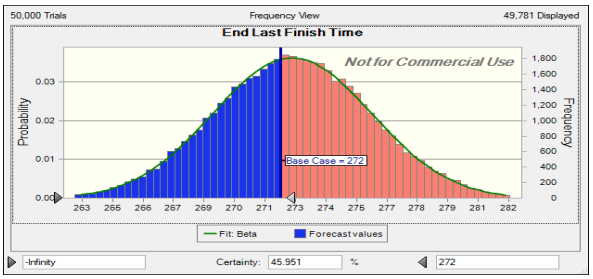

Fig. 2. Output of end last finish time forecast result using Monte Carlo program

From Figure 2 as above, the result as the main chart to examine for certainty of project completion, shows that forecast certainty level which range of end last finish time is from 264 days to 272 days (Base-Case) is 43.375%. In addition, critical paths from Monte Carlo simulation are the same as those from Open Plan program that mentioned earlier.

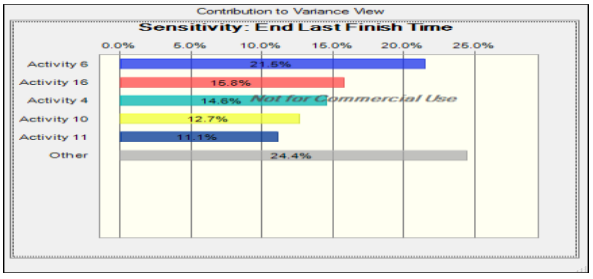

Fig. 3. Output of end last finish time sensitivity result using Monte Carlo program

From Figure 3 as above, the sensitivity result shows which activities have the greatest impact on the last finish time forecast. Activity 6, Activity 16, Activity 4, and other activities sequentially affect the finish time that you can discover where schedule delays occur.

2.4 Duration Control Chart Program

As mentioned earlier, Critical Path Method (CPM) is a modeling technique for scheduling a set of project activities, so, analysis of critical path is such that the variance from original schedule caused by any change can be measured, and its impact on ahead of (behind) schedule of project. To control critical path for optimal scheduling of project, the accuracy of activity duration estimates is absolutely necessary. This can be improved by considering estimating uncertainty and risk. And, project schedule can be modeled as a Beta Distribution with a three-point estimates as follows; most likely, optimistic, and pessimistic. Control Chart using activities duration variances that found from Beta Distribution with twenty activities durations was used for the Minitab simulation.

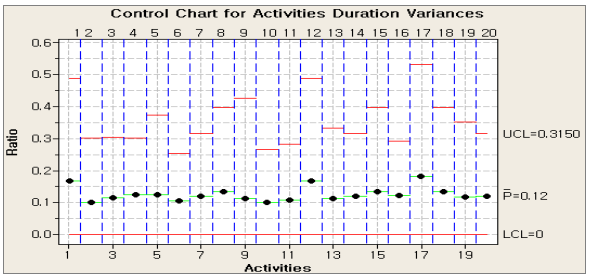

Fig. 4. Output of Control Chart result for activities duration variances using Minitab program

Control Chart result which can help you to focus only those changes in duration variances that affect critical path is as shown above Figure 4. Using Control Chart, it's possible more easily to prevent scheduling risk that may be caused by changes in duration variances of each activity and monitor performance during the project.

3. Conclusions

Building the Nuclear Power Plant is required a great deal of time and fundamental knowledge related to all engineering. That means that integrated project scheduling management with so many activities is necessary and very important. Simulation techniques for scheduling of NPP project using Open Plan program, Crystal Ball program, and Minitab program can be useful tools for designing optimal schedule planning. Thus far, Open Plan and Monte Carlo programs have been used to calculate the critical path for scheduling network analysis. And also, Minitab program has been applied to monitor the scheduling risk. This approach to stochastic modeling through risk analysis of project activities is very useful for optimizing the schedules of activities using Critical Path Method and managing the scheduling control of NPP project.

This study has shown new approach to optimal scheduling of NPP project, however, this does not consider the characteristic of activities according to the NPP site conditions. Hence, this study needs more research considering those factors.

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