Risk Assessment for Project Plan Collapse

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Abstract Following the adoption of probabilistic risk assessment (PRA), which has traditionally been applied to the risk assessment of physical systems like nuclear power plants, chemical plants, railroad facilities, and so on, to information security, this study attempts to apply PRA to project management (PM). This paper discusses the quantitative risk assessment by PRA, especially focusing on the case in which cost planning of a project collapsed.
Key words PRA; Risk assessment; Project plan collapse; Scenario management

1 Introduction

Probabilistic Risk Assessment (PRA) is a strong tool for assessing the safety risks of physical system such as nuclear power plant, chemical plant, railway facilities, etc. The study of PRA was made public in 1975 with the codename WASH-1400 as one of the studies on the safety of the nuclear reactors in the United States. When an accident type has been identified as, for example, an explosion, there exist various steps, scenarios, and a series of events before the occurrence of the accident. In order to quantify the risk of the accident, in the first place, it is necessary as well as important to enumerate the scenarios and quantify the scenarios. In the field of information security and project management, the same can be applied.

The previous study of mine attempted the application of PRA to information security [1], and this study examines the application of PRA to project management. To be concrete, based on the scenario, the quantification of the project plan collapse of cost plan, quality plan, and staff plan is discussed.
PRA is composed of event trees and failure trees. While failure trees are employed to analyze the causes of functional failure, event trees are the key tool for enumerating the accident scenarios. The event tree is a kind of decisive tree that starts from the initiating event and finally reaches success or failure. The accident scenario of each individual initiating event is enumerated with the event trees that start from the initiating event.

2 Scenario Management

As the preliminary step for the application of PRA, this section illustrates the course of a project plan collapse, enumerating the courses of the plan collapse of cost plan, staff plan, quality plan, and delivery plan.

2.1 Cost plan collapse

The course of the cost plan collapse is as follows:

1)The in-house design document was handed to the client, who orally accepted the design.

2)However, no documented inspection acceptance was obtained from the client.

3)Bugs in the generated file were detected by the system test.

4)In order to correct the bugs, modification program had to be generated. As a result, incremental man-hour is required.

5)The negotiation with the client broke down due to the additional fee, the delayed delivery, and the additional staff.

6)The budget was not secured enough.

Consequently, the cost plan collapsed.

2.2 Staff plan collapse

The course of the staff plan collapse is as follows:

1）Since the number of system engineers who are familiar with the work was few, the project plan depended on the partner company staff.

2）Due to the flaw of the project, delivery to the client had often been delayed. However, the delivery deadline of the deliverables was at the beginning of April. On the other hand, the man-hour of the system engineers from the partner company was overflowing due to trouble resolution and Q&A

correspondence. Moreover, due to the flaw of the project, new tasks were accumulating, which led to the lack of Key Men who are able to design with good knowledge of specifications. As a result, it was impossible to implement the project with the staff plan. Thus, the staff plan collapsed.

2.3 Quality plan collapse

The course of the quality plan collapse is as follows:

1） The implementation test was done, but it did not encompass all the real jobs, i.e., it was done by sampling the weekly, monthly, and annual jobs on the ordinary online.

2） The test was coding by using the Inspect Instructions of PC Cobol. Four to five hours after the real online started working, the middleware caused Abend. Abend Dump was obtained, and Dump was analyzed to identify the cause. Then, it turned out that the cause of Abend was the Instruction Inspect of PC Cobol, thus the patch was made. In this case, if the implementation test encompassed all the real jobs, this Abend could be evaded. Then, recovery measure was taken by re-coding with PC Cobol without using Inspect. Finally, operation check and operation test were conducted. As a result, medical accounting jobs recovered, but it took long to recover, and the work stopped. Thus, the original quality was not obtained, and the quality plan resulted in collapse.

2.4 Delivery plan collapse

The course of the delivery plan collapse is as follows:

1） The in-house design document was handed to the client, who orally accepted the design. However, no documented inspection acceptance was obtained from the client.

2） Bugs in the generated file were detected by the system test.

3） In order to correct the bugs, modification program had to be generated. As a result, incremental man-hour is required.

4） The negotiation with the client for increment of staff broke down.

5）Despite the necessity of incremental man-hour, it was not possible to increase staff members. As a result of the work done by current staff members, the delivery due was not observed. Thus, the delivery plan collapsed.

3 Application of PRA to Project Management

In applying PRA to project management (PM), firstly, it is necessary to define the accident and clarify the initiating event for the occurrence of the accident. Here, the initiating event is the factor that triggers the accident. Then, the accident scenario is enumerated with event trees. Finally, event probability of each scenario is calculated.

3.1 The merits of the application of PRA to PM

The conceivable merits of the application of PRA to PM are as follows:

1） Accident scenarios can be enumerated with event trees.

2）The risk can be assessed by both the combination of the event probability of the scenario and the degree of influence.

3） The risks can be assessed for each scenario.

3.2 Problems of uncertainty

In the previous section, the scenarios of collapse of cost plan, quality plan, staff plan, and delivery plan were enumerated. Also, the scenarios with high event probability to fail were able to be extracted. However, these event probabilities of the main collapse are only qualitatively presumed, i.e., they have uncertainty. Therefore, this paper attempts to examine the uncertainty of the accident scenarios of the collapse of cost plan, quality plan, staff plan, and delivery plan.

4 An Example of the Application of PRA to PM

In this paper, PRA is regarded as an approach to risk management, a knowledge area of PMBOK, and the focus hereafter is on cost plan collapse. In this case, from the event trees, 10 scenarios can be identified as is shown in **Figure 1**. In discussing the application of PRA to PM, the case that enough cost could not be obtained and thereby the cost plan collapsed is taken as an example. The merit of the application of PRA is that it enables to draw up the scenarios that lead to the accident. The definition of the accident is “the collapse of the cost plan,” and that of the initiating event is “what causes the collapse of the cost plan.”

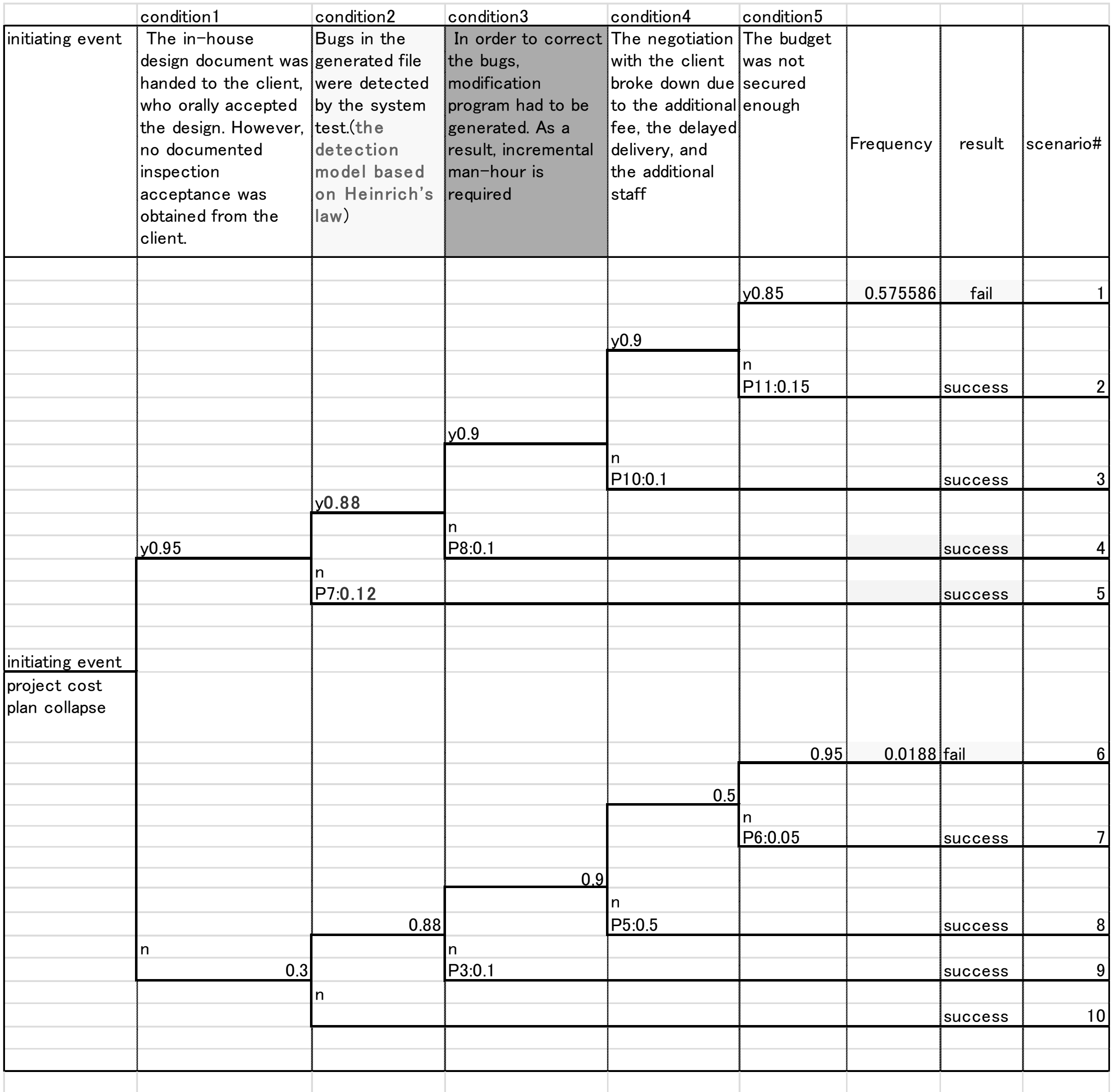

Figure 1 ET_Cost Plan Collapse

5 Scenarios of the Cost Plan Collapse

The course of the cost plan collapse is stated in 2.1, 1) to 5).

In discussing the application of PRA, let us take the case that enough cost could not be obtained and thereby the cost plan collapsed. By illustrating the course of cost plan collapse with event trees, 10 scenarios can be identified from the event trees in **Figure 1**. The probability that the in-house design is delivered to the client, and the documented inspection acceptance is obtained from the client is supposed 0.05 (P1). The probability that the bugs in the generated file are not detected is supposed 0.12 (P2, P7). The probability that no correction program, incremental man-hour, or incremental cost is necessary is supposed 0.1 (P3, P8). The probability that the negotiation with the client concerning incremental fee, extending delivery due, and incremental staff does not break down is supposed 0.1 (P5, P10). Finally, the probability that the contingency budget is not secured is supposed 0.05 (P6, P11).

Scenario 1

The in-house design was delivered to the client, who agreed with it, but the inspection acceptance document was not received from the client. In the system test, bugs of the generated file were detected. Increment of correction program, incremental man-hour, and incremental cost were necessary to complete the project. However, the negotiation with the client with regard to incremental fee, extending delivery due, and incremental staff broke down. The contingency budget is not secured.

Scenario 2

The in-house design was delivered to the client, who agreed with it, but the inspection acceptance document was not received from the client. In the system test, bugs of the generated file were detected. Increment of correction program, incremental man-hour, and incremental cost were necessary to complete the project. The negotiation with the client with regard to incremental fee, extending delivery due, and incremental staff broke down. However, the contingency budget is secured.

Scenario 3

The in-house design was delivered to the client, who agreed with it, but the inspection acceptance document was not received from the client. In the system test, bugs of the generated file were detected. Increment of correction program, incremental man-hour, and incremental cost were necessary to complete the project. However, the negotiation with the client with regard to incremental fee, extending delivery due, and incremental staff did not break down.

Scenario 4

The in-house design was delivered to the client, who agreed with it, but the inspection acceptance document was not received from the client. In the system test, bugs of the generated file were detected. However, increment of correction program, incremental man-hour, and incremental cost were not necessary to complete the project.

Scenario 5

The in-house design was delivered to the client, who agreed with it, but the inspection acceptance document was not received from the client. In the system test, bugs of the generated file were not detected.

Scenario 6

The in-house design was delivered to the client, who agreed with it, and the inspection acceptance document was received from the client. In the system test, bugs of the generated file were detected. Increment of correction program, incremental man-hour, and incremental cost were necessary to complete the project. The negotiation with the client with regard to incremental fee, extending delivery due, and incremental staff broke down. Moreover, the contingency budget is not secured.

Scenario 7

The in-house design was delivered to the client, who agreed with it, and the inspection acceptance document was received from the client. In the system test, bugs of the generated file were detected. Increment of correction program, incremental man-hour, and incremental cost were necessary to complete the project. The negotiation with the client with regard to incremental fee, extending delivery due, and incremental staff broke down. However, the contingency budget is secured.

Scenario 8

The in-house design was delivered to the client, who agreed with it, and the inspection acceptance document was received from the client. In the system test, bugs of the generated file were detected. Increment of correction program, incremental man-hour, and incremental cost were necessary to complete the project. However, the negotiation with the client with regard to incremental fee, extending delivery due, and incremental staff did not break down.

Scenario 9

The in-house design was delivered to the client, who agreed with it, and the inspection acceptance document was received from the client. In the system test, bugs of the generated file were detected. However, increment of correction program, incremental man-hour, and incremental cost were not necessary.

Scenario 10

The in-house design was delivered to the client, who agreed with it, and the inspection acceptance document was received from the client. In the system test, no bugs of the generated file were detected.

Now, focusing on Scenario 1, whose appearance probability would be the highest due to the fail, let us generate normal random numbers of the appearance probabilities of plan collapse condition 1, 3, 4, and 5 in Section 2.1 of this paper, on the condition that the probabilities take normal distribution. As for condition 1, normal random number is generated with 0.95 averages and 0.01 SD. As for condition 3, 4, 5, normal random numbers are generated with averages of 0.9, 0.9, and 0.85 and with SD of 0.02, 0.02, and o.1 respectively. As for condition 2, adopting the detection model based on Heinrich's law, detection rate of 0.88 under the static condition is applied.

The occurrence probability of Scenario 1 is given by the equation (I) blow.

(Scenario 1 occurrence probability) = (condition 1 occurrence probability) X (condition 2 occurrence probability) X (condition 3 occurrence probability) X (condition 4 occurrence probability) X (condition 5 occurrence probability) (I)

In order to obtain the occurrence probability of Scenario 1, the simulation to generate normal random numbers was repeated 1,000 times.

As a result, the probability distribution histogram illustrated in Figure 2 was obtained, while the qualitative estimate value of the occurrence probability of Scenario 1 is 0.575. The histogram in Figure 2 shows that the occurrence probability falls in the interval between 0.563 and 0.623 with high frequency. Therefore, it can be considered that the qualitative estimate value of the occurrence probability of Scenario 1 is within the valid interval. As for the probability that this occurrence probability is below 0.573, the result of the calculation of cumulative of this histogram from 0 to 0.573 is 0.443. This means that the occurrence probability that the qualitative estimate value is below 0.575 is around 0.443.

Next, in the simulation that the occurrence probability of condition 1 is 0.8 and the occurrence probabilities of condition 2, 3, 4, and 5 are the same as those in Figure 2, probability distribution histogram illustrated in Figure 3 was obtained. Although the qualitative estimate value is 0.485, the results of the simulation fall in the interval between 0.444 and 0.484 with high frequency. Thus, it can be considered that the qualitative estimate value tend to be rather over estimate.

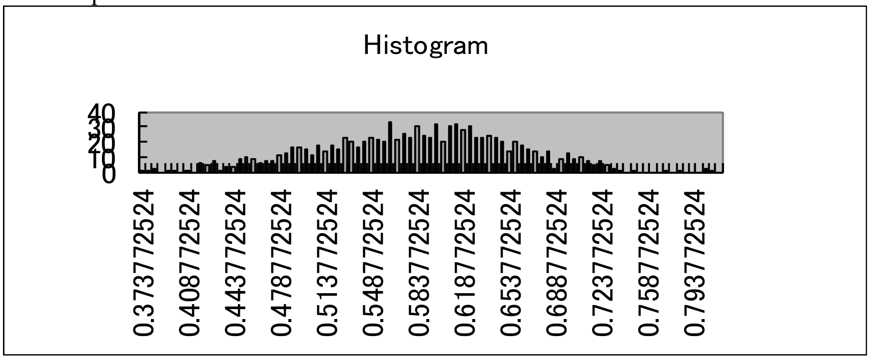

Figure 2 Occurrence Probabilities Distribution of Scenario1(case1)

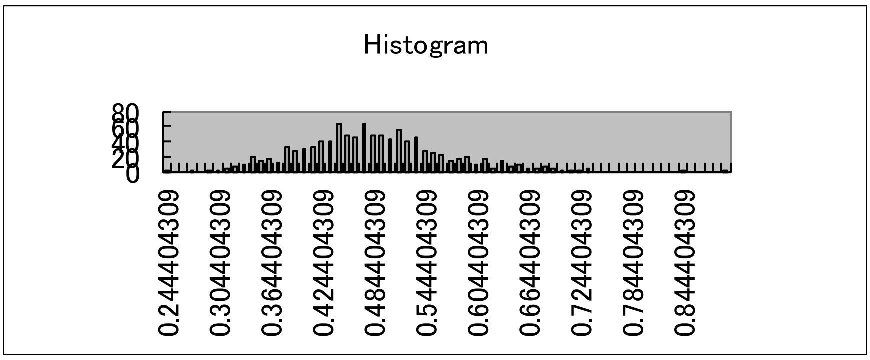

Figure 3 Occurrence Probabilities Distribution of Scenario1(case2)

5.1 The detection model

So far, detection models focusing on human kinetic and static states have been developed and improved [2]. As a result, around 88% detection rate has been obtained for static state, while around 50% detection rate for simple kinetic state [2]. In this paper, the 0.88 detection rate for static state is applied to the detection of the bugs in the file generated for the system test.

5.2 Application to cost plan making

The resulted figures of this simulation can be used in the calculation of contingency reserve.

In coping with the penalty article in the contract on a success-fee basis, it is possible to calculate the contingency reserve by using the resulted figures of this simulation. Contingency reserve is given by the equation below:

(Contingency reserve) = (cost for the threat risk) X (occurrence probability of the risk)

When the contingency budget for the occurrence of Scenario 1 is 5 million yen, in the case 1 in Figure 2, the contingency reserve is indicated as follows:

5,000,000 X 0.563 ≦ contingency reserve ≦ 5,000,000 X 0.623

2,815,000 ≦ contingency reserve ≦ 3,115,000

That is to say, the contingency reserve would be between \2,815,000 and \3,115,000. With the qualitative estimate value 0.575, contingency reserve is calculated only uniquely as 5,000,000 X 0.575 = 2,875,000 (yen). However, with the use of the simulation, the contingency reserve can be obtained more specifically, i.e., between \2,815,000 and \3,115,000.

6 Conclusions

As a result of this study, by employing event trees, the scenario with high occurrence probabilities of main failure in the case of cost plan collapse was able to be extracted. By generating normal random numbers against cost plan collapse conditions 1, 3, 4, and 5 (Section 2.1) of this scenario, and by applying the detection rate under the static condition in Heinrich's law (0.88) to condition 2, histograms of probability distribution were obtained. Furthermore, the occurrence probability of the scenario, which had been qualitatively and uniquely estimated, was able to be analyzed and assessed multilaterally because the frequency of occurrence probability of each condition was obtained by the simulation. In addition, calculation of contingency reserve was able to be available.

On the other hand, project management is the field where experience is respected, and thus computer support is difficult. By accumulating the achievement experience of the veteran PM, the tendency of each industry application can be grasped, which could be a strong support to future PM work. Therefore, it is our future subject to promote improvement in the efficiency and quality of project management work.

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