Importance Determination Process Considering the Severity and the Opportunity

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1. Introduction

The importance determination process evaluates the measure of contribution to the achievement of operation purpose for the target facilities. So, this process can give the basis of the priority for effective management under the limited resources and, the reliability of the importance determination results has been magnified in the aspect of safety and economics.

The quantitative method (such as PSA model) can give the relatively exact results since it can evaluate the relative importance as the number. But, the usage of this method is limited due to technical and economical aspect. And in this case, the qualitative importance determination process, such as Delphi method which derives an agreement through repeated discussion of experts, is used. However, the Delphi method may show the different results according to the level of knowledge and expertise, and the propensity, subjectivity of each expert, especially in the complex facilities that requires the various expertises such as Nuclear Power Plant. So, the reliability of this process due to the increase of uncertainty has been issued

In this paper, the newly developed qualitative importance determination process which minimizes the uncertainty using 6σ technique is described.

2. Method and Results

2.1 Identification of Key Factor of Uncertainty

In order to derive the key factor of uncertainty in Delphi method using 6σ technique, the preparation of Cause-Effect diagram through the interview of the experts, the identification of relative importance between the potential factor using Pair Matrix, and derivation of key potential factor using Parato Analysis was performed. As the results of above processes, the 1st major factor which increased the uncertainty is identified as the broad band of point distribution from 1 to 10. The 2nd major factor is the lack of understanding about the defense-in-depth concept of the system, and the 3rd major factor is the lack of understanding about the Delphi evaluation item.

2.2 Development of New Process

"Importance Determination Process Considering the Severity and the Opportunity" method that separates the severity evaluation and opportunity evaluation was developed. In this method, the range of point distribution was downsized from 1 to 5 in the severity evaluation, and the objective data was used to the maximum instead of subjective point of view in opportunity evaluation. The newly developed process is shown in Fig.1.

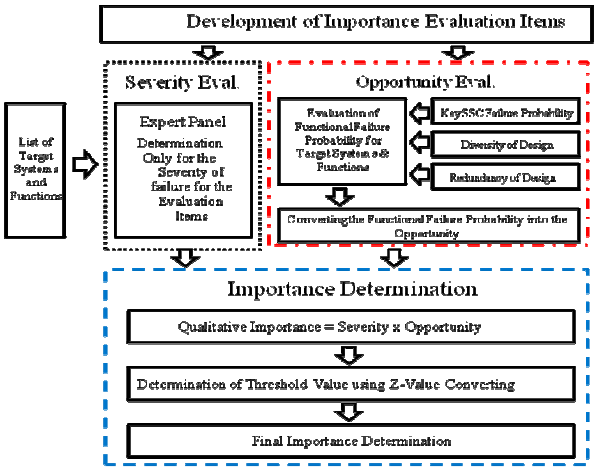

Fig 1. The process of Importance Determination Process Considering the Severity and the Opportunity

2.3 Severity Evaluation

The method for severity evaluation is the same as the Delphi method. But only the effect of failure and the usage of alternative means are considered, and the range of point distribution is limited from 1 to 5 as shown in Table 1.

Table 1. Table of Point Distribution

P	Effect on the Evaluation Item in case of Functional Failure
1	None
2	Minor effect
3	Partial failure, but the goal is fully achieved by the alternative means
4	Full Failure, but partially achieved by achieved by the alternative means
5	Directly affecting the functional failure

2.4 Opportunity Evaluation

This evaluation is consisted of the following steps.

1) Obtain the failure rate of key SSCs through the reliability database from PSA model or design specification of manufacturer
2) Calculate the "Redundancy Value" that is reflected in the design of system function. In this process, the success criteria are surely confirmed.
3) Calculate the "Diversity Value" that is reflected in the design of system function. Also in this process, the success criteria are surely confirmed.
4) Calculate the functional failure probability based on the results of process 1),2) and 3) using the method

generally used in the Fault Tree Analysis. The calculation method according to the success criteria is shown in Table 2.

Table 2. Method for calculating Functional Failure

Success Criteria	Failure Probability Calculation	Defintion
1/3	FA．FB．FC	Capacity of A,B,C,D : 100% FA : Failure rate of A
2/4	(FA．FB)+(FA．FC)+(FA．FD) +(FB．FC)+(FB．FD)+(FC．FD)	
2/3	(FA．FB)+(FA．FC)+(FB．FC)	
3/3	FA + FB +．FC	

5) Convert the functional failure rate into the opportunity value. Since the functional failure rate is calculated as a very small number, it is necessary to convert into the appropriate number in order to make the final importance determination value combined by the results of Severity and Opportunity Evaluation. So, the converting table for opportunity is developed as shown in Table 3.

Table 3. Opportunity Converting Table

Point	1	2	3	4	5
Failure Rate	≤ 1.0E-9	1.0E-08 ~ 1.0E-09	1.0E-07 ~ 1.0E-08	1.0E-06 ~ 1.0E-07	1.0E-05 ~ 1.0E-06
Point	6	7	8	9	10
Failure Rate	1.0E-04 ~ 1.0E-05	1.0E-03 ~ 1.0E-04	1.0E-02 ~ 1.0E-03	1.0E-01 ~ 1.0E-02	> 1.0E-01

6) Calculate the qualitative importance value by multiplying the point of Severity and Opportunity Evaluation.
7) Set up the threshold value. The threshold value can be determined by the appropriate number from the judgment of Expert panel. Or, it can be determined by the value converting the RRW via Z-Value transformation that is one of the statistical approach in the 6σ theory.

3. Verification

To verify the effect of "Importance Determination Process Considering the Severity and the Opportunity" method in actual importance determination process, 17 functions that their quantitative importance evaluation results are not coincide with the qualitative importance evaluation results are selected. The verification was performed by the Expert Panel in Wolsong Unit 3&4, which performed the Delphi evaluation for the development of Maintenance Effectiveness Monitoring Program.

The improved effect by this process is shown in Fig. 2. In this figure, it is confirmed that the importance gap distribution is sharply improved and the distribution of evaluation results between experts in severity evaluation is clearly decreased.

That is to say, the "Importance Determination Process Considering the Severity and the Opportunity" method can secure the reliability of the results by reducing the uncertainty in the evaluation process. The improved effect according to this method also can be showed by the quantitative value in the 6σ theory as following.

1) Capability Z_{st} is improved from 1.6 to 2.31
2) Defect Rate is reduced from 460,000 to 200,000ppm
3) Improved effect on DPMO (Defect per Million Opportunities) is 57%

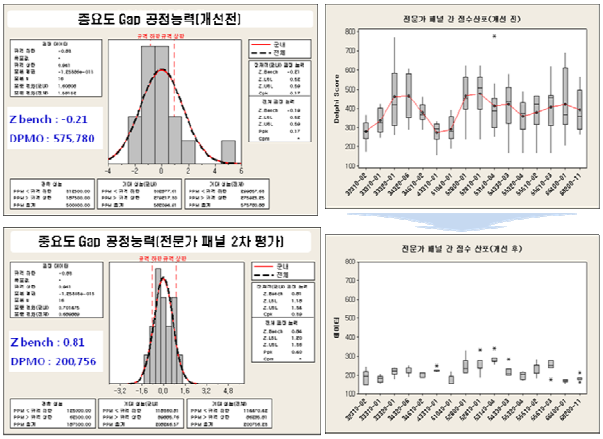

Fig 2. Improved Effect of Newly Developed Process

4. Conclusions

In order to improve the uncertainty in the present Delphi method, the new method named as "Importance Determination Process Considering the Severity and the Opportunity" was developed. In this method, the range of point distribution by experts which was the main factor of the uncertainty was limited. And, the opportunity was separated from the subjective judgment by expert and, calculated by the objective design documents or requirements.

As the results of verification process for this method, it is shown that the accuracy and the reliability of the qualitative importance determination process can be improved. But, in order to fully utilize this method to actual risk importance determination process, it is needed that the re-verification should be performed for the whole function of the Plants, and the in-depth study about the application plan for the design that cannot calculate the Redundancy Value and Diversity Value in opportunity evaluation.

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