A STUDY ON ACCIDENT SCENARIO IDENTIFICATION METHOD TO APPLICATION ON RISK ASSESSMENT

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PRA is a technique for evaluating the risk of nuclear power plants. In the level 1PRA, the identification of accident scenarios is very important. It is performed by top-down analysis method or bottom-up analysis method. In our previous study, the marine accident in Akashi Strait was analyzed by the bottom-up analysis method. However, the identification of accident scenarios was required more effective analysis to extract factors without exception. So, in this study, we discussed the accident scenario identification method from both top-down and bottom-up analysis methods. In order to establish the identification method from both top-down and bottom-up analysis methods, an example of the analysis on marine accidents was shown by both methods. The analysis result of the bottom-up method was quoted as the previous study of the marine accident in Akashi Strait. As the top-down analysis method, the Master Logic Diagrams (MLD) was utilized and accident records of the marine accident in Akashi Strait were classified by the MLD method. By comparing the analysis result of the MLD to the previous study, we discussed the effectivity of the identified accident scenario by both the both top-down analysis and the bottom-up analysis. As a result, using the MLD method as the top-down analysis methods, validity of the proposed method was shown.

I. INTRODUCTION

PRA is a technique for evaluating the risk of nuclear power plants. In particular, the level 1PRA has general versatility and has been utilized in various fields. In the level 1PRA, the identification of accident scenarios is very important. It is performed by top-down analysis method or bottom-up analysis method. In our previous study, the marine accident in Akashi Strait was analyzed by the bottom-up analysis method (Ref. 1). However, the identification of accident scenarios was required more effective analysis to extract factors without exception. So, in this study, we discussed the accident scenario identification method from both top-down and bottom-up analysis methods.

Hazard identification is the preliminary and the most important task in risk assessment of plants. Several methods have been proposed in the literature for hazard identification, such as What If Analysis, Failure Modes and Effects Analysis (FMEA) and Hazard and Operability Analysis (HAZOP). FMEA is one of the most widely used method for hazard identification. It is a bottom up analysis and identify failure modes, and their causes and effects. On the other hands, the Master Logic Diagrams (MLD) have been presented and applied in the past for initiating event identification of nuclear plants (Ref. 2). It is a top down analysis, providing initiating events, which may be quantified in other tasks of risk assessment. FTA is also a top down method but it has mathematical properties. However, this mathematical properties are not utilized in this study. So, by setting accidents occurred actually as the top event, the MLD was utilized as the classification method of accidents.

II. METHOD

In this study, in order to establish the scenario identification method using both top-down and bottom-up analysis methods, examples of an analyzed marine accident were shown by both methods. The analysis result of the bottom-up method was quoted as the previous study of the marine accident in Akashi Strait. As the top-down analysis method, the MLD was utilized. Accident records of the marine accident in Akashi Strait were classified by the MLD method. These accidents records were obtained from web sites of Japan Marine Accident Tribunal and Japan Transport Safety Board (Ref. 3). Characteristics of Akashi Strait is a congested sea area of the top class in the major domestic water channel. Transit number of vessels of the day is more than 800.

For this classification, a cognitive model was utilized for each layer of the MLD. The cognitive model consisting of “the recognition and the judgment and the operation” was used. As the top event, “Maritime Collision Accident” was settled. In the second layer, “Maritime Collision Accident” was decomposed into the event based on “the operation.” The second layer was decomposed into the event based on “the judgment”. And the third layer was decomposed into the event based on “the recognition.” Development continued until a level was reached the background of the event.

By comparing the analysis result of MLD to the previous study, we discussed the effectivity of the identified accident scenario by both the both top-down analysis and the bottom-up analysis.

III. RESULTS

The accident factor of maritime collision accident occurred in Akashi Strait was extracted and decomposed using the MLD method. As shown in Figure 1, "Maritime Collision Accident" was set at the top event and decomposed into the second layer, “Avoidance Behavior” as “the operation” that caused "Maritime Collision Accident". The second layer was also decomposed into the third layer, “Judgment of the Navigation” as “the judgment” that caused each event in the second layer. Again the third layer was decomposed into the fourth layer, “Human Error” as “the recognition” that caused each event in the third layer. This fourth layer was decomposed into the fifth layer, “Background” that caused each event in the fourth layer. In this figure, the number at the upper of each event means the number of accidents classified in each event.

Thirteen of “Marine Collision Accidents” was decomposed as shown in Figure 1. Twenty six ships in total associated with each collision were analyzed. Some parts of this diagram would be shown, because this MLD is too large. As direct factors of the “Maritime Collision Accident”, two events of “Delay of collision avoidance behavior” and “No collision avoidance behavior” were generated as “Avoidance Behavior” in the second layer.

In the case of “Delay of collision avoidance behavior” of the second layer, the third layer was generated as the direct cause of “Delay of collision avoidance behavior”, for example, “Not notice the approach of other vessels”, as “Human Error”. Number of ships classified in “Not notice the approach of other vessels” was eight and the most in the third layer. Then, the fourth layer was generated as the direct cause of the “Not notice the approach of other vessels”, for example, “Insufficient watch”, as “Background”. Number of ships classified in “Insufficient watch” was four and the most in the fourth layer. The fifth layer was generated as the “Further Background” of “Background” of the fourth layer, for example, “Assumption”.

In the case of “No collision avoidance behavior” of the second layer, the third layer was generated as the direct cause of “No collision avoidance behavior”, for example, “Not notice the approach of other vessels”, as “Human Error”. Number of ships classified in “Not notice the approach of other vessels” was eight and the most in the third layer. Then, the fourth layer was generated as the direct cause of the “Not notice the approach of other vessels”, for example, “Insufficient watch”, as “Background”. Number of ships classified in “Insufficient watch” was six and the most in the fourth layer. The fifth layer was generated as the “Further Background” of “Background” of the fourth layer, for example, “Assumption”.

In both “Delay of collision avoidance behavior” and “No collision avoidance behavior”, number of ships classified in “Not notice the approach of other vessels” was the most in the third layer. Then, “Not notice the approach of other vessels” was considered as one of the important problem for this “Maritime Collision Accident” in Akashi Strait.

On the other hand, in the lowest layer, most of events are based on human errors. Human factor is very important problem in the maritime field (Ref.4). From this result, this problem became clear.

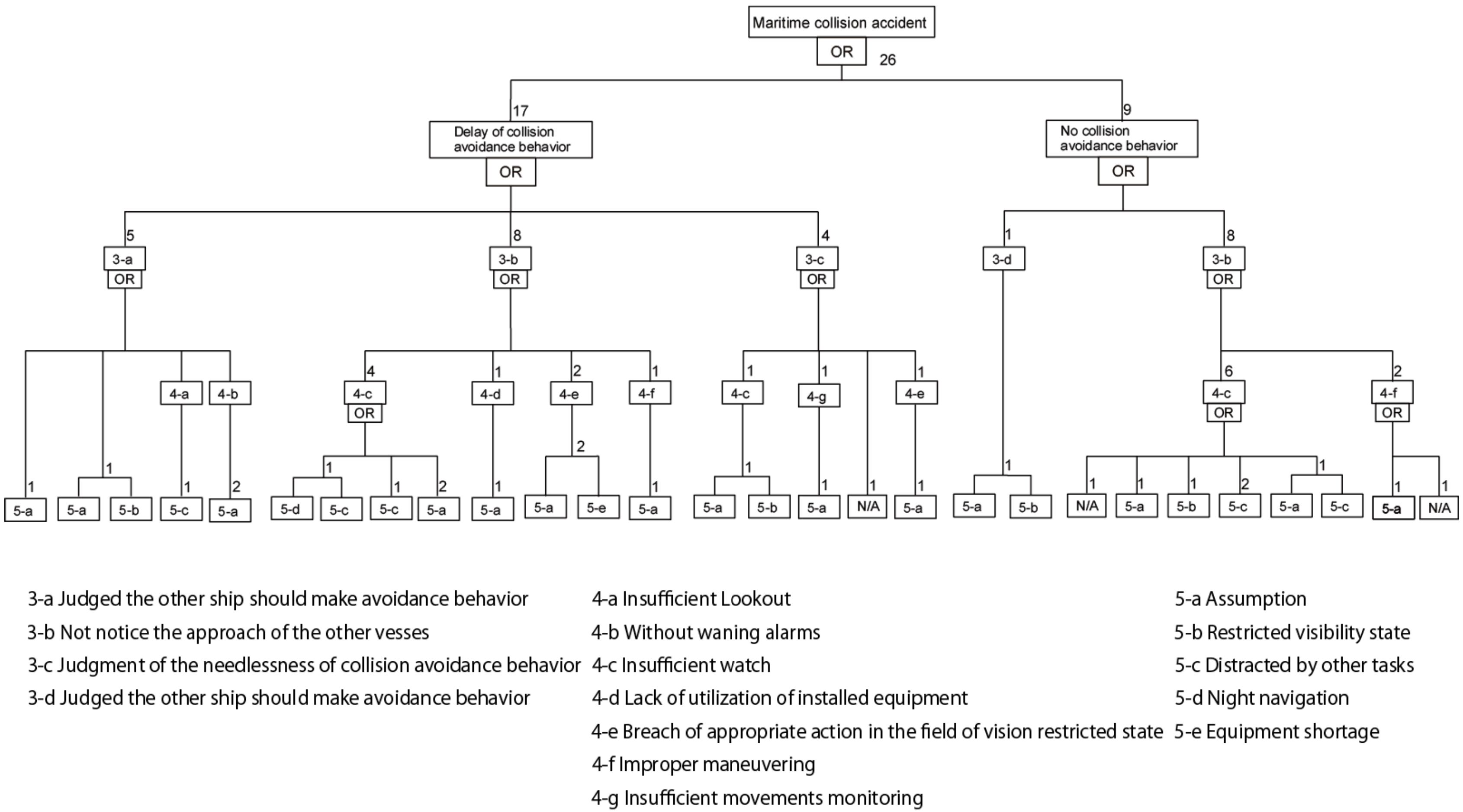

Fig. 1. Master Logic Diagram of the maritime collision accident in Akashi Strait.

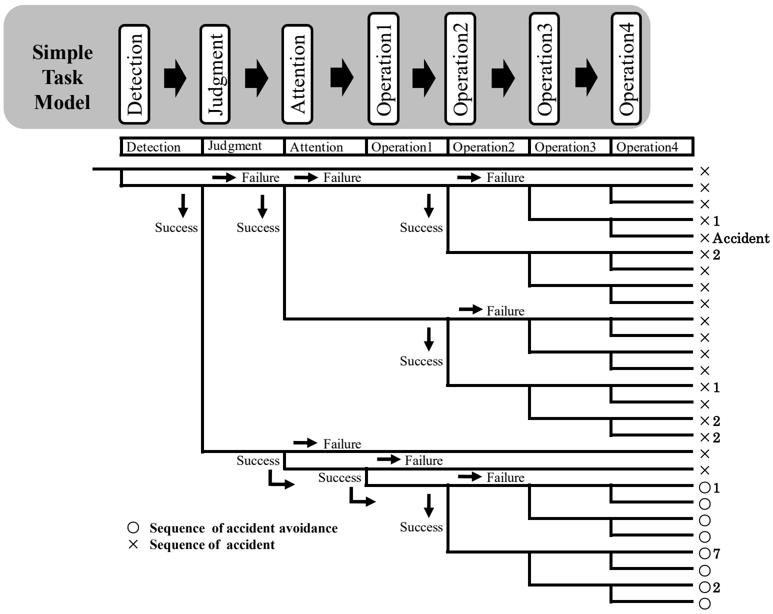

Fig. 2. Event Tree Analysis of Maritime Collision Accident in Akashi Strait (Ref. 1)

IV. DISCUSSION

Purpose of this study is to propose the method to identify the accident scenario using both the top-down and the bottom-up analysis methods. Then, using the MLD method as the top-down analysis method, a Maritime Collision Accident in Akashi Strait was classified. For comparing this result with the result of the bottom up method, results of the Event Tree were utilized (Ref.).

Event Tree Analysis of Maritime Collision Accident in Akashi Strait was performed by NISHIZAKI etc., as shown in Figure 2. In this study, the Bridge Simulator was used and the accident situation was reproduced by the Bridge Simulator. As the result of this study, the accident scenario was proposed as the heading of the Event Tree in Figure 2.

In our study, some scenario were obtained from classified results by the MLD method. The heading of the Event Tree is nearly same as the combination of "Delay of collision avoidance behavior", "Not notice the approach of other vessels", "Insufficient watch" and "Assumption" in classified results of this study. This combination is the most many accidents of the analysis results. From this result, validity of this method using both the top-down and the bottom-up analysis methods was shown.

IV. CONCLUSIONS

Purpose of this study is to establish the method to identify the accident scenario using both the top-down and the bottom-up analysis methods. For this purpose, an example of the analysis on marine accidents was shown by both methods. The analysis result of the bottom-up method was quoted as the previous study of the marine accident in Akashi Strait. Based on these results, validity of this method was discussed. Results of this study are listed below:

- As the top-down analysis method, the MLD was utilized and accident records of the marine accident in Akashi Strait were classified.
- A combination of classified results of this study was nearly same as the previous study.
- This combination was the most many accidents of the analysis results.
- From this result, using the MLD method as the top-down analysis methods, validity of the proposed method was shown.

REFERENCES

1. C. NISHIZAKI et., "Analytical Approach to the Navigational Behavior By the Bridge Simulator Experiments," *The journal of Japan Institute of Navigation*, **123**, 95, (2010).
2. I.A. Papazoglou, O.N. Aneziris, "Master Logic Diagram: method for hazard and initiating event identification in process plants," *J. of Hazardous Materials* **A97**, 11 (2003)
3. The Japan Transport Safety Board, "MARINE ACCIDENT INVESTIGATION REPORT"
4. Japan Coast Guard, "For measures and the current state of marine," 2013