Study on the assessment method for results of ship maneuvering training with the simulator

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Abstract: In this study, evaluating results of ship simulator training was treated. This study proposed a method that clarified factors of errors in ship simulator training for bay pilot trainees. In this method, event tree was made from behaviors of trainees during ship simulator training, and then the branch point that led to errors was made clear. Training results of 52 subjects were analyzed by the proposed method, and then the cause of the failure of 16 subjects was clarified.

Keywords: Simulator Training, Task Model, Event Tree Analysis**,** Importance Measure

1. INTRODUCTION

Pilotage low of Japan was revised in 2007. Before the revising the pilotage low, harbor pilots worked for ship berthing and leaving port, and bay pilots worked for navigating crowded sea area. After the revising the pilotage low, harbor pilots required works for bay pilots and bay pilots required works for harbor pilots. Therefore, they have to take training program to expand their license limit. At Tokyo University of Marine Science and Technology, pilot training program takes many times of ship handling simulator training for them. Results of these simulator training are evaluated based on instructor's subjective view. However more effective training is possible, if the assessment is made quantitatively. For the training of harbor work, Okazaki [1] proposed a method that assesses training result of berthing ships quantitatively. Then, trainees can clear up problems they should improve in their berthing maneuvering. However, for the training of bay work, instructor's subjective evaluation is only the index of their maneuvering skill. To evaluate results of ship handling simulation for bay work is complexity problem. First step to solve this problem, we try to clarify factors of errors of simulation results for bay work.

Therefore, the purpose of this study is clarifying factors of errors in simulator training of bay work. For this purpose an assessment method based on the risk assessment has been proposed. In this method, event tree is made from behaviors of trainees during ship simulator training, and then the branch point that leads to errors is made clear. The method like the importance measure is employed to clarify this branch point [2-4].

In this paper, the most difficult training scenario for bay work was treated and the training results of 52 subjects were analyzed. Using with proposed method, factor of error in the results of simulator training was clarified.

2. TRAINING OF SHIP SIMULATOR

In this study, a training scenario that contains crossing heavy traffic sea lane and requires specific ship maneuvering as pilots is selected among Bay Training. Details of this scenario are shown as below.

2.1. Training Scenario

In this study, Tokyo Bay area was treated. Fig.1 shows the outline of the scenario. This scenario assumes the situation that own ship which enters Tokyo Bay, goes north and enters Yokohama port. In

this scenario, to save the training time, starting position was set to the exit of the Uraga channel where indicated in Fig.1. The own ship which passes the Uraga channel navigates in the sea route on the west side of Nakanose, then turns left at the position of No.2 Beacon(B'n), crosses the sea route, and enters the Yokohama port. When own ship crosses the sea route at the position of No.2 B'n, the trainee should secure the safety distance between own ship and the other ships which go south in the sea route. However, there are a lot of ships which go south in this sea route. Therefore, the trainee should find the space for own ship to cross from among the traffic stream of going south ships at the early stage of the simulation run. Moreover, the trainee should pay attention to other ships, because some ships which crosses the own ship course appear while own ship reaches No.2 B'n position. As an additional selection, trainee can cross the sea route around No.1 B'n, if the trainee can secure the safety of own ship. Anyway, main point of the target scenario is how appropriately the trainee can find the space for own ship to cross from among the traffic stream of south going ships. Therefore, the trainee should estimate the time when own ship arrive at around No.2 B'n. Then the trainee required predicting the positions of south going ships in the sea route at the time. Moreover, in the first half of the simulation run, own ship will encounter the ships which cross the own ship course. If the trainee feels the collision risk at the situation, he should change the ship's speed or ship's course to avoid collision risk. However, speed of own ship is changed, the estimation time when own ship arrive at around No.2 B'n could be changed. Therefore, the trainee required to re-estimate the time and re-predict the position of south going ships in the sea route. Then, he required to find the space for own ship to cross safely again.

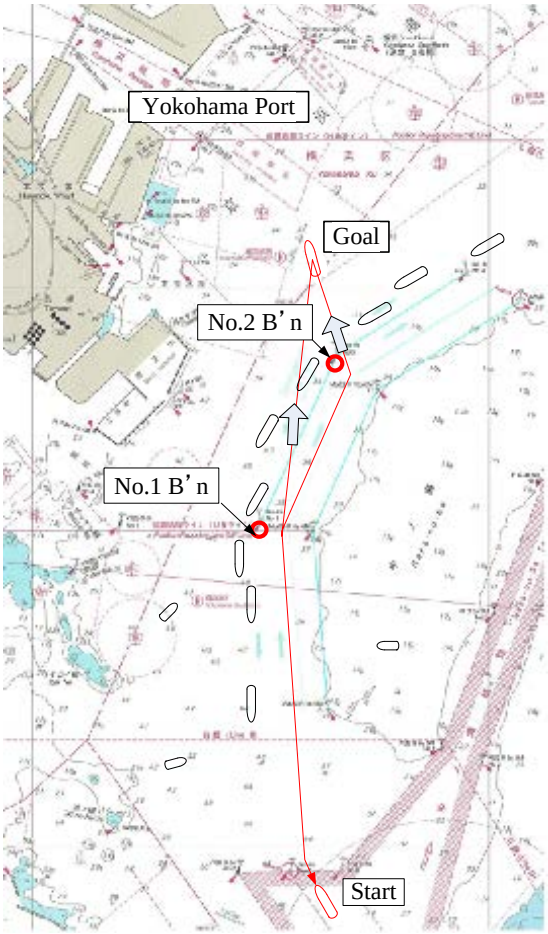

Fig.1 Outline of target scenario

2.2. Training data

Ship simulator trainings using this scenario were conducted from 2007 to 2011 with many trainees. In this study, training data by not enough experienced trainees were excluded, because this scenario requires higher navigation skill and data of not enough experienced trainees may be different from real ship operation and less reliable. Then, data used in this study were selected under conditions shown as below.

Trainees of first grade pilot: All trainees have captain's experience for at least two years or more.
Trainees of bay training program: Harbor pilots who expand their license limit for bay work

3. MAKING EVENT TREE

In this study, simple1 task model [2] is made from results of ship simulator training. For this task model, events which have effects on ship maneuvering and action for these events are both selected, first. Then from these events and actions, more important events and task are selected as simple task.

3.1. Selecting Events

In the early part of the scenario, target ships which cross the course of own ship come up, then these encounters are considered as events. On the other hand, in the latter part, they must cross the traffic stream of going south ships, then position of crossing the stream and following ship for crossing were considered as events. The “target ship” means the ship which own ship must give-way for safety of navigation or other ship must give–way for own ship for safety of navigation. The “following ship” means that the ship is one of south going ship and has safety space to cross own ship at her stern side. In other word, if own ship turns to the left to following after the stern of the following ship, the own ship can cross the south going stream.

In the first half of the simulation run, there are three target ships which cross the own ship course. One is fishing boat (ID No.5) from direction of Yokosuka to Nakanose, container ship from Nkanose basins to Negishi (ID No.33), Gat ship (ID No.28) from Negishi to Kawasaki. If the trainee feels the collision risk for these target ships, he should change the ship's speed or ship's course to avoid collision risk. Therefore, these actions are selected as event.

In the second half of the simulation run, trainees can select the position for crossing the south going stream at around the No.2 B’n or around the No.1 B’n. If the trainee selects No.1 B’n as position for crossing stream, choices of the following ship are four as follows, ID No.24 ship, ID No.25 ship, ID No.35 ship, or non. If the trainee selects No.2 B’n as position for crossing stream, choices of the following ship are four as follows, ID No.2 ship, ID No.3 ship, ID No.23 ship, or non. In addition, after crossing the stream, there is one target ship (ID No.3) comes up.

As a result, selected events are shown in Table 1.

Table 1: Selected events

Event	Action
a. Change speed for No.5 ship	Speed up
	Not
	Speed down
b. Steering course for No.5 ship	Steering course
	Not
c. Change speed for No.33 ship	Speed up
	Not
	Speed down
d. Steering course for No.33 ship	Steering course
	Not
e. Change speed for No.28 ship	Speed up
	Not
	Speed down
f. Steering course at No.1 B’n	Yes
	No
g. Following ship	No.24 ship
	No.25 ship
	No.35 ship
	Non
h. Steering course at No.2 B’n	Yes
	No
i. Following ship	No.2 ship
	No.3 ship
	No.23 ship
	Non
j. Steering course for No.3 ship	Steering course
	Not

3.2. Judgment of training results

In this method, one simulator training result is replaced with one sequence of event tree. Therefore, it is necessary to judge the success or the failure of training result. A collision with other ship is considered as one of a judgment point of training. In the simulator training, operators of the simulator make ships give-way, then no collisions are occurred. However, in the case which overextended performance of the ship is needed to avoid the collision, the result of this training is defined as the failure, because these case means the very hazardous situation near-collision in real situation. Moreover, the purpose of this training is to improve the ability of the pilot. Sorting out the traffic stream to make safety and efficient environment is required one of the ability as a pilot. Then the case which has not yet led to a collision but the traffic stream is disturbed by the burdening of the ship is defined as the failure.

It is difficult to make certain standards for judgments, because congestion situation of ship traffic, difference of navigation performance of each ship and intendment of trainees etc. should be considered and it is difficult to make certain standards. Then in this study, judgments were made subjectively by one of authors who have enough knowledge and experience as a navigation officer.

4. RESULTS

4.1. Event Tree of training data

Headings of event tree are used selected events which shown in Table 1 in this study. Event trees were numerous in this analysis, so representative examples are shown. Fig.2 and Fig.3 show event tree of these training results. In this figure, number of trainees who selected each action is shown. Fig.2 shows the first event tree of this analysis, and Fig.3 shows the example of latter part of Fig.2. Table 2 shows the training result. In this table, numbers of trainees are shown, by success or failure. These results are shown in right column of Fig.3

Table 2: Training results

Result	Number of Trainees
Success	36
Failure	16

4.2. The Importance measure

The importance measure is often utilized to clarify the most important heading with Event Tree method [3]. So, in this study, the method like the importance measure was employed to clarify the important heading to success or fail this training. This method makes it possible to determine the most important heading [2-4]. By using this importance measure, the most important heading was attempted to select the important action in this training.

Training result of failure is 16 in Table 2. Then by selecting the only one branch, most effective heading to reduce failure sequences was evaluated. Evaluation results show that “f. Steering course at No.1B’n” is the most important heading in this training. If “f. Steering course at No.1B’n” was not performed, the number of failure was reduced to only three. Then it was shown that “Steering course at No.1B’n” were mistakes of trainees.

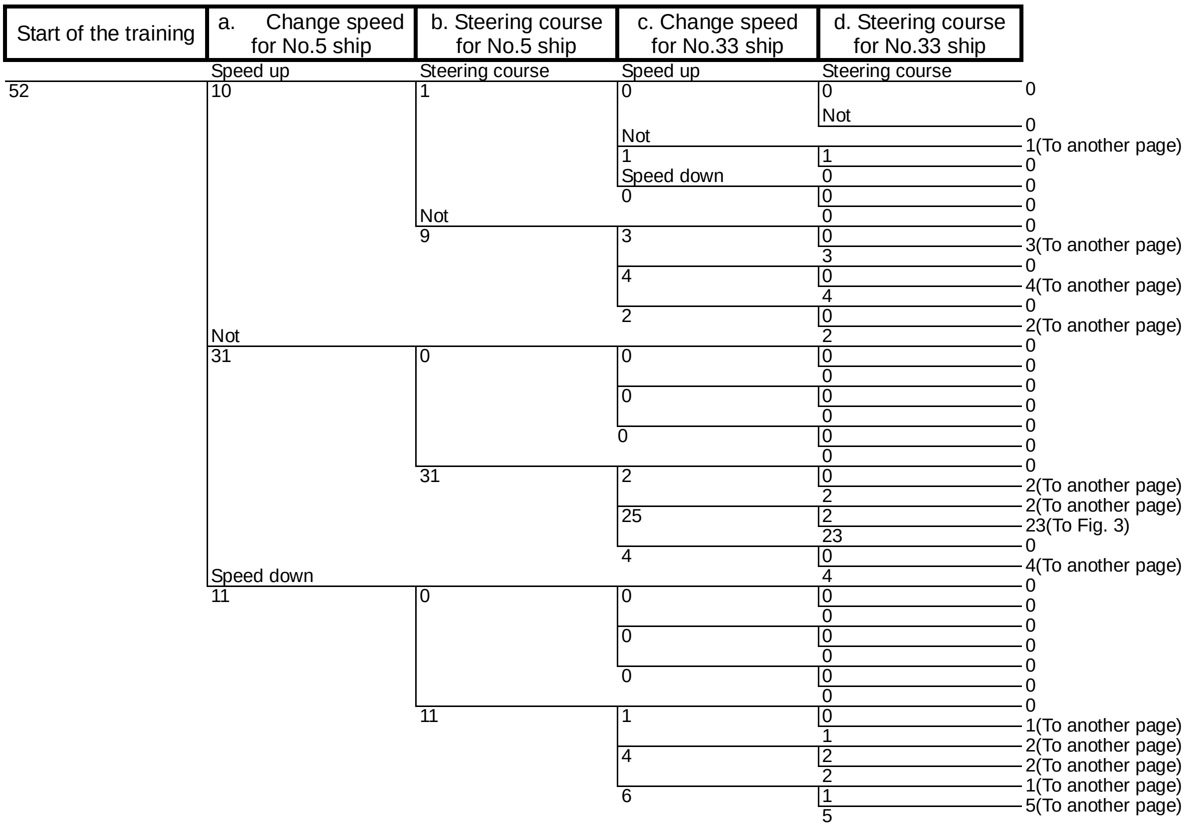

Fig.2 Result of Training with Event Tree

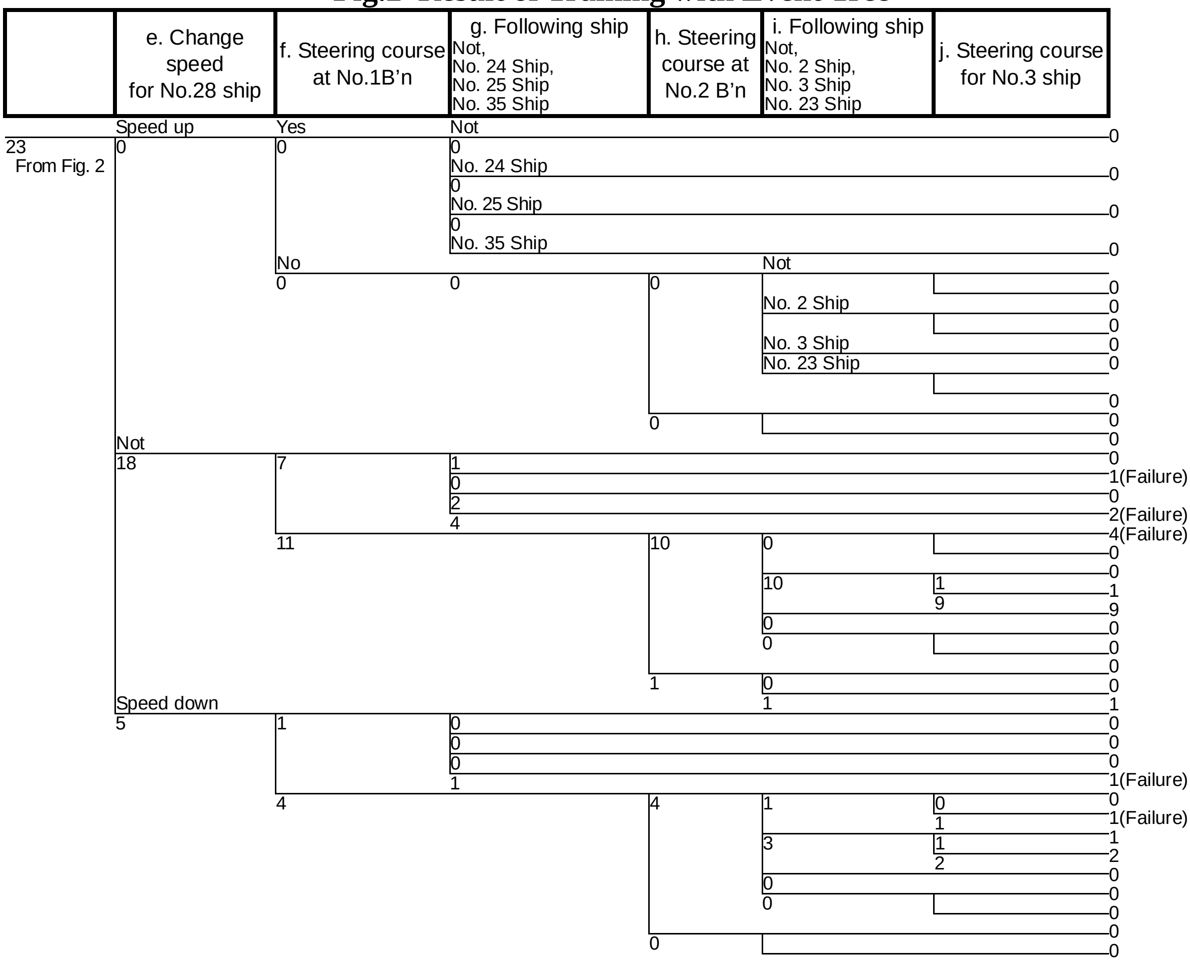

Fig.3 Result of Training with Event Tree

5. DISCUSSION

From the result of the importance measure, reasons of the importance of "f. Steering course at No.1B'n" is discussed in this section.

5.1. Timing of following ship

It is difficult to practice timing of following ship in case of crossing traffic lane at No.1 B'n. In this case, trainees have to make roundabouts or get near to the objective ship of following. In case of following ship at No.2 B'n, the objective ship comes near crossing from right to left. On the other hand, in case of following ship at No.1 B'n, the objective ship passes each other. Stern or a little back of objective ship are made in case of following ship, crossing is better for following ships.

5.2. Crossing coming down lane and coming down ships

In case of crossing the lane at No.1B'n, difficult ship maneuvering is needed after crossing. Moreover, more dangerous condition occurred in crossing. In case of crossing the lane at No.2'Bn., ship maneuvering is not so difficult after crossing. And crossing condition is more safety.

5.2. Navigable sea area

In case of crossing the lane at No.1B'n, navigable sea area is very narrow. Moreover trainees have to maneuver the sea lane where traffic is very congestion. Then, dangerousness is very high.

6. CONCLUSION

In this study, we aimed to clarify factors of errors of ship maneuvering. For this purpose, an assessment method that was based on the risk assessment had been proposed. In this paper, event tree was made from behaviors of trainees during ship simulator training, and then the branch point that leads to errors was made clear.

The following result was obtained.

1) Important event was evaluated and selected to make Event Tree.
2) Event Tree was made for a training scenario.
3) The idea of the important factor was utilized to make clear the branch point that led to failures.
4) As a result, "Steering course at No.1B'n" was the most important heading.

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