Study on the functional construction in bridge team

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Abstract

The construction of Bridge Team is changed corresponding with the degree of difficulty in navigational condition. Each member of Bridge Team makes a team by dividing and combining their functions and accomplishes the objective of navigation. The purpose of this study is to analyze the composition of the function and state of assignment and combination of the function in Bridge Team. The obtained results are summarized as follows:

(1) The function of Bridge Team is mainly represented by three functions as the function of ship handling technique, the function of communication between members and the function of cooperation and management between members.
(2) The state of assignment and combination of each function is clarified by analyzing the ship handling situation composed by plural members as assignment and attainment rates of each function in some examples of navigation.

1 Introduction

As vessels become larger, the human, material and environmental damage by one marine casualty comes more serious. In difficult maneuvering conditions, such as traffic route, restricted visibility area, advanced and adequate maneuver is always required to ship operator. Bridge Team is constructed on the purpose
to prevent marine casualty in these difficult navigational conditions. It is expected for Bridge Team to show the higher ability than not only the ability of each operator, but also the sum of each member's ability by cooperating each other.

To investigate the function of Bridge Team, we analyzed the maneuvers into tasks and clarified the needed function to attain each task. In this paper we analyzed the state of assignment and combination of each function by discussing ship handling situation at ship handling simulator.

2 Analysis of Navigation

Generally, each ship handling is composed of one mate and one crew, this state is called "Single Watch". Single Watch accomplishes most of navigational objectives. As vessel comes to the difficult navigational condition, number of bridge member is increased corresponding with the difficulty of navigation condition. The state of navigational watch that the number of watch member increased is called "Bridge Team".

Bridge Team accomplishes the objectives of navigation by performing tasks such as avoiding other ships, docking, etc. So authors analyzed the navigation condition in each condition performed by Bridge Team into tasks. Table 1 shows the part of tasks in each condition.

For example, the navigation under the condition of passing narrow channel is divided into the task of general navigation, controlling ship's position, altering course, reducing her speed and avoiding other ships. And the navigation under the condition of congested area is divided into the task of general navigation, altering course and avoiding other ships.

Moreover, each task is developed into elemental techniques such as position fixing, watch keeping, instrument manipulate and etc. Developing the tasks into elemental techniques means developing each member's function and the construction of function in whole Bridge Team.

Table 1: Tasks in each condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrow channel</td>
<td>general navigation, controlling position, altering course reducing speed, avoiding other ships</td>
</tr>
<tr>
<td>Congested area</td>
<td>general navigation, altering course, avoiding other ships,</td>
</tr>
<tr>
<td>Port and harbor</td>
<td>general navigation, docking and undocking maneuvering in port, altering course, avoiding other ships</td>
</tr>
<tr>
<td>Restricted visibility</td>
<td>general navigation, instrument navigation altering course, avoiding other ships</td>
</tr>
<tr>
<td>Traffic route</td>
<td>general navigation, navigation in order altering course, controlling ship speed, avoiding other ships</td>
</tr>
</tbody>
</table>
3 The function of Bridge Team

Figure 1 shows an example of each member’s functional division under the condition of avoiding other ship. In this condition, master analyzes and decides the way how to avoid other ship based on the information by radar from second mate (2/O), information by VHF from third mate (3/O) and visual information by all members of Bridge Team.

In this way, each member of bridge team shares the function of ship handling techniques. In order to combine each member’s function as a team, it is necessary to assign information about the navigation. Function of communication is the function to take partial charge of information between members. And function of cooperation and management to accomplish the common objective in Bridge Team is also necessary. So authors classified the essential function of each member into three kinds of functions. The contents of these three functions are discussed in following sections.

3.1 Function of ship handling technique

Functions on ship handling are understood to be composed of nine elemental techniques. The principal contents of nine elemental techniques are as follows;

1) Watchkeeping
   The technique to identify and recognize the moving targets and the fixed targets and to gather information of direction, distance and speed and to estimate the future situation of the targets.

2) Positioning
   The technique to find the position of ship by selecting and recognizing proper obstacles using visual information, radar and etc.

3) Maneuvering
   The technique to control course, speed and ships position using steering, main engine control and etc.

Fig. 1. Functional division in Bridge Team
4) Instrument Manipulation
The technique to properly utilize instruments for watchkeeping, positioning, ship handling and etc.

5) Communication
The technique to exchange information among the bridge and inside and/or outside of the ship.

6) Rule of Road
The technique to handle the ship based on the Regulations for Preventing Collision at Sea and etc.

7) Planning
The technique to gather information concerning the navigational environment conditions and to make an operational plan and a navigational plan.

8) Emergency
The technique to cope with malfunction of a main engine, a steering system, etc. and a rescue activity properly.

9) Management
The technique to make good use of members' ability and raise the bridge team's performance.

In case of Single Watch, objectives of navigation are accomplished by duty officer's function of ship handling technique only. In case of Bridge Team, each member assign the function of ship handling technique. So the objective of navigation cannot be accomplished only by that each member attains just assigned function.

By this reason, the function to combine assigned functions of ship handling technique show the ability as a team. The following two functions are to combine each member's function and show the ability as a team.

3.2 Function of communication between members

Function of communication between members is to exchange information each other and hold the information in Bridge Team in common. On the other side, communication with outside of the team, as other ship or vessel traffic service and etc, are also included to communication in function of ship handling technique.

3.3 Function of cooperation and management between members

Function of cooperation and management between members are to accomplish higher technique by combing each member's function. The specific contents of this function can be shown as follows;

1) Function of cooperation
Function to combine each member's ship handling technique and accomplish higher technique under the common objective in Bridge Team.

2) Function of management
   Function to assign the jobs and to check the accomplishment of assigned job.

3) Function of compensation
   Function to compensate a lack of other member's attainment.

Function of communication is to be considered one part of communication function in elemental technique, and function of cooperation and management are included into management in elemental technique. In the viewpoint of Bridge Team function, these two functions should be paid special attention.

4 The adequacy of construction in Bridge Team function

To prove the adequacy of the concept for Bridge Team function, authors analyzed the results of ship handling.

Generally, function of ship handling technique is needed for both of Single Watch and Bridge Team for the operation. So it is necessary to clarify the effect that caused by function of communication and cooperation and management. Form the viewpoint of Bridge Team function, authors show some results of ship's operation affected by these two functions.

4.1 Effect of the function of communication

Figure 2 and 3 show the example of altering course maneuver that affected by the function of communication. In the case of figure 2, 3/O fixed ship's position at 1.2 miles before altering course point and reported it to master immediately. Due to the report, master ordered "port 10" at proper timing at 600 meter before the point. The maximum deviation of ship's position after altering course was 190 meters right side from planned course line.
In the case of figure 3, 3/O fixed ship's position at 1.9 miles before altering course point, but did not report it to master. Next, 3/O fixed ship's position at 1.0 mile before altering point but reported it at 300 meter before the point. As a result of delaying of report, the maximum deviation of ship's position after altering course was 560 meters right side from planed course line, even though master ordered "port 15".

In these cases, both of 3/O attained the assigned function of ship handling technique such as positioning, Instrument manipulate. The deference occurred between two maneuvers due to 3/O's function of communication. From these analysis, the function of communication should be treated as important function for Bridge Team.

4.2 Effect of the function of cooperation and management

Figure 4 show an example of maneuver to reduce ship's speed that effected by the function of cooperation and management. In case A upper case in Fig.4, 2/O paid extra attention to the following ship during reducing her speed and report the distance to the following ship at 6 and 5 cables.

Due to 2/O's lookout, master noticed and contacted with the following ship and understood the intention of maneuver each other. The distance between own and following ship was kept in proper value.

In case B, no one paid extra attention to the following ship during reducing ship speed. As a result, the following ship contacted using VHF at distance 2 cables from own ship.

In these cases, whether 2/O cooperate aggressively toward common objective as reducing ship speed effected to the result of maneuver. Therefore, the function of cooperation and management should be also treated as important function for Bridge Team.

In same way, more than 80 deferent result of ship handling effected by the functions of Bridge Team are analyzed. As a result of these analyses, it is obtained that the function of Bridge Team should be focused on the function of communication and function of cooperation and management. The elemental techniques above mentioned are needed for ship handling, the technique of communication and management in developed 9 techniques are specially

![Fig. 4. Effect of the function of cooperation](Image)
important for the competence of Bridge Team from viewpoint of BRM. Therefore, we analyzed the competence of Bridge Team base on 3 main factors, such as, communication, management and basic ship handling technique corresponding to developed techniques above mentioned.

5 Assessment of Bridge Team function

In above section, authors examined about the adequacy of the concept that the function of Bridge Team is constructed by three functions as function of basic ship handling technique, function of communication, and function of cooperation and management. In this section, the contents of three functions of each member are assessed quantitatively and the state of the partial charge of function and combination of each function is clarified. The method to assess each function of members is explained as follows.

5.1 Guideline for Bridge Team

To establish the guideline for Bridge Team, the related contents to the Bridge Team function is extracted from the opinions of expert mariners and ship safety manuals of major shipping companies, and classified and arranged for three functions. The guideline for Bridge Team show in table 2 is designed based on the guideline for ship handling (elemental) techniques that is explained in Reference [4].

Table 2: The contents of Guideline for Bridge Team

<table>
<thead>
<tr>
<th>Function of Communication</th>
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<tbody>
<tr>
<td><strong>On Watch keeping</strong></td>
<td>To report information about other ship. To report information about weather. To confirm information in case that one cannot understand the information.</td>
</tr>
<tr>
<td><strong>On Maneuvering</strong></td>
<td>To inform intention before action in case of changing ship’s course.</td>
</tr>
<tr>
<td><strong>On Planning</strong></td>
<td>To explain navigation plan to members. To confirm the plan in case that one cannot understand the explanation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Function of Cooperation and Management</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On Positioning</strong></td>
<td>To give information about ship position complying with the situation.</td>
</tr>
<tr>
<td><strong>On Instrument Handling</strong></td>
<td>To report information gotten by RADAR complying with other member’s report.</td>
</tr>
</tbody>
</table>
5.2 Training scenario

To investigate the state of the partial charge of function and combination of each function, the scenario shown is developed for Bridge Team to perform these function's sufficiently. The navigational conditions as traffic route in congested area, are set up including the tasks that should be attained by Bridge Team.

5.3 Assessment list

The items to accomplish the task are extracted from the guideline for Bridge Team. And these functional items are divided into each member's function according to master's intention. Elemental techniques of each member are assessed based on this assessment lists and added up into three functions of Bridge Team. The quantitative assessment can be possible by using applied assessment system that is developed based on new MET system [5].

6 Experiments using ship handling simulator

The training for BRM were carried out according to above-mentioned method. As a result of these training, rate of the assignment and the attainment of function were obtained. The way to calculate both rates is shown in formula (1) and (2).

\[
\text{assignment rate} = \frac{\text{number of assigned items}}{\text{sum number of assigned items}} \quad (1)
\]

\[
\text{attainment rate} = \frac{\text{number of attained items}}{\text{sum number of assigned items}} \quad (2)
\]

Figure 5 shows the representative three results of navigation. In these cases, Bridge Team is composed of four members as master, second mate (2/0), third mate (3/0), and helmsman. The assignment and attainment rates of three members except helmsman are discussed.

The rate of assignment is approximately same in these cases; 40～45% for
master, 30% for second mate and 25-30% for third mate. As the results, total attainment rate is 89.2% in case 1, because of every member’s high attainment rates. In case 2, every member’s attainment rates are insufficient and total attainment rate is 51.7%. And in case 3, though the attainment rate of second mate is insufficient, other two members got high attainment rates, so total attainment rate is 82.7%.

Figure 6 shows the details of each member’s function. The function is divided into three functions as function of ship handling techniques, function of communication and the function of cooperation and management.

In case 1, every member attains every function well, so total attainment rate of is good. This is the ideal example that every member of Bridge Team attain assigned functions and combine them.

In case 2, 2/O’s attainment rate of the function of ship handling technique is insufficient. And master and third mate did not enough attained the function of communication, cooperation and management but function of ship handling technique. In this case, the attainment rate as whole team is low, ability of Bridge Team does not work sufficiently.

In case 3, 2/O’s attainment rate of the function of ship handling technique is also insufficient. But other member’s functions are well attained. Especially master and third mate attained the functions of cooperation and management very well. And that means master and third mate compensate for second mate’s
lack of function of maneuvering technique.

In the next, the state of attainment in function of cooperation and management is shown in these cases.

Figure 7 shows the rate of the function of compensation in three functions that compose the function of cooperation and management. In case 3, the function of compensation appeared by master and third mate many times. And 11 times in 13 compensating action acted by master and third mate, were toward second mate. From this, it is also understood that master and third mate compensate for second mate’s lack of function.

As mentioned above, the state of assignment, attainment and combination in Bridge Team function is clarified by analyzing essential techniques on the viewpoint of three functions.

7 Conclusion

Summary of this study is as follows;

(1) Authors proposed a concept that the function of Bridge Team is composed by three functions as function of basic ship handling technique, function of communication, function of cooperation and management. And by analyzing the results of ship handling effected by function of Bridge Team, it is obtained that the proposed concept is appropriate.

(2) By analyzing the results of Training for BRM in ship handling simulator, three functions of Bridge Team are confirmed and assessed quantitatively. As a result, the state of assignment, attainment and combination is obtained and the effectiveness of Bridge Team is clarified.

References