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Alcohol Drinking Status of Officers on a Ship and Drunk-navigation Experiments Using Ship Handling Simulator

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Abstract : *Based on the previous studies on alcohol effects on human behaviour and performance in transportation system such as airplane and car driving, the alcohol exposure before and on watch of a ship has a great influence on subsequent behaviour. In this paper, to examine the drinking status of officers on board multiple choice questionnaires are circularized under instruction and surveyed for 118 officers. According to the results of the questionnaire survey on alcohol dependency (Alcoholism) that was invented by WHO, over 27 % of those surveyed represented alcohol abuse symptoms. In addition to that, the existing state and awareness for on-board-drinking was summarized to make a scenario of drunk-operation with a ship handling simulator to investigate the effect of alcohol (0.08 g% blood alcohol concentrations) on ship operational performance. A main effect for alcohol was found indicating that ship operational performance was comparatively impaired by this alcohol relative to performance in the non-alcohol condition. The results of this research can be applied to minimize marine accidents as basic data.*

Key words : Alcohol, Officer, Alcohol Drinking Status, Ship Operational Ability, Ship Handling Simulator

요 약 : 항공기와 자동차의 운전을 중심으로 알코올이 인간의 행동과 수행도에 미치는 연구가 많이 이루어져 왔으며, 이를 통해 선박의 당직 전 및 당직 중의 음주는 이어지는 행동에 큰 영향을 미친다고 할 수 있다. 본 연구에서는 승선 중 음주 실태를 파악하기 위하여, 선택형 앙케트를 교육 중인 사관들에게 배포하여 118명으로부터 얻어진 결과를 조사하였다. 알코올 의존도에 관한 자가진단결과에 따르면, 조사대상자의 27% 이상이 알코올 남용 증세를 나타내었다. 또한, 승선 중 음주 현황 및 인식에 관한 사항을 정리하여, 선박운항 시뮬레이터를 이용한 음주 운항 시나리오를 마련하였으며, 알코올이 선박운항능력에 미치는 영향을 알아보았다. 실험결과를 분석한 결과, 알코올의 섭취가 선박운항능력을 다소 저하시키는 것으로 나타났다. 이러한 분석결과는 앞으로 선박운항자의 피로에 의한 해양사고 발생을 근본적으로 줄이기 위한 기초자료로 활용할 수 있을 것이다.

핵심용어 : 선박운항능력, 알코올, 음주운항, 승선사관, 선박 운항 시뮬레이터

1. Introduction

On March 24, 1989, the supertanker Exxon Valdez, under the command of Exxon Master Joseph Hazelwood, ran aground on Bligh Reef in Prince William Sound, Alaska, discharging millions of gallons of crude oil into the pristine ecosystem of the Sound. Captain Joe Hazelwood tested positive for alcohol several hours after the accident. However, little attention is given to the effects of alcohol at sea except in cases of major disasters such as the Exxon Valdez accident.

Studies into the effects of alcohol on performance have a long and well-documented history, especially concentrated on transportation system such as airplane and car driving (Lacefield. and Roberts 1975, Levine and Karras 1977, Finnigan and Hammersley 1992).

Ship operational errors, poor navigational equipment. and fatigue among others have been identified as human elements in ship operation. Of them, fatigue is the main factor that contributes to accidents during long ship operations. Such fatigue is caused by a lack of sleep, tight schedule, lack of rest, alcohol intoxication, health problems, work and boarding conditions and other various stress factors.

In this paper, to examine the drinking status of officers on board multiple choice questionnaires are adopted for 118 officers. In addition to that, the effects of one of these

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fatigue-causing elements, alcohol, on simulator performance are evaluated using a Ship Handling Simulator.

2. Effects of Alcohol on Ship Operation

Alcohol tends to impair such job performance not only when it is absorbed but also when one has become sober (Lee 2002, Aksnes 1954). In particular, alcohol intoxication of pilots can lead to fatal accidents (Newman 2000). Here, the cognitive function plays an important role that determines the transformation of cognitive factors.

Research on the effects of alcohol on ship operation is scarce. Limited research using simulators have been conducted partially, and following is a summary of such research. In order to study the effects of alcohol intake of BAC 0.04% on collision avoidance in ship operation, Howland (2001) conducted an experiment on 38 maritime university students with more than 100 hours of simulator experience. The aim of this study was to examine changes in ship operational ability based on alcohol intake. A scenario was provided for simulation and the performance was analyzed in both a sober state and an intoxicated state. Also, in the simulation done under intoxication, some subjects were given a drink without alcohol with the awareness that they were alcohol drinks (hereinafter called "placebo"), and were tested on their ship operational abilities. In Figures 1 and 2 the result indicated that at BAC 0.04% their performance was reduced, but experiment subjects who were given alcohol answered that their performance improved from before the alcohol or there was no difference. This demonstrates that at BAC 0.04% one cannot perceive one's own reduction of performance.

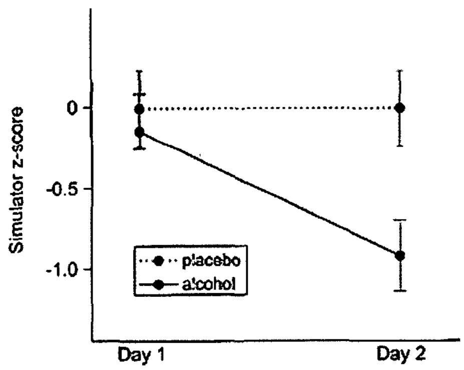

Fig. 1. Observer-rated performance (z-score) in the simulator on Day 1(base line day) and on Day 2(alcohol, placebo) High score reflect better performance.

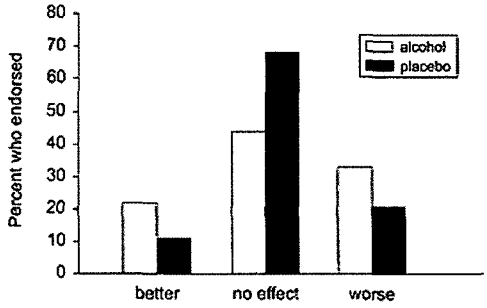

Fig. 2. Self-rate effects of alcohol.

Table 1. Statistics on ship operation under intoxication for the last four years (Korea)

Year	Survey No.	Exposure No.	Average BAC	Max. BAC
2000	12,480	38	0.15%	0.34%
2001	11,489	62	0.16%	0.34%
2002	9,358	49	0.17%	0.41%
2003	11,211	61	0.15%	0.50%
Total	44,538	210	Average 0.16%	0.40%

To examine the effects of alcohol and caffeine on ship operation ability, Marsden and Leach (2000) conducted an experiment on 12 crew members for four conditions: no alcohol intake, alcohol-only intake, caffeine-only intake, and alcohol and caffeine intake. Then, 75ml of whisky that has 40% alcohol and 250mg of coffee without sugar were provided. Their performance on VST (visual search task) for searching for similar english alphabets, on Chart Search (navigational search) for searching for signs on the marine chart, depth of water and danger area, and on Navitask (navigational problem-solving task) for solving problems that occur during sailing were evaluated. The test results showed that there was no difference between the four conditions on VST, and that the performance on Chart Search and Navitask without alcohol were better than at the other three conditions.

Due to the lack of sufficient research on ship operation and alcohol, parts of the results were different from the expected results.

Table 1 shows the crackdown on ship operation under intoxication for the last five years (Yang et al. 2004). As can be seen in Table 1, the total number of crackdowns on intoxicated ship operation during the last four years was 44,538, and the total umber of disclosures was 210, with an annual average number of disclosures standing at 40. The criteria for crackdown here is BAC 0.08%. Also, the table indicates the average BAC and max BAC of ship operators who were regulated during the last four years by year. The average BAC of ship operators who were regulated during the last five years was 0.15%, about two times higher than the criteria imposed in Korea. The max BAC was 0.5%.

3. Questionnaire for alcohol drinking on a ship

In order to determine the current state of drunken navigation on commercial ship, a survey of 118 officers (higher than non-commissioned office rank) in training is conducted at Korea Institute of Maritime and Fishers Technology. Eighty-four percent of the respondents were second officers and engineers or above. First a pre-survey was given to nine officers and engineers with more than three years of experience and the final survey was written based on the analysis of the pre-survey. The final survey is composed of the following:

1. Current drinking habits onboard: the number of alcohol intakes during a one-way trip and drinking habits before going on duty
2. Perception on drunken navigation: whether drunken navigation is tolerated onboard and to what degree it is allowed
3. Education onboard related to drinking on duty, and understanding and observance of domestic and international regulations: whether the company's rules, domestic and international regulations and laws are observed
4. Officers' self-diagnosis on alcohol dependency

3.1 Alcohol drinking status on board

Figure 3 shows the ratio of onboard parties to average number of sailing frequency (port to port). We can see that about 60 percent of the respondents have opportunities to consume alcohol for more than 25 percent of the sailing frequencies.

Furthermore, more than half (about 52%) of the respondents have answered that they drink for more than 25 percent of the sailing days. However, it has been concluded that many of them consume alcohol during the hours not affecting their duties from the 15 percent responses of those who have drunk alcohol four hours before going on duty. These data are similar between ocean and coastal navigations.

On the other hand, to the question whether they have witnessed someone else drink during the four hours before going on duty, about 67 percent answered yes. Therefore, in reality, more than 15 percent of officers are estimated to drink before duty.

3.2 Perception on drunken navigation

To the question asking the state of sobriety of officers on duty, about 27 percent answered that up to two shots (22%) or four shots (5%) of soju do not affect them in ship operation. Two to four shots of alcohol raise blood alcohol concentration (BAC) to 0.05-0.08%, which is enough to increase accident rate 2-5 times when driving a car. This is probably because officers think there are no direct relations between accidents and alcohol consumption. In other words, 15 percent of officers are certain that they would not cause accidents even after drinking. Also, as shown in Fig. 4, nearly 60 percent of officers were confident that accidents

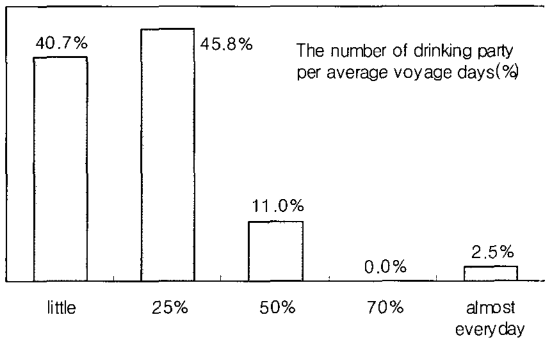

Fig. 3. ratio of onboard parties to average number of sailing frequency (port to port).

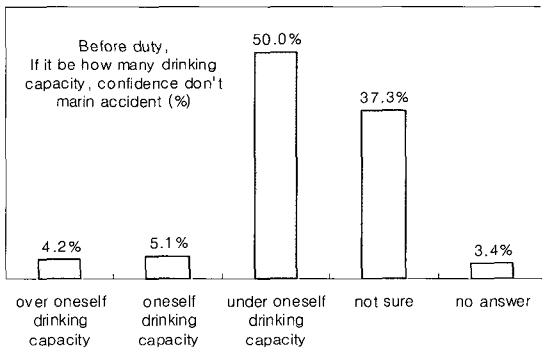

Fig. 4. Drinking limits and confident that accidents would not occur (before duty).

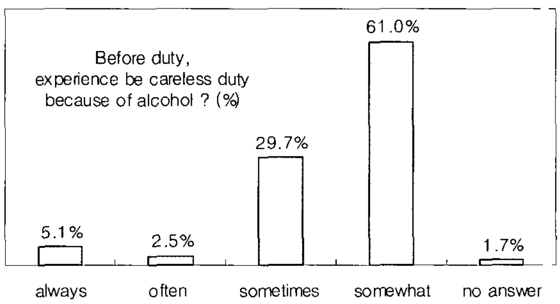

Fig. 5. Experience of being careless on duty due to alcohol intakes.

would not occur as long as they drank within their limits. However, the majority has admitted to their experience of being careless on duty due to alcohol intakes, which shows that alcohol causes excess confidence (Fig. 5).

3.3 Education onboard related to drinking on duty, and understanding and observance of domestic and international regulations

In terms of understanding domestic and international

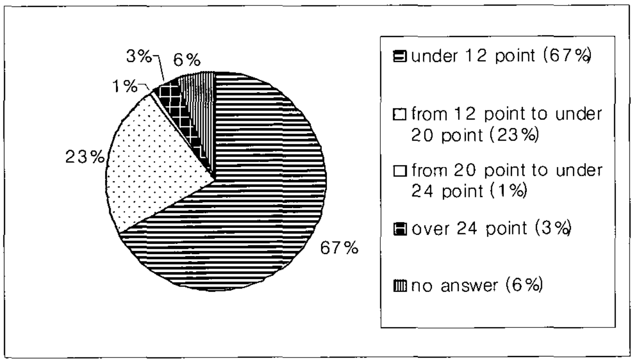

Fig. 6. The Self-test alcohol dependency.

regulations, only about 50 percent of the respondents have answered that they know of alcohol-related regulations. In addition, high-ranking officers have shown lack of priority on onboard education with only 27.2 percent responding yes to whether they are providing education onboard on drinking. The U.S.-destined ships are required to provide DRUG & ALCOHOL education once every month or within 24 hours after departure if more than 1/3 of officers were replaced.

3.4 Officers' self-diagnosis on alcohol dependency

In order to determine how dependent officers are on alcohol while onboard, self-diagnosis chart, made by WHO, was given with the survey. Each of the ten questions was scored differently and the total scores are evaluated as follows:

1. 12+ points: habitual excess drinker (a warning needed)
2. 20+ points: 'problematic drinker' or 'possible alcohol-dependent patient' ('appropriate measures' needed such as counseling by a physician or a psychiatrist)
3. 24+ points: alcohol-dependent patient (psychiatric treatment needed)

Alcohol dependency means drinking more than usual drinking habits or more than the amount accepted in the society. Therefore, his/her medical factor, or how that factor is influenced by genes, physical constitution or metabolism is irrelevant.

Figure 6 shows the result of each respondent's self-diagnosis on alcohol dependency. About 27 percent were categorized as habitual excess drinkers and about 3 percent were found to be alcohol-dependent.

4. Experiment of Ship Operational Ability Impairment by Alcohol

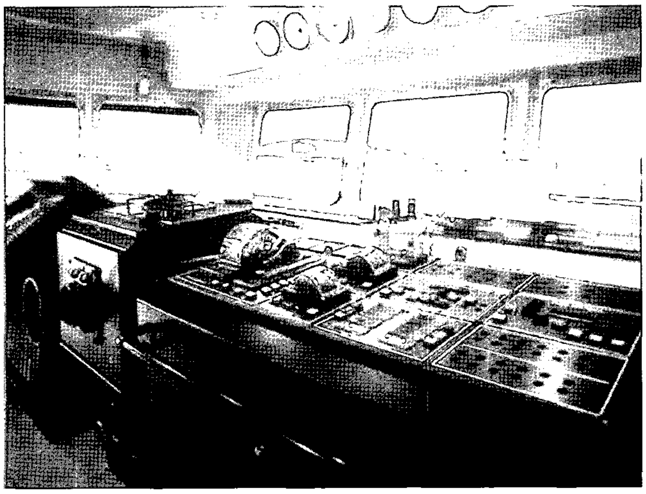

Fig. 7. Image of a ship bridge of the simulation system.

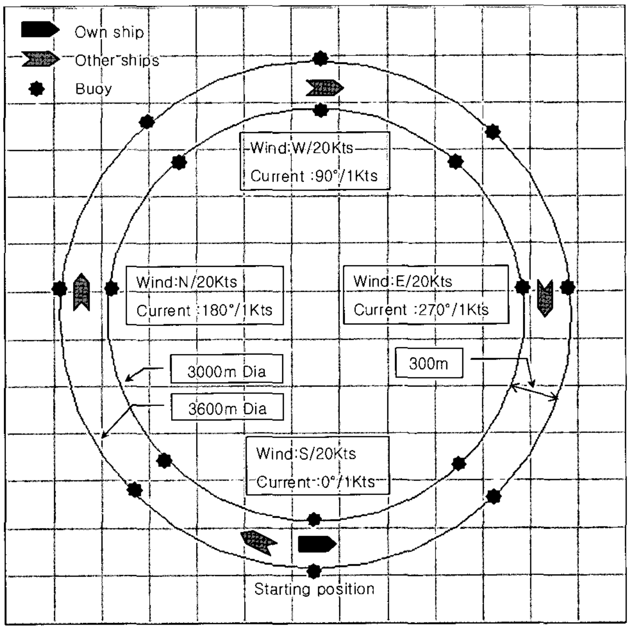

Fig. 8. Scenario used in the experiment and environment condition.

4.1 Experiment Method

The experiment was conducted on 8 volunteer deck officer cadets in their senior year with more than 100 hours of simulator usage. The drinking capacity of the test subjects was more than half a bottle of soju (Korean hard liquor), and the cadets average age was 23.1, average weight 66kg and average height 175cm. The subjects were prohibited from smoking, drinking coffee, taking alcohol or stimulants before the experiment.

Additional experiments were done on maritime pilots, who are considered to be experts on ship operation, to compare results with that of the students.

The case where the subjects took a carbonated drink that was diluted 3:1 with alcohol with 40% alcohol concentration was set as blood alcohol concentration 0.08-0.09 (Marsden and Leach 2000, IMO 2001). The existence of alcohol in the drink was not notified to the subjects in order to examine the effects on alcohol intake.

Fig. 7 shows the image of a ship bridge of the simulator system that was developed and operated with the technology of the Korea Research Institute of Ships and Ocean Engineering (KRISO) of the Korea Ocean Research and Development Institute (KORDI).

Figure 8 shows the overview of the simulation and examples of environmental conditions. The experiment was to circle around the chosen sea route (300m width) counter-clockwise. In order to reduce time-related problem of the simulator, both the radar and simulator were put on the same screen. The ship for the experiment was a war vessel with the length of 84m and the width of 9.7m. The other ships were 12,000TEU container ships, 354m in length and 55m in width. Grid lines, buoys and the ships were shown on the radar to accurately identify the route and the location of the ship. To reduce educational effect and induce active participation, external factors (wind and current) were adjusted each time by 90 degrees, but the total factors were modified to be the same. The test was to navigate the ship counter-clockwise and come across other ship every 3-4 minutes, eight times during the course.

4.2 Results

Figure 9-10 show the results of two students navigating the ship with BAC 0.0% and BAC 0.08% respectively. Overall, students used the rudder too much when going around other ships and their control of the ship lacked skills. However, a qualitative analysis shows that with BAC 0.08%, the data were highly irregular.

Figure 11 is a comparison of eight students' average navigation track before and after drinking. In general, average radius of the navigation track and standard deviation were bigger under BAC 0.08%.

Figure 12 is the result of the tests done by maritime pilot. It is obvious that their ship operational abilities are better than the students' (Figure 9-11.) Also, the differences between the results of navigating with BAC 0.0% and with BAC 0.08%, the average radius of the navigation track and standard deviation were 11m and 0.5 higher respectively.

Figures 13 and 14 are comparisons of use of rudders and total simulation time between students and maritime pilots. As for the students, the use of rudders was reduced with alcohol consumption, but the total time increase by more than one minute. As for the maritime pilots, both the use of rudders and overall time were reduced.

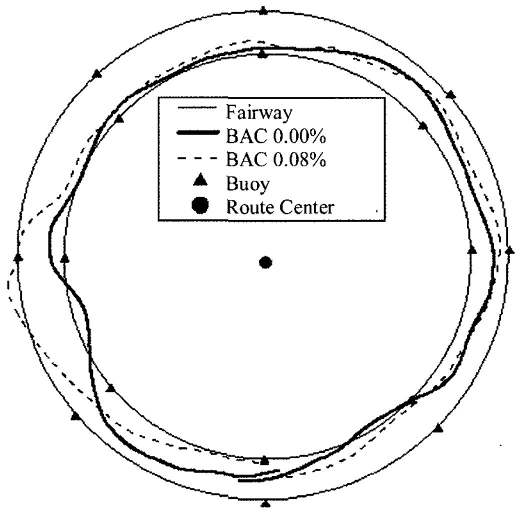

Fig. 9. Ship Track of Cadet 'A' in BAC 0.00% and 0.08% cases.

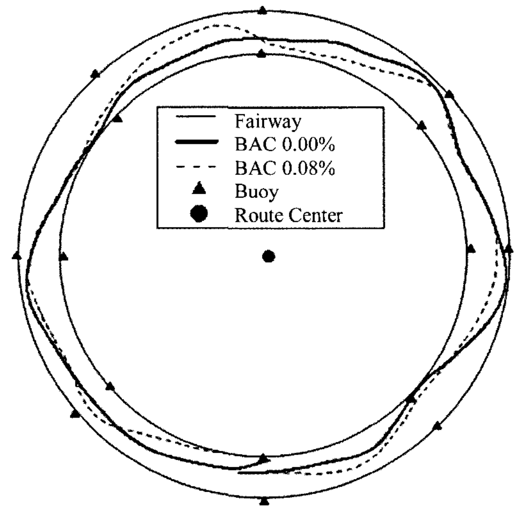

Fig. 10. Ship Track of Cadet 'B' in BAC 0.00% and 0.08% cases.

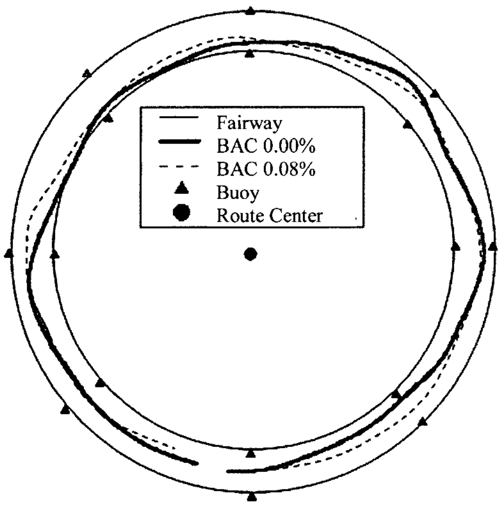

Fig. 11. Cadets' average in ship operation tracks.

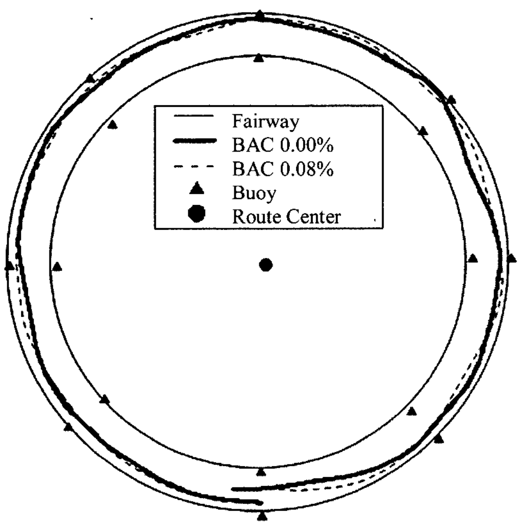

Fig. 12. Ship Track of maritime pilot in each BAC 0.00% and 0.08% cases.

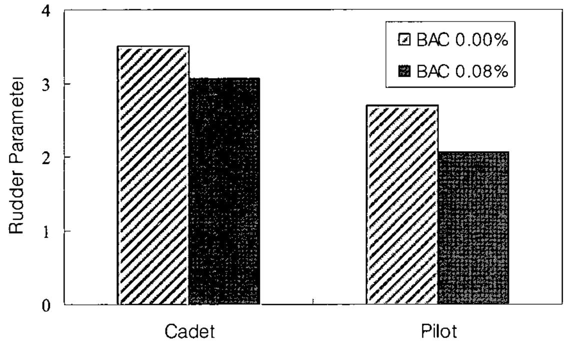

Fig. 13. Rudder parameters in an average for cadet and pilot.

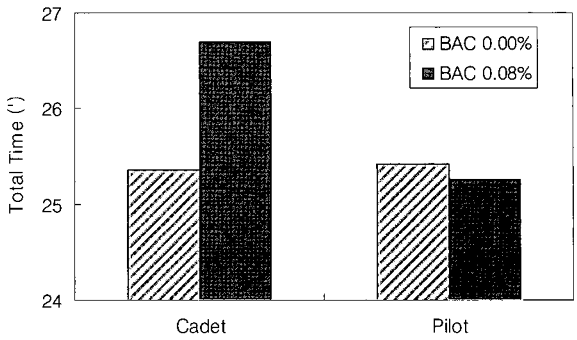

Fig. 14. Total ship operation time in an average for cadet and pilot.

5. Concluding Remarks

This research was done to determine the current state of alcohol intakes onboard and the influence of alcohol on ship operational ability. To this end, a survey and an experiment via Ship Handling Simulator were conducted.

The result shows that the respondents lack perception on drinking onboard and have high dependence on alcohol. The respondents have indicated their knowledge of regulations on alcohol onboard to be included in the law and their companies' rules, but tend to not put them into action. This trend is possibly due to the fact that the regulations are too general and not appropriate for the life at sea.

The influence of alcohol on ship operational ability was not as clear as other results. Officers were more focused when operating ship under the influence of alcohol because they recognized the physical and psychological differences in their bodies due to the alcohol intake. However, considering the fact that such high concentration cannot be maintained for more than four hours in real life, it is estimated that the actual decline in ship operational ability is higher than shown in the research.

The results of this research will be useful in the future to fundamentally reduce the number of accidents at sea caused by exhaustion.

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