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Study on Education and Training Methods to Enhance Non-technical Skills of OICNW Using the Psychological Test

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ABSTRACT: First, we especially focused on Uchida-Kraepelin performance test (hereinafter, referred to as UK-Test) in order to check the ability of non-technical skills of the officers in charge of a navigational watch (hereinafter, referred to as OICNW). UK-Test is one of the psychological test for understanding the personality. In this paper, we considered whether UK-Test is effective methods for OICNW in order to check the ability of non-technical skills using UK-Test results and collision avoidance manoeuvre experiments results on the ship handling simulator (hereinafter, referred to as the simulator). Specifically, we analysed the correlation between UK-Test results and collision avoidance manoeuvre experiments results on the simulator. We also created the collision avoidance scenario that required a lot of the ability of non-technical skills as OICNW, and evaluated the ability of non-technical skills of OICNW.

1 INTRODUCTION

According to the reference [1], the number of the vessel collision accidents in the roughly 30 years from 1991 to 2021 has almost halved from 1,214 to 525 in Japan. Furthermore, the number of collisions (including the number of single-collisions) which remained at the 800 level from 2006 to 2010, has decreased to the 600 level since 2011 as shown in Figure 1. On the other hand, the trend in the number of single-collisions over the 10 years from 2009 to 2019 is almost no change. In other words, it can be seen that the number of collisions with other vessels is on the decline.

In addition, more than 90% of the cause of collisions have been human error such as inappropriate lookout and non-compliance with COLREGs (Convention on the International Regulations for Preventing Collisions at Sea, 1972) rules [2, 3]. We considered the decreasing trend in the number of collisions was caused by a variety of complex factors, including hardware aspects such as navigation equipment and software aspects such as education and training for OICNW. The 1978 STCW Convention (The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978) 2010 Manila Amendment was completed enforcement on January 1, 2017, it is necessary to continue to observe the effect of the newly stipulated the competence of BRM (Bridge Resource Management) knowledge and skills (It has begun to be required to educate and train the ability of situational awareness.) [4], but we believed that further measures to prevent the collisions are to educate and train OICNW on the software side in the near future. It is necessary to enhance the ability of non-technical skills of OICNW to avoid collisions with other vessels. However, the current education and training for OICNW focused mainly on the requirements for obtaining a mariners license (STCW requirements such as basic knowledge for

navigational skills, principles of navigational equipment, specific factors that affect vessel manoeuvring and so on.), which classified technical skills.

In this study, we focused on "non-technical skills", which are already being emphasized in the railway industry (especially train drivers education and training), and considered a new educational method for OICNW to avoid collisions. We considered what kind of the education and training should be introduced to enhance the ability of non-technical skills required for OICNW, how should evaluate the ability of non-technical skills of OICNW, moreover how should enhance the ability of non-technical skills of OICNW in order to prevent the lack of non-technical skills from leading to the collisions.

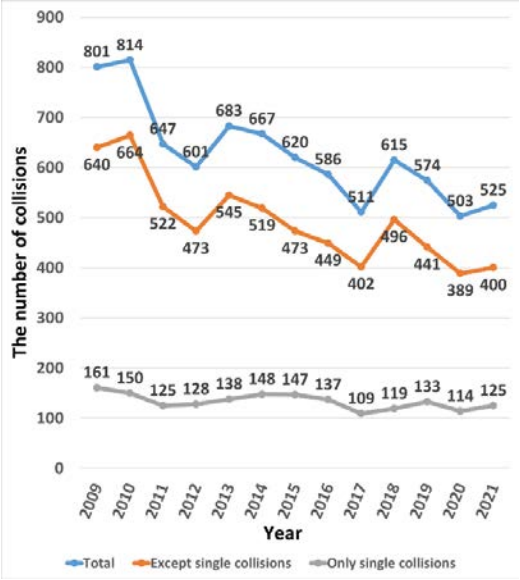

Figure 1. Changes in the Number of Collisions [1]

2 RELATIONSHIP BETWEEN COLLISIONS AND NON-TECHNICAL SKILLS

We considered that the relationship between the collisions and non-technical skills could be shown by the CORLEGs rules [3] that did not be complied by OICNW.

2.1 *Non-technical skills*

Non-technical skills are consisted of situational awareness, decision-making, communication, teamwork, leadership, stress management, and control the fatigue [5]. The reference [6] stated that "situational awareness skills" is the most important of the seven categories that is consisted of non-technical skills. Figure 2 [6] shows a flow chart of non-technical skills when ordinary workers act. After workers are aware of the situation and communicating with other workers, the worker makes a decision to act [6]. Depend on the situation, there are cases in which the worker makes a decision to act after be aware of the situation without communication [6]. In any case, the worker must be aware of the situation appropriately to act something.

Therefore, we focused on the situation awareness skills, decision making skills and communication skills of OICNW as the worker's non-technical skills in this study.

Figure 2. Flow chart of workers' non-technical skills [6]

2.2 *OICNW's situational awareness skills and should follow COLREGs rules*

As shown in Figure 3, in a breakdown of non-compliance with COLREGs rules [3] applied to collisions in Japan which were enforced administrative determinations by the Japan Marine Accident Tribunal [7], rule2(a) "the ordinary practice of seaman's management" accounted for about half of the cases over the past more than 10 years. When collisions cannot be avoided by the general rules (such as rule 13~15 and 18) of COLREGs, it is left to the OICNW's proper decision making (good seamanship) [8].

Figure 3. COLREGs rules applied to collisions [3, 7]

3 UK-TEST

UK-Test which operated by Nisseiken Inc., is a genre of the psychological test for understanding the personality. UK-Test which marks the 100th anniversary in 2023 from the beginning of its research [9]. UK-Test is mainly used as the aptitude test in job hunting by private companies at their own decisions.

3.1 *Overview of UK-Test*

UK-Test is an aptitude test/ personality inventory that is optimal for measuring the Capability, behavioural and personality traits of examinees with objective indicators. UK-Test is a psychological test of a

performance test that does not use words. Therefore, the UK-Test is not affected by own mother tongue or culture, and can be used overseas in exactly the same way as in Japan, operated in Japan and the other ASIAN 14 countries [10].

On the other hand, UK-Test has been required mandatory for train drivers by ministerial ordinances of Japanese government [11]. It is not only rare that the transportation operators are required mandatory for licensing, but it is also rare that they are required mandatory once every three years until the retire as train drivers. The fact, that UK-Test has been used mandatory for train drivers in Japan from 1956 to the present, we can be considered it is the evidence as the effective method for checking the ability of non-technical skills.

UK-Test is a psychological test in which the examinee performs a simple single-digit addition, and based on the result, measures examinees' capability and behavioural and personality traits.

3.2 *UK-Test procedures and interpretations*

UK-Test is proceed by a simple single-digit addition is performed by examinees every minute in a row as shown in Figure 4 (A), a total of 116 figures from 3 to 9 are printed at random in each row on a sheet of paper [10, 12]. Examinees do it for a total of 30 minutes (30 rows) after 2 minutes practice, 15 minutes (15 rows) each in the first half and the second half after 5 minutes breaks in between. Examinees are instructed to change the row every minute. [12].

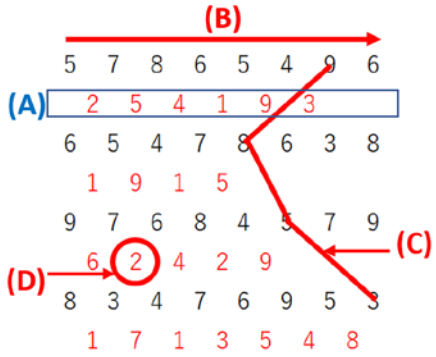

Figure 4. Sample of UK-Test procedures and interpretations [10]

The interpretations of UK-Test are based on the total amount of calculation (work amount in Figure 4 (B)), how the amount of calculation changes every minute (working curve (UK curve) in Figure 4 (C)), and incorrect answers in Figure 4 (D), the characteristics of the examinee's capability, behavioural and personality traits are comprehensively measured. [10] UK-Test judges examinees' capability and behavioural and personality traits as "Basic index" which can be seen by the two axes in Figure 5 [13, 14]. The vertical axis shows examinees' capability by 5 steps from high until low based on the work amount, the horizontal axis shows examinees' behavioural and personality traits by 5steps from general until individual based on the working curve. The examinees' results are classified by 5 x 5 matrix which divided into 2 main groups (typical group and atypical group) and subdivided into 5 groups as Figure 5. 5gruops are classified as highly typical group, typical group, quasi typical group, atypical group, and severe atypical group.

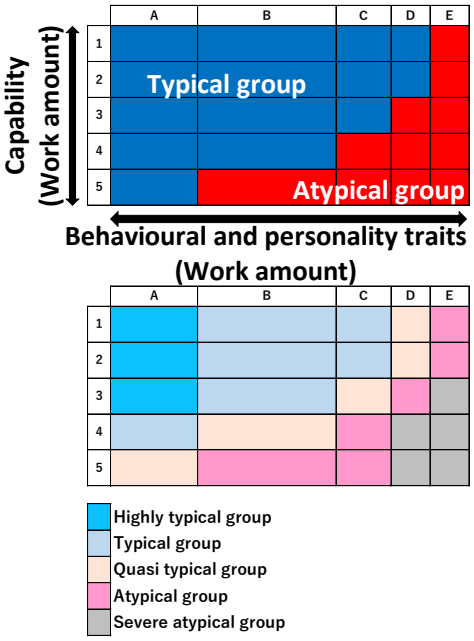

Figure 5. Basic index of UK-Test [13, 14]

3.3 *UK-Test results*

We tested for 12 examinees. 12 examinees had been included 8 students (Limited third mate's license holders, age 20s) and 3 teachers (one teacher is a master mariner holder, the other two are chief mate's license holders, age 30~40s) of Marine Technical College, a master of ocean-going vessels (master mariner holder, age 50s) in add. The results were shown in Figure 6. We had given to 12 examinees ID as E01~E12. Typical group was counted 10 examinees, on the other hand atypical group was counted only 2 examinees. The details were as below.

- Located in square 2A (highly typical group): E01
- Located in square 3A (highly typical group): E12
- Located in square 4A (typical group): E02
- Located in square 2B (typical group): E09
- Located in square 3B (typical group): E03, E04, E05, E06, E07, E08
- Located in square 3C (quasi typical group): E10
- Located in square 3E (severe atypical group): E11

	A	B	C	D	E
1					
2	E01	E09			
3	E12	E03 E04 E05 E06 E07 E08	E10		E11
4	E02				
5					

Figure 6. 12 examinees' basic index results of UK-Test

4 COLLISION AVOIDANCE MANOEUVRE EXPERIMENTS ON THE SIMULATOR

We created the scenario for collision avoidance manoeuvre on the simulator in order to evaluate the non-technical skills (especially, we focused on situational awareness, decision-making, and communication). The simulator has equipped with 360 degrees visual view, CCTVs for recording inside the bridge, and same navigational equipment as genuine vessels such as GYRO compass repeater, binoculars, RADAR, ECDIS, AIS, VHF, internal telephone, whistle, and so on.

4.1 *Overview of collision avoidance manoeuvre experiments*

The purpose of evaluation were whether OICNW are able to aware changes in the surrounding navigational situation by use appropriate navigational equipment, communicate with external (other vessels) and internal (call the master), and take action to avoid the collision situation.

The experiments had been terminated in 15 minutes following 10 minutes pre-training time in order to grasp the vessel manoeuvrability, dark adaptation for visual lookout, and familiarize navigational equipment. The 12 examinees were same as UK-Test examinees.

4.2 *Scenario of collision avoidance manoeuvre experiments*

Scenario outlines of collision avoidance manoeuvre experiments were mentioned as Table 1. The overview of a traffic situation was shown in Figure 7. The other vessels movement is total 4 vessels (“A” ~ “D” in Figure 7, “A” is 499 GT small cargo vessel without AIS signal, “B” is 8, 000 TEU container vessel with AIS signal, “C” is high speed small pleasure craft without AIS signal, and “D” is towing 2 barges with AIS signal “a vessel restricted in her ability to manoeuvre”) will get close to own vessel around 12 minutes after the start if OICNW do not take any action. Own vessel is crossing situation against “A”, head-on situation against “B”, overtaking situation against “D”, and “C” is overtaking situation against own vessel at the same time. Therefore, COLREGs rule 2 (A) is apply in this situation instead of rule 13~18 [3], also the visibility will slowly get down until 0.5 NM at the potential collision point. We deployed many fishing boats including slow speed pair trawling with AIS signals, which would not get close unless OICNW change course or speed.

All of the RADAR function value such as CPA / TCPA, GAIN / SEA/ RAIN, range, other vessels vector lengths, and so on, were set minimum in order to evaluate OICNW are able to check the function value and change the settings on RADAR depend on the situation.

Table 1. Scenario outlines

Items	Details
Duration of a voyage	0500-0515 ST
Voyage area	Open sea (Lat. 15N, Long. 130E)
Own ship model	PCC 6000 units
Watch level (crew in bridge)	Single OICNW with a helmsman
Steering mode	Auto-pilot mode at the start
Visibility	8 NM
Speed of own ship	20 kt
Wind & wave	North 10 m/s, North 5 m
Course line	<000>

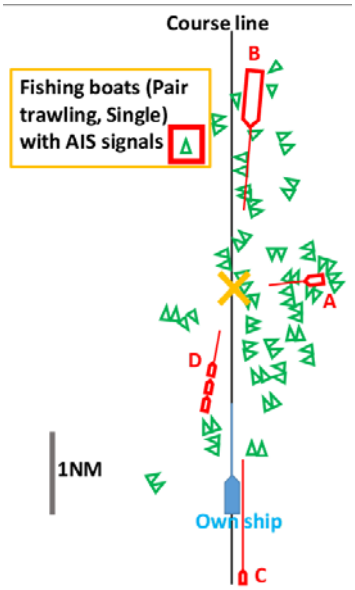

Figure 7. Scenario of collision avoidance manoeuvre experiments

4.3 *Results of collision avoidance manoeuvre experiments*

All of 12 examinees successfully avoided collision with other vessels, but 5 examinees had happened the incidents less than 2 cables to any of vessels “A” ~ “D” due to delay be aware of the getting close situation and take action to avoid collision. 5 examinees had followed the course line until arrived the potential collision point. The other 7 examinees had left from the course line widely, and steered port side (passed the stern of vessel “D”), they passed vessels “A” ~ “D” with safe distances whether they had found vessels “A” ~ “D” or not. Especially, nobody were aware of vessel “C” presence on the RADAR (nobody acquired the vessel “C” by the RADAR’s Target Tracking function) regarding situational awareness.

Regarding decision making, all of 12 examinees had changed steering mode from auto-pilot to hand steering, also only 2 examinees had reduced speed using own vessel engine without notice to ECR (Engine Control Room) and captain. The other 10 examinees had not reduced speed, then they avoided the collision situation by changing only own vessel’s course.

Regarding communication, only 3 examinees had turned on the navigational lights. Nobody contacted the other vessels by using VHF, only 2 examinees

used fog signal by a whistle in restricted visibility situation. Only 1 examinee had called the master in order to notice vessel was in restricted visibility situation (visibility was less than 3 NM).

5 CORRELATION BETWEEN UK-TEST AND THE EXPERIMENTS RESULTS

We examined the correlation between results of UK-Test and the experiments on the simulator. Results of UK-Test and the experiments on the simulator were shown in Table 2. First, typical group was the large number (8 examinees) of UK-Test results. We found 80% of examinees were typical side group. The only 1 (ID: E11) examinee was severe atypical group of UK-Test, but this examinee had not occurred any incidents to other vessels in the experiments. On the other hand, 2 examinees (ID: E01 and E12) were highly typical group of UK-Test, E12 had not occurred any incidents. However, E01 had occurred incidents due to delay take collision avoidance action. And 3 of 8 UK-Test typical group examinees had occurred incidents.

Therefore, we could not clarify if atypical group of UK-Test tends to cause incidents directly for OICNW due to the number of atypical group examinees was too small. However, we considered typical group has better non-technical skills than other groups, because only typical group examinees (ID: E02, E03, and E05) were able to use engine for reducing speed, turn on navigational lights, switch on a fog signal, and call the maser for notice the changing navigational situation.

Anyway, the facts that all examinees were finally able to avoid a collision with other vessels by taking collision avoidance action, are believed that licensed education and training so far as technical skills were not wrong way.

Table 2. Results of UK-Test and the experiments on the simulator

ID	UK-Test	Incidents	VHF usage	Engine usage	Fog signal	Nav. light	Call the Master
E01	highly typical	Yes	No	No	Off	Off	No
E02	typical	Yes	No	No	Off	On	No
E03	typical	No	No	Yes	On	On	Yes
E04	typical	Yes	No	No	Off	Off	No
E05	typical	No	No	Yes	On	On	No
E06	typical	No	No	No	Off	Off	No
E07	typical	Yes	No	No	Off	Off	No
E08	typical	No	No	No	Off	Off	No
E09	typical	No	No	No	Off	Off	No
E10	Quasi typical	Yes	No	No	Off	Off	No
E11	Severe atypical	No	No	No	Off	Off	No
E12	highly typical	No	No	No	Off	Off	No

6 CONCLUSIONS

We focused on UK-Test in order to consider whether it is the effective method for checking the ability of non-technical skills of OICNW. Finally, OICNW in atypical group of UK-Test did not cause incidents directly in this study. It is possible atypical groups should not generally be considered a bad direction regarding non-technical skills in the case of OICNW unlike train drivers (In case of train drivers, if UK-Test result is in atypical groups, railway companies tend to prohibit to hire as drivers or drive trains due to past statistics of high accident rates in Japan [15].). On the other hand, we also found that we need to increase the number of examinees in order to collect more atypical group data.

However, no doubt UK-Test is effective method for checking the ability of non-technical skills by the history of the railways. Therefore, we will continue to examine how should combine UK-Test and collision avoidance manoeuvre exercises on the simulator as a better education and training methods in order to enhance the OICNW's non-technical skills. We believe that customized education and training for each OICNW individually based on OICNW grasp own non-technical skills level will be necessary in order to minimize the number of collisions.

REFERENCES

[1] Japan Coast Guard : "Kainan no Genkyo to Taisaku"(2010~2021), https://www.kaiho.mlit.go.jp/doc/hakkou/toukei/toukei.html, accessed 2023.03.

[2] Japan Marine Accident Tribunal : "2020 Report Kainan Shinpan", p.27, 2020.11.

[3] IMO (International Maritime Organization): "Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs), 2003 Edition (IB904E)", IMO publication，2003.

[4] IMO (International Maritime Organization): "STCW including 2010 Manila Amendments, 2017 Edition (ID938E)", p.104, IMO publication, 2017.

[5] Rhona Flin, Paul O'Connor, and Margaret Crichton, translated by Akinori Komatsubara, Hiroshi Sogame, and Miwa Nakanishi : "Genba Anzen no Gijutsu", p.1-2, KAIBUNDO PUBLISHING CO., LTD., 2012.

[6] Tadao Minamikawa : "Sangyo Genba no Non-technical skills wo Manabu Jiko Boushi no Torikumi", The Chemical Daily Co., Ltd., pp.1-135, 2017.08.

[7] Japan Marine Accident Tribunal : "Report Kainan Shinpan" (2012~2022).

[8] Japan Marine Accident Tribunal : "Umi no Koutsu Houki Nyumon", https://www.mlit.go.jp/jmat/monoshiri/houki/houkinyumon/jyoumu/jyoumu.htm, accessed 2021.03.

[9] METI Government of JAPAN Japan Internship Program : https://internshipprogram.go.jp/english/theme/case/case2019_05.html, accessed 2023.03.

[10] Asia Dynamic Communications Co., Ltd : https://adc-japan.com/uk/, accessed 2023.03.

[11] e-Gov "Hourei-Kensaku" : "Douryoku-sha Souju-sha Unten Menkyo ni Kansuru Shourei", https://elaws.e-gov.go.jp/document?lawid=331M50000800043, accessed 2023.03

[12] Seiichi Kuraishi, Masahide Kato, Bien Tsujioka: "Development of The "Uchida-Kraepelin Psychodiagnostic Test" in JAPAN", PSYCHOLOGIA volume 1 number 2, pp.104-109, 1957.

[13] Nisseiken Inc., Briefing materials "Muryo Setsumeikai – hantei kekka hen", 2023.

[14] One World Human Resources Development Inc., https://one-world-hrd.com/en/member/?page_id=330, accessed 2023.03.

[15] Nisseiken Inc., Briefing materials "Muryo Setsumeikai – genba katsuyou hen", 2023.