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JUNG SIK JEONG, JAEYONG JEONG
Mokpo National Maritime University, Republic of Korea

HYE-JIN KIM, SUN-YOUNG KIM
Korean Ocean Research and Development Institute, Republic of Korea

USER REQUIREMENTS SUPPORTING THE SAFE NAVIGATION IN KOREAN COAST

ABSTRACT

This research aims at investigating the user requirements at the service level for safe navigation system, following e-navigation strategy implementation plan. The user requirements is surveyed to collect real-time navigational information and then to find out services through the presentation of the collected information. To provide the information on user needs for the system developer, a questionnaire survey has been made. Based on this surveys, this research investigated which navigational information is with higher priority for the safe navigation during ship operation by bridge team in harbour and in coastal and confined.

Keywords:
user requirements, user needs, e-navigation, safe navigation, navigational information.

INTRODUCTION

In Korea, a national R&D project has been conducted to develop the advanced navigation system which supports the safe navigation of inbound and outbound vessels for major Korean ports. As a first stage of the project, this research aims at giving the user requirements with high priority for safe navigation system, following e-navigation strategy implementation plan. The Sub-committee of Safety of Navigation 56th session confirms that it is necessary to verify and update user needs as and when necessary during the implementation process of IMO e-Navigation strategy [2].

The user requirements is surveyed to collect real-time navigational information and then to find out services through the presentation of the collected information. The

information is categorized into the two groups, i.e., information related with weather condition and sea state, and information related with situation awareness for anti-collision/grounding. The questionnaire is for pilots, masters, VTS operators, and Coast Guards. To understand the end-user services from the viewpoints of system developer, the questions are given. The guideline to masters and officers for safe watchkeeping, Bridge Procedures by ICS (The International Chamber of Shipping), is also considered [1]. The primary duties of the OOW are revisited to the functions carried out onboard ship and/or by pilot.

As a consequence, this research represents the information with high priority for the safe navigation during ship operation by bridge team in harbors, coastal waters.

FUNCTIONS RELATED TO E-NAVIGATION ROLES

The concept of e-navigation can be drawn as below Figure 1. The process of e-navigation will affect whole process of development. The process of practice and operation is affected by user requirements, operational function, and technical equipment. The user needs and especially the operational functions may be also influenced by the safety management of the company, the culture. The issues of quality, reliability, human element, interoperability, harmonization, standardization must be addressed throughout the e-navigation process in terms of data systems and training.

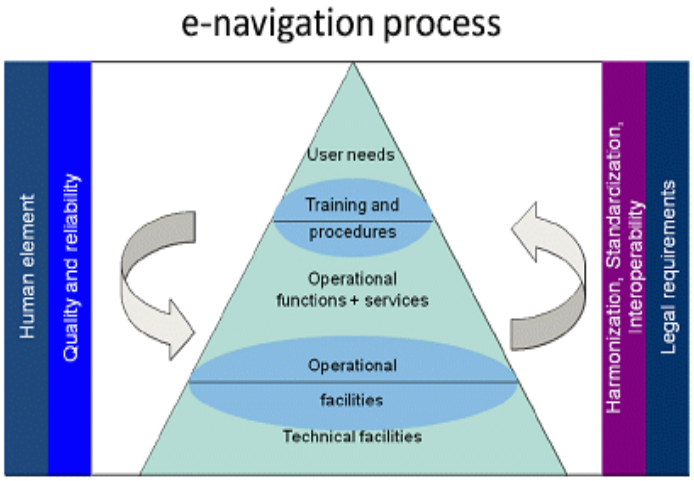

Fig. 1. IMO Strategy for E-Navigation Process [own study]

Figure 2 represents the part of e-navigation architecture specification process which is related to user needs. It is seen from Figure 2 that user needs are provided to define the functions related to the role and responsibilities of stakeholders, to define information elements, and to specify end-user services. Taking into account a safe navigation by bridge team under STCW Code [3], the scope of e-navigation can be defined by means of the responsibility of the Master as mentioned in NAV 56/WP.5. A unique and generic set of such responsibility can be represented by the master's role. The architecture elaboration process defines the functions to be carried out on board ship under a master's formal responsibilities and pilot's responsibilities.

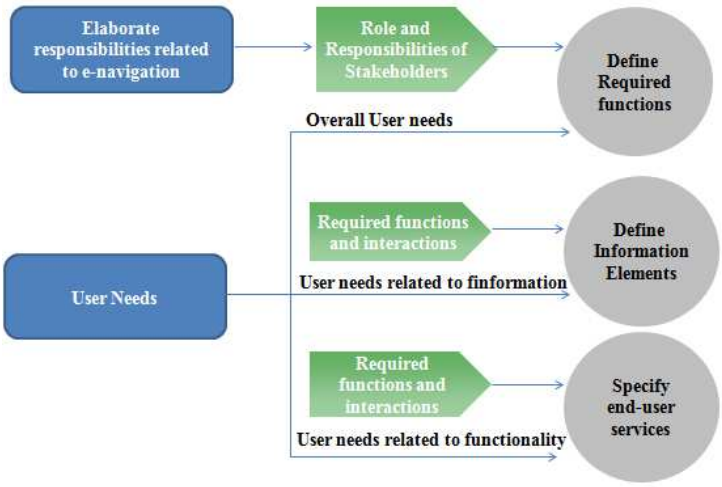

Fig. 2. Flow of User Needs excerpted from E-Navigation Architecture Specification Process [own study]

Functions carried out on board ship:

— Support and Control of Navigation;
— Safe Navigation;
— Management of Information;
— Support Incident and Emergency Management;
— Support Maritime Security.

Functions related to pilotage:

— Acquire Request for Pilotage;
— Acquire Information about Ship;

— Draft Passage Plan;
— Agree with Master on Content of Pilot Card;
— Acquire Real-time Information on Conditions for the Passage;
— Exchange Relevant Information with Master;
— Acquire Situational Information from Master;
— Agree with Master on Passage Plan;
— Support Safe Navigation;
— Refuse Pilotage due to Danger to the Safety of Navigation or the Environment;
— Report Incidents or Accidents to Authorities.

The OOW (Officer of the Watch) is the master's representative and has responsibility for the safe navigation at all times under STCW Code. It is natural that the duties of the OOW can be directly related to the functions carried out onboard ship and by pilot. The primary duties of the OOW will involve watchkeeping, navigation, and GMDSS radio watchkeeping [1].

USER REQUIREMENTS

In consideration of the roles of master and duties of OOW and also the corresponding functions to be carried out on board ship, The survey of user requirements was carried with the issues on a safe navigation and the services supporting the safe navigation. 45 experts related to vessel operations were participated for the questionnaire, i.e., pilots, masters, VTS operators. Among them, 35 persons have worked as mariners more than 15 years. All respondents have experiences in the field related to vessel operations for more than 10 years. The scope of questionnaire is to understand user needs for safe navigation in coastal and harbor operations. The questions consist of the two parts, i.e., Weather/Sea Conditions, Situation Awareness and Anti--Collision/Groundings.

Weather/Sea Conditions

Even though some weather/sea state information is available by bridge equipments, mariners require to collect the further detailed information from shore. Such information includes wind direction, wind force, set and/or current, water level,

water depth so on. Respondents answered for 6 navigation situations, i.e., preference of weather information from shore in relation with harbor operation, heavy weather situation, navigation in narrow channel, restricted visibility situation, in sight of one another, in any condition of visibility. Fig. 3–6 shows respondents want to get the detailed weather/sea state information from shore in case of harbor operation. The preference index is the ratio of the number responded for each item to the total check numbers for all navigation situations. To represent the priority of weather/sea information from shore. the preference index is weighted by the difference of respondents number, and then ranges from 0 to 1.

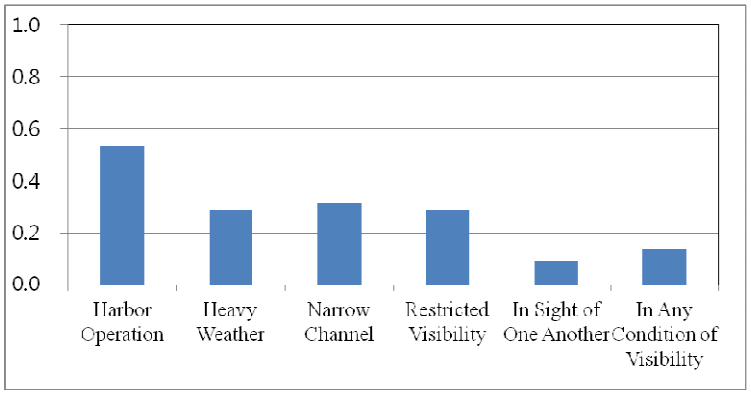

Fig. 3. Preferences for Wind direction, Wind force [own study]

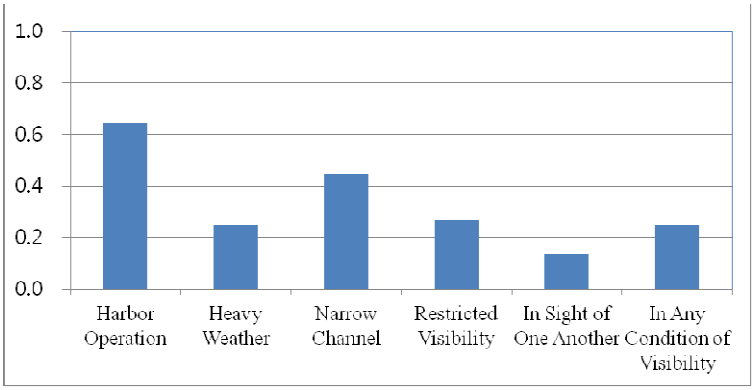

Fig. 4. Preferences for Set, Current [own study]

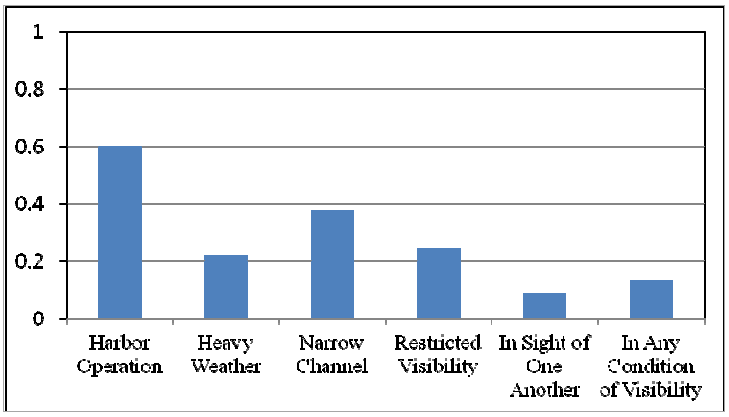

Fig. 5. Preferences for Water Level [own study]

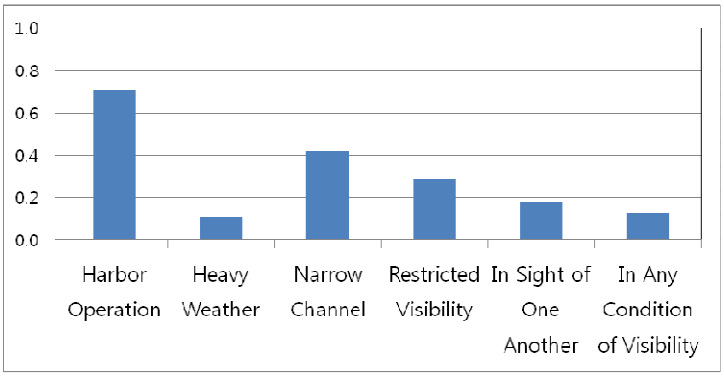

Fig. 6. Preferences for Water Depth [own study]

For coastal navigation, the priority of forecast information for weather and sea state is higher than real time information.

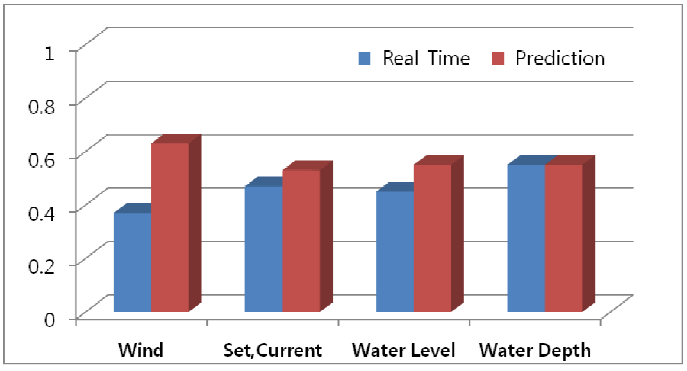

Fig. 7. Preferences of the forcasted weather/sea state [own study]

Giving weather and/or sea state, respondents are favor of DUKC, air draft, display of safe route as services with high priority, as shown in Table 1.

Table 1. Weather Conditions, Sea State [own study]

Elements	Services
Wind direction, Wind force, Set, Current, Tide	Display of Navigable Area/Route Prediction of Route and Leeway
	Ditto
	Ditto
Depth, Tide, Trim	Dynamic UKC
Depth, Tide, Draft, Trim, Bridge Height	Air Draft in Time Series

The requirements for the accuracy of UKC is surveyed. Respondents prefer to have accuracy of UKC to be less 10 cm for berthing/unberthing. For harbor operations, the accuracy of 10 cm to 50 cm is prefered, as shown in Fig. 8. On the other hand, Figure 9 shows the accuracy requirement of bridge height from waterlevel. The accuracy of 10 cm to 50 cm is required to safely pass below Bridge.

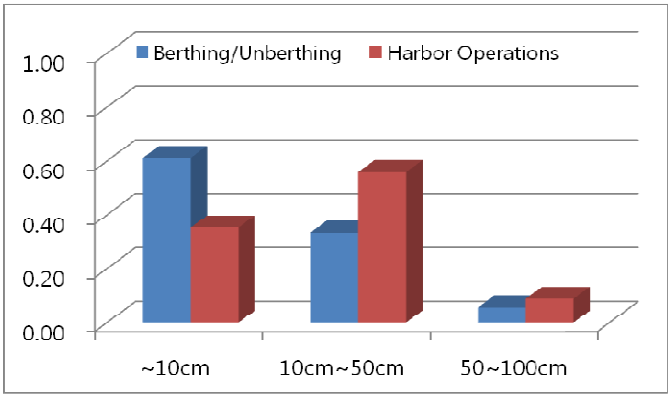

Fig. 8. Accuracy Requirement for UKC [own study]

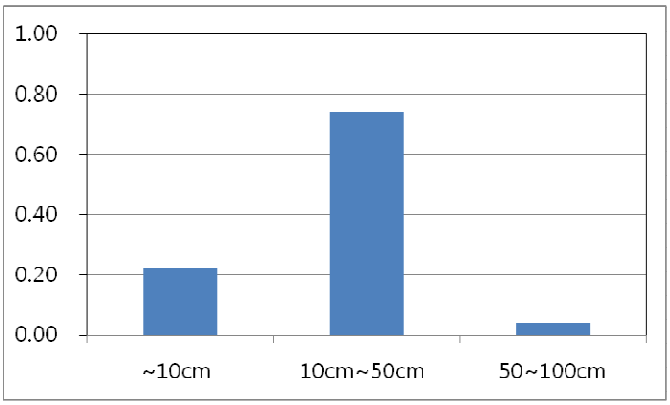

Fig. 9. Accuracy Requirement for Bridge Height from Waterlevel [own study]

Situation Awareness and Anti-Collision

Mariners require information elements and services pertaining to the planning and execution of voyages, the assessment of navigation risk and compliance with regulations. The required information elements and services may be identified and specified based on the functions that are to be carried out and the required interactions, as shown in Section 2. Such Information elements and services should be useful to support a proper decision making by increasing situational awareness. There will most likely be different sets of services in most given situations or locations — e.g., ports, coastal, and high seas. We consider the number of the services which are related to the situation awareness and anti-collision in port and coastal navigation. All information requirements are collected from survey results and summarized in term of element and services, as shown in Table 2. Within e-navigation, some services may be automated, whilst others will continue to be carried out through interactions between persons and systems.

Table 2. Situation awareness and anti-collision [own study]

Information	
Elements	Services
Visible Range	Prediction and Broadcast of Visible Range on Intended Route
Distance to target ship	Guide on an avoidable area/route
Target ship course/speed/size/draft/ cargo loading condition	Display of Collision Risk, Broadcasting/Warning Message to Surrounding Vessels

Waypoints of Target Ship and Own Ship	Intended Route of Target Ship to be encounter, Exchange of Voyage Planning
Target Ship Position/Course/Speed	Transmission of Target ship's Trail and Speed history
Encountered Type	Display of Collision Risk and Guide on Applicable Navigation Rules
Manoeuvering Characteristics, Draft, Weather Information, Sea State, Current/Set	Prediction of Maneuvering Characteristics
Traffic Information	Traffic Image Transmission to the Related Vessel. Prediction of vessels/location to be encountered
Overtaking vessel's speed/intended course	Transmission of Navigational Assistance Message to Own Ship
Risk alarm, Target ship information	Display of Collision/Grounding Risk
Berth no. of inbound Vessel/ETA	Transmission of Image of Berth to be moored, and Current Harbor Plan
Position/Route of non-AIS Vessel	Position Display of Non-AIS Vessels in the vicinity of Own Ship
Positions/Route of Fishing Vessels	Position Display of Fishing Vessels in the vicinity of Own Ship
Working area of Fishing Vessels	Display of Fishing Area in the vicinity of Own Ship
Fishing net, Fishing type, Depth of Fishing Net under Waterlevel	Location/Picture/Description of Fishing Net, Fishing Method
Dangerous Area/Object	Display of Dangerous Areas/Objects, Display of No Go Area
AToN Update	Information Services & Navigational Assistance Services from VTS in Real Time: Display on ECDIS and/or PPU
Working Area at Sea /a proper speed at working area	
Nationality/Language of the encountered ship crews	Delivery of Mariner Information from Ship to VTS and/or Ship
Mariners experiences in the navigation route/ harbour	
Voice Communication between Mariners	System Supporting Poor Expression in English
AIS data, Ship Registry Information	Confirmation on Reliability of AIS information via VTS
Check of Own Ship Position	Transmission of Ship Position from VTS in case of Navigation Equipment Troubles
Location of Maritime Accident, Marine Pollution area, location of sunk vessel	Guide/Display of Maritime Accident Location
Deviation from ship route when approaching a breakwater	Display of Proper Course and Speed in addition to Route Monitoring

From Tables 1–2, the suggested services can be used for the bridge checklist:

— Preparation for Arrival in Port;
— Pilotage;
— Passage Plan Appraisal;
— Navigation in Coastal Waters;
— Navigation in Restricted Visibility;
— Navigation in Heavy Weather.

Fig. 10 represents the preference for the range to be intensively monitored in advance before anti-collision actions are taken. It shows that target ships' movements are intensively and continuously monitored when they approaches within miles from own ship for overtaking, 6miles in crossing and in head-on.

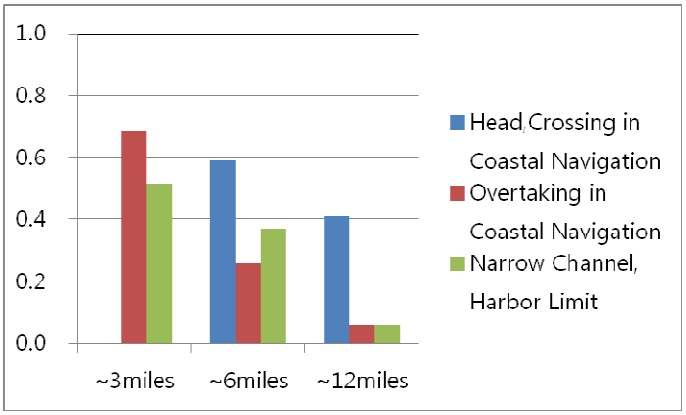

Fig. 10. Range to be intensively monitored for anti-collision actions [own study]

CONCLUSIONS

The purpose of this is to find out the information with high priority for the safe navigation during ship operation by bridge team in harbour and in coastal and confined water. The user requirements was surveyed to collect real-time navigational information and then to find out services with high priority through the presentation of the collected information. The questionnaires are distributed to pilots, masters, VTS operators, and Coast Guards.

As results, the preferences for weather condition/sea state information were represented. The accuracy requirements for UKC and Air Draft were suggested. All information requirements were collected from survey results and summarized in terms of element and services.

In fact the optimal approach is to reflect harmoniously the requirements from users, engineers, and man-machine specialists. Further survey should be done to incorporate the user needs into the requirements of system engineers.

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JUNG SIK JEONG, JAEYONG JEONG
Division of International Maritime Transportation Science
Mokpo National Maritime University
Mokpo City, 530-729, Republic of Korea
e-mail: jsjeong@mmu.ac.kr; jyjong@mmu.ac.kr

HYE-JIN KIM, SUN-YOUNG KIM
Marine Safety and Pollution Response Research Department
Korean Ocean Research and Development Institute
Daejeon City, 305-343, Republic of Korea
e-mail: hjk@moeri.re.kr; sykim@moeri.re.kr

STRESZCZENIE

W artykule przedstawiono wyniki badań wymagań użytkownika związanych z poziomem bezpieczeństwa nawigacji, stosownie do strategii wprowadzania e-nawigacji. Badano oczekiwania użytkowników odnośnie informacji nawigacyjnej dostarczanej w czasie rzeczywistym

oraz sposobu jej prezentacji metodą ankietową. Wykonano przegląd kwestionariuszy dla ustalenia informacji o potrzebach użytkownika z myślą o projektantach systemów. Na bazie opisywanych badań ustalono, jakie informacje nawigacyjne cechują się najwyższym priorytetem w opinii użytkowników, zarówno w warunkach żeglugi przybrzeżnej, jak i w porcie lub akwenie ograniczonym.