Development of usability checklist for ECDIS

Hongtae Kim, Jun Hyuk Jang

Korea Research Institute of Ships & Ocean Engineering, Daejeon, KOREA

The International Maritime Organization developed harmonized guidelines on Human Centred Design, Usability Testing, and Software Quality Assurance. In considering e-Navigation, IMO emphasizes the necessity of focusing on human factors to meet user needs and safety requirements. Although many methods for assessment and evaluation of usability have been introduced in various fields, there is room for improvement in the maritime domain. The aim of this paper is to propose items for evaluation of navigational equipment. The Quality Function Deployment (QFD) method is used for objective selection of the evaluation items. Based on the QFD results, a checklist is proposed for the evaluation and assessment of Electronic Chart Display and Information System (ECDIS) usability.

Keywords: HCD, usability, checklist, ECDIS, navigational equipment

1. Introduction

Due to a recent increase of damage due to marine accidents, there has been increasing interest in the safer navigation of ships. Technologies have been actively developed for the regulation of navigation and prevention of marine accidents. In addition, it is noted that a large proportion of past marine accidents were caused by human error (about 80%). This has made measures for reduction of human error an important research subject.

Most of the human errors that cause accidents involve making incorrect decisions. As a result, a variety of navigational equipment applying IT technologies have been developed to help sailors make better decisions improve navigation. However, if too much, and too varied forms of information are provided, it may instead disturb decision-making.

The International Maritime Organization (IMO) presents harmonized guidelines on Human Centred Design, Usability Testing, and Software Quality Assurance. Now considering e-navigation, the IMO emphasizes the need for evaluation the perspective of users. Research is now ongoing, mainly in Australia and Japan, concerning human-centred design (HCD) and construction of navigational equipment. This approach attaches importance to ergonomic factors, regarding evaluation of the usability of navigational equipment. From Japan, a methodology was proposed for usability evaluation of navigational equipment, along with a guideline(IMO, 2011a)(IMO, 2011b). A later proposal and guideline from Australia emphasized the importance of the user-centric design as part of the HCD approach (IMO, 2013).

The International Organization for Standardization (ISO) defines usability as "a matter regarding effectiveness, efficiency and satisfaction in the use in a specific context when a specific user uses a certain product in order to achieve a specific purpose." In various fields, evaluation items or checklists have been developed and applied for evaluation of usability, but they are not sufficient for application to navigational equipment (ISO, 1998, 2010).

Now, it is time to study efficient information display and service method, rather than senselessly providing sailors with more information to help them make decisions. ECDIS (Electronic Chart Display and Information System) is an important device that provides sailors with information affecting navigation of ships, and helps them make decisions.

With this in mind, the objectives of this study were to develop items by which to evaluate the usability of ECDIS equipment, with appropriate sub-factors, and to develop a checklist. It is judged that the empirical results from this study would have significance for evaluation of specific navigational equipment with sub-factors drawn up specifically for usability evaluation of navigational equipment. It is expected that the research results would contribute to the promotion of the usability of navigational equipment and ergonomic improvement and design of ships.

2. Selecting items for usability evaluation

In this study, the evaluation items collected from various fields, where they were used in ways similar to those intended here. These were sorted; then used to draw up a list of the best 33 items for evaluation of usability. Starting with these 33 items, expert evaluation was used to shorten the list to 16 for specific evaluation of the usability of navigational equipment. These evaluation items are presented in Table 1 (Kim et al., 2014).

Table 1. Items for usability evaluation of navigational equipment

	Item		Item
1	Accuracy	9	Effectiveness
2	Control	10	Feature functionality
3	Consistency	11	visibility
4	Errors	12	readability
5	Clarity	13	Efficiency
6	Accessibility	14	Feedback
7	Match	15	Utility
8	Operability	16	Directness

Using the opinions of ECDIS equipment developers about the list of 16 navigation-equipment related items, 11 items for evaluating the usability of ECDIS were selected and integrated. These are presented in Table 2.

Table 2. Usability evaluation items for ECDIS

	Item		Item
1	Accuracy / Clarity	7	Consistency
2	Control / Operability	8	Effectiveness
3	visibility / readability	9	Feature functionality
4	Errors	10	Efficiency

5	Accessibility	11	Feedback
6	Match		

Next, sub-factors were drawn up for the 11 items, and a final checklist was prepared. Table 3 shows examples of the sub-factors used in this study.

Table 3. Examples of sub-factors of two of the usability evaluation items

No.	Item	Sub-factor	No.	Item	Sub-factor
1	Accuracy / Clarity	Term	4	Errors	Processing speed
		Symbol			Rate of response
		Input/output information			Warning of the occurrence of errors
		Definition of Function			Causes of errors
		Display of positions			Severity of errors
		Available features			Recovery of errors
		Meanings of colours			Level of operating
		Names of menus			Provision of feedback
		Present status			Prediction of results

3. Usability evaluation checklist

Finally, a checklist suitable for the evaluation of each sub-factor was provided in the form of a list of questions. This process was carried out after discussion with experts, and with the participation of experts (in usability evaluation and ECDIS development). Each sub-factor used terms and sentence structure that evaluators could understand quickly and easily. Detailed matters were expressed simply and specifically so that the evaluators could precisely detect relevant problems with usability. Table 4 is an excerpt from the actual document, and provides examples from the finished checklist.

Table 4. Checklist for ECDIS usability evaluation

No.	Item	Sub-factor	Checklist
1	Accuracy / Clarity	Term	▪ Are suitable terms and abbreviations used correctly?
			▪ Are the terms clear and easy to understand?
		Symbol	▪ Are the meanings of the symbols expressed correctly?
			▪ Are the icons classified clearly?
		Input/output information	▪ Is the entered information expressed correctly?

		Display of positions	▪ Are the position-related indicators (Distance and bearing) displayed correctly?
		Available features	▪ Are the features for use given clearly?
		Meanings of colours	▪ Are accurate colours used?
		Names of menus	▪ Are the names of the menus displayed accurately?
			▪ Are the names of the menus easy to understand?
		Present status	▪ Is the present status expressed accurately?
4	Errors	Processing speed	▪ Can wrong inputs be modified quickly?
		Rate of response	▪ Is rapid feedback given for errors?
		Warning of the occurrence of errors	▪ Is the method for the expression of warning appropriate?
		Causes of errors	▪ Are the accurate causes of errors provided?
		Recovery of errors	▪ In the event of errors, can the job be restored?
		Provision of feedback	▪ Is feedback provided in various forms?
		Prediction of results	▪ Is notice about errors in the job results given in advance?

4. Conclusions

In this study, a final list of 11 items was selected specifically for evaluation of the usability of ECDIS equipment. After consideration of appropriate sub-factors, a checklist was developed to be used for evaluation of the usability of ECDIS equipment. However, detailed review and supplementation would be necessary, considering user patterns and actual usage in the environment within which the usability evaluation would occur.

It is judged that this study has significance as an empirical study that evaluates navigational equipment using the proposed checklist with sub-factors. In the future, the checklist could be applied to the specific usability evaluation of other navigational equipment, considering the characteristics of that equipment.

Acknowledgements

References

IMO (2013). Development of an E-navigation strategy implementation plan, NAV 59/6/1

IMO (2011a). Preliminary Draft Guidelines for Usability Evaluation of Navigational Equipment, NAV 57/INF.7

IMO (2011b). Proposal for a way forward on the development of usability assessment methodology for navigational equipment, NAV 57/6/5

ISO (2010). Ergonomics of human-system interaction-Part 210 Human-centred design for interactive systems, 9241-210

ISO (1998). Guidance on usability, 9241-11

Kim, Hongtae, et al. (2015). A study on usability evaluation for navigation equipment, Korea Institute of Navigation and Port Research, Proceedings, p179-180