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IMPLEMENTATION OF THE ECDIS SYSTEM: AN OOW PERSPECTIVE AS AN INTEGRAL PART OF EDUCATIONAL IMPROVEMENT

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Abstract. Current year marks the completion of the Electronic Chart Display and Information System (ECDIS) implementation period. During the past three decades system evolved from its initial purpose to a complex navigation information system support tool. This transition represents substantial step in navigation, and one would expect that all related issues are shaped smoothly. From the very beginning of ECDIS implementation, Officers of the Watch (OOW) are experiencing various issues ranging from functional, operational, educational, legislative and finally, practical. Numerous organizational standards, resolutions, circulars, reports, guidelines and other documents support this fact, as well as number of ECDIS-related marine accidents, detentions and fines.

The proposed paper represents a segment of a systematically carried long-term research aiming at educational process improvement. This aim is to be achieved through specific approach, proper communication and various and subtle activities, always striving at the user-centered, often neglected issues and their solving. The particular research refers to opinions and attitudes of OOWs towards ECDIS mandatory implementation period completion. Individual knowledge has also been examined in terms of new technology perception, as well as understanding of the system. Internationally distributed questionnaire was used for this purpose. Answers were processed and analyzed together with accompanying comments. Results are shown in the context of transitional period, representing a flow of end-user opinions over the years. Observations and findings are presented and discussed. Research results are especially referring to future officers who are given an objective, immediate and critical insight, beside official education and relevant materials. In this way, OOWs are indirectly exchanging their opinions and knowledge with their younger colleagues. This interrelation, accompanied with theoretical background, is one of the center features of the research. The paper concludes with provision of possible guidelines and planned activities towards further educational improvements, but also towards system development as well.

1 INTRODUCTION

'Let go of that grotesque story about system failures and computer unreliability, please. Everything can be solved from the office ashore within two hours.'

– *2nd Officer, Year of birth: 1981, Seagoing/ECDIS experience: 8/6 years, No official ECDIS education, September 16th, 2014.*

'The pencil is always a pencil; the divider is always a divider'

– *2nd Officer, Year of birth: 1981, Seagoing/ECDIS experience: 15/5 years, Possession of ECDIS Generic & Type Specific Course Certificate, April 16th, 2014.*

'I was learning the whole life that paper charts are the best way (and the safest way) to navigate so this withdrawal is confusing to me at this stage.'

– *Chief Officer, Year of birth: 1982, Seagoing/ECDIS experience: 15 /0.5 years, No official ECDIS education, January 11th, 2016.*

Mandatory implementation of ECDIS system commenced on July 1st, 2012. During 6 years of transitional period numerous changes were made in order to improve the system and its features, given that variety of issues and problems emerged as lateral effects. The nature of problems varies from technical, legislative, operational but mostly mind-based and educational, being one of largest influential factors.

This study focuses on ECDIS knowledge, operation and OOWs' opinion regarding the system in general, its features and its role as a justified substitution of traditional navigation means. Mentioned was achieved through international questionnaire distributed to seafarers. So far, over three hundred respondents were examined for the study, consisting mainly of OOWs employed on international voyages.

The paper is organized as follows. The background chapter refers to summarized overview of the ECDIS system, providing relevant information for the study. Given that many documents relate to the system, the reader is referred to the references cited. Methodology of the research is presented with main features of the research, past achievements and main goals it relies on, or strives to, respectively. Presented results are summarized and discussed given OOW's point of view, with consideration of main findings calling to desired continuation of the research.

2 BACKGROUND

Main ECDIS involved organizations are International Maritime Organization (IMO) – providing performance standards (system centered), International Hydrographic Organization (IHO), which provides standards regarding electronic data (chart centered) and International Electrotechnical Commission (IEC), providing operational standards, methods and required test results (system centered) [5]. One of the main reasons of electronic displays' introduction was the necessity of real-time tracking of vessels with possibility of displays of *ice and environmental conditions, true position, radar input and chart information* [4]. How it will eventually turn out, the system changed means of navigation, with data integration as a true added value [13]. As a recognized improvement, ECDIS system was officially accepted as meeting carriage requirements of Safety of Life At Sea (SOLAS) Convention in 2002 [10]. According to [14], in May 2015 most of the global fleet of respective vessels (51% and total, and 59% of vessels engaged on international trade) was compliant with the Convention

regulation regarding ECDIS carriage. The system has to be type approved; use up-to-date Electronic Navigational Charts (ENCs); (software) maintained and has adequate back-up arrangements [6, 10].

These regulations allow for navigation without obligation of paper charts possession, reflecting also on nautical publications and other paper documents used through the navigation venture. Here, OOWs are coming to the fore. The handling with the system should be flawless and smooth, which implies unquestionable integrity and reliability of the system, and properly trained and educated operators. Among all stakeholders involved being equipment manufacturers, instructors, chart producers, hardware and maintenance providers, ship owners, related organizations' representatives and inspection executors [12], seafarers can be considered as true system end-users. As the system evolves further, more and more features emerge, drawing attention from basic features and its initial purpose. In general, the system is accepted as such, and this level of acceptance will surely increase over the time. Benefits of the system are recognized, as well as its influence on the workload and navigation. However, certain elements still remain incomplete and ambiguous [1, 16]. Besides technical issues [11, 15] different problems end-users are experiencing are categorized as problems related to charts, navigation & positioning problems, handling problems and insufficient knowledge [2]. As for mandatory Generic ECDIS course, measurable amount of opinion was observed regarding insufficiency of 40 hours [3, 18], as prescribed in the relevant IMO Model Course 1.27 [8]. Survey on basic safety settings and primal system features showed a certain level of misinterpretation between OOWs [17, 2].

3 THE SURVEY

During years, authors initialized and maintained a two-way communication with OOWs in terms of feedback development, one of which is the ECDIS EHO *(Experience, Handling and Opinion)* questionnaire containing basic, advanced and functional questions. This part of the research elaborates OOWs' experience and work with the ECDIS system through years of implementation period, with key points referring to their opinion on paper chart withdrawal and features of ECDIS navigation as compared to traditional means.

As to date present, the questionnaire was fulfilled by 271 active OOWs employed on vessels subject to ECDIS carriage requirements[1] (Figure 1): 89 Masters (M), 66 Chief Officers (1/O), 55 Second Officer (2/O), 10 Third Officers (3/O), 22 Apprentice Officer (C) and 29 Undefined respondents (U). Questions were conceived as requiring a YES/NO answer primarily, but also providing the possibility for descriptive answers. Apprentice Officers were considered for the study as well. A *NA* (*not applicable*) refers to ambiguous answer, or the column remained blank.

[1] Total number of 304 respondents was filtered excluding other stakeholders not directly related to the system.

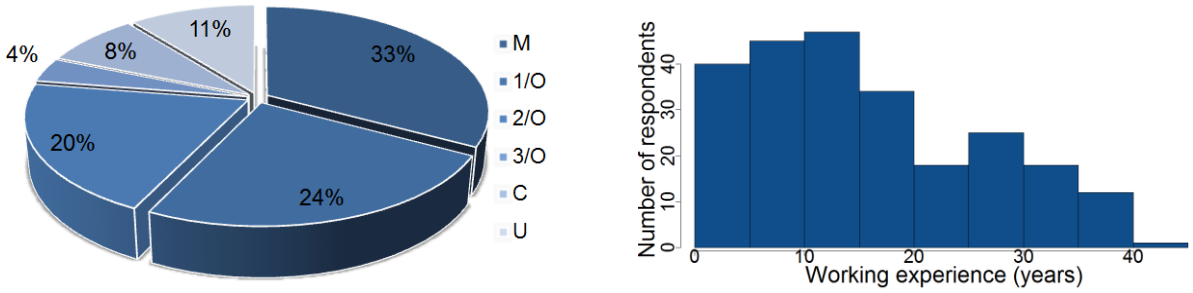

Figure 1: Profile of respondents (left) and distribution of their seagoing experience (right)

Respondents' experience (in years) ranges from 0.5 to 41, with the mean value of 16.8, standard deviation of 11 and the median amounting to 15. The following questions were used for the study:

- *Do you agree with the fact of withdrawal of paper charts from the service, if certain conditions are met regarding the system, i.e. there is no further obligation to possess the same? (abbreviated further as Q1)*
- *Do you think that there are still advantages of paper charts and traditional navigation means over ECDIS/ENC? (abbreviated further as Q2)*

3.1 Results

In general, over half of respondents agree with the paper chart withdrawal. At the same time a majority of OOWs believes that there are still advantages of paper charts over ECDIS system. Share of Q1 answers is presented in Table 1 and on Figure 2, respectively.

Table 1: Share of answers on Q1

Rank	M	1/O	2/O	3/O	C	U
Yes	39	34	37	5	11	14
No	46	28	16	2	9	15
NA	4	4	–	3	1	–

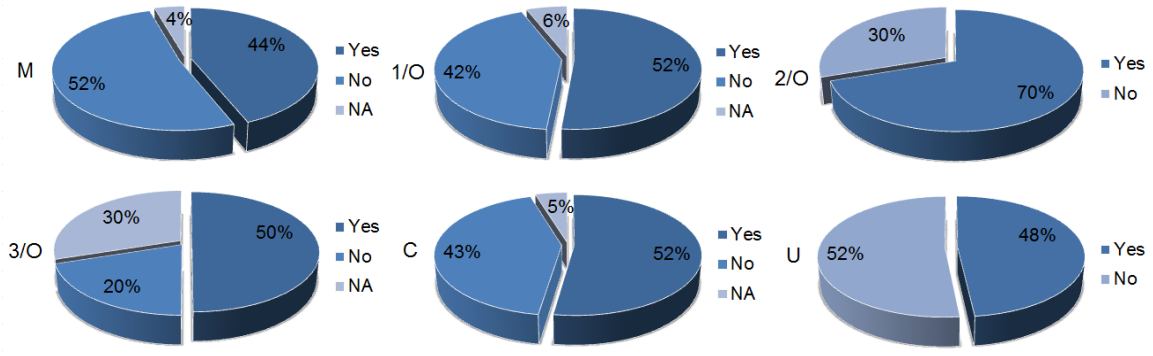

Figure 2: Share of answers (in %) among ranks considering Q1

There is similar share among all ranks, except that in *Masters* and *Undefined* group the answer *NO* prevailed. Most dispersed share is present in *3/O* group, while the situation is straightforward with Second Officers.

As for Q2, the overall share is presented in Table 2 and on Figure 3, respectively.

Table 2: Share of answers on Q2

Rank	M	1/O	2/O	3/O	C	U
Yes	52	39	33	4	13	15
No	26	22	13	3	2	9
NA	11	5	9	3	7	5

Advantages of paper charts over ECDIS are recognized by majority of respondents including 2/O group, while most dispersed answers are present with 3/O, as before.

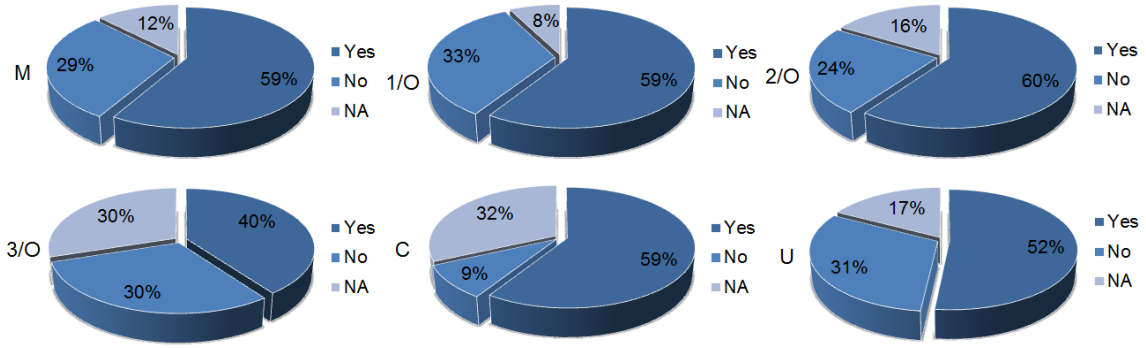

Figure 3: Share of answers (in %) among OOW ranks considering Q2

This general presentation has been further divided according the year of survey completion, thus forming four representative groups[2] (Figure 4 and Table 3, respectively); the number of respondents in each group (year) is equivalent to 100%, with relative share of answers distributed within.

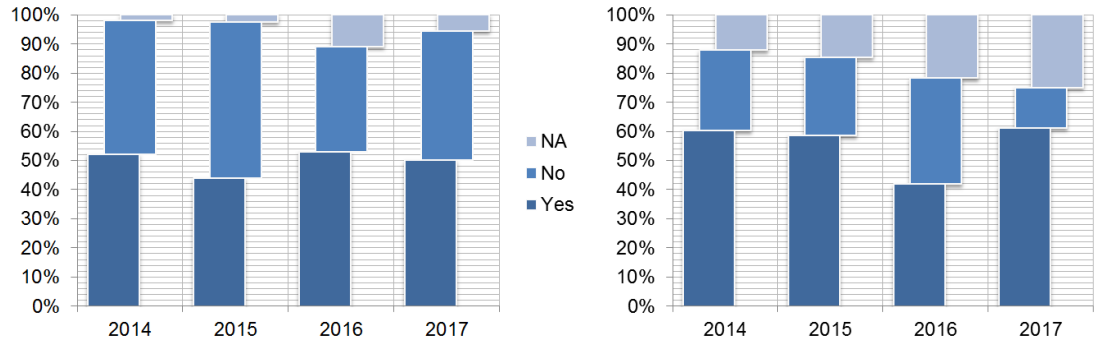

Figure 4: Share of answers on Q1 (left) and Q2 (right) through elaborated period

[2] Recent year (in time of writing) was not considered for the survey.

Table 3: Relative share of answers on Q1 and Q2

	Q1					Q2			
A/Y	**2014**	**2015**	**2016**	**2017**	**A/Y**	**2014**	**2015**	**2016**	**2017**
Yes	0.52	0.44	0.53	0.5	**Yes**	0.60	0.58	0.42	0.61
No	0.46	0.54	0.36	0.44	**No**	0.28	0.27	0.36	0.14
NA	0.02	0.02	0.11	0.06	**NA**	0.12	0.15	0.22	0.25

This classification was made in order to find eventual regularities that should form according to time passing and acceptance of the system, obtaining sort of confirmation with increased number of seafarers recognizing its benefits. However, another confirmation took place, although more indeterminate and less defined. In 2016 there is a significant deviation in trend with most pronounced withdrawal agreement (Q1). Afterwards, the share of answers returns as in previous years. In 2017, a sudden increase in affirmation of paper charts was back noted. As for advantages over ECDIS system (Q2), the confirmative answer prevails over the years, with increase of undefined (*NA*) answers. Accompanying comments on respective answers are summarized as follows. In this context, respondents can be categorized as *system supporters*, *traditionalists* and *restrained*.

3.2 Discussion on OOW viewpoints and opinions

Several allegations can be considered as common (Table 4). Main features being specific outlines were compared, showing dissent in opinions. Conditional category of answers refers to supporters who consider the system as paper chart equivalent, however after certain conditions are fulfilled.

Table 4: Summarized OOW comments (table key points are referring to ECDIS system)

Traditional supporters	**System supporters**
Unreliability	Ease of usage
Underdevelopment	Future of navigation
Viruses and attacks	Better accuracy
ENC legibility & insufficient coverage	Execution of navigational tasks
No standardization & many functions	Technical improvement
Information overload	Contribution to safety
Small displays & poor overview	Time consumption
Human error increase	Human error reduction
Best scenario: ECDIS & APC	ECDIS & APC scenario as needless
Over-reliance	
Lack of knowledge	
Conditional statements	
Increase of minimum standards	
Proper implementation of rules	
On demand service, satellite-availability, on-board charts printing	
Increase of ECDIS reliability	
Standardization and simplification	
Improved education and training	

As for restrained group, advantages of paper charts over ECDIS exist, however they vanish as the time goes. They recognize the significance of implementation period and time required for proper settlement of the system as primary navigational mean, consciously stating that both means represent navigational aids only.

As a general observation present in each group, paper charts should be always kept on-board as a back-up (mainly small scale folios, as stated). Several respondents are stating certain issues with ENC service that have to be solved. A Master-respondent states that *'Paper charts keep officers busy and more focused on navigation tasks'*. Over-reliance is a serious problem, already recognized as a threat. If not handled correctly, any new critical equipment can be harmful, leading to a display-oriented end-user, without sufficient outlook and awareness. Issues with system alarms are worth considering as well. As noted, a large number of alarms make OOWs more relaxed and inattentive (as opposed to work with paper charts). On the other hand, other respondents find system alarms disturbing.

4 FINAL CONSIDERATIONS AND FURTHER WORK

As a primary navigational mean, the ECDIS system is mainly accepted, and this appreciation should increase over time. However, opinion over the years does not support this fact completely. A measurable level of uncertainty and confusion is found among answers. The lack of knowledge can be distinguished as most pronounced issue, potentially leading to further problems. Therefore, besides regulated official education and training, it appears a need for further development of the teaching process regarding the ECDIS system and its related elements. The proposed study provides a possibility for identification of most *vulnerable* respondents, or category of respondents, respectively.

So far, the ECDIS EHO research resulted in several scientific contributions, but also new courses and studies related to navigation information systems onboard vessels. For the purpose of this paper general analyses were made. Future activities imply elaboration of respondents according to their experience with the system and the level of education. The research is devoted to present and future officers of the watch, providing a segment of real and varying situation which their colleagues are experiencing. An OOW perspective presented in the paper serves as additional tool providing tangible and real feedback, and it is applicable to be incorporated in any educational process. The presented methodology and research results refer to development of critical thinking prior to actual contact with system handling.

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