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A Case Study for Using Operational ECDIS Functions

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Abstract

Electronic Chart Display and Information System (ECDIS) offers navigators more functions and information than a paper chart. ECDIS manufacturers have applied all navigational operations to ECDISs that can be performed using paper charts. The system is designed to support the navigators in a way that does not look like a paper chart with these functions. However, the frequency of using ECDIS functions may vary due to different age groups, fields of study, competencies, etc. ECDIS functions, suitability and usage frequency are subjected in this study. Ship masters and deck officers (including deck cadets) apply the "ECDIS Functions Usage Frequency Questionnaire" for aiming to understand how they use these functions via a web-based survey. In addition, how often the navigators use the specified ECDIS functions were assessed. A total of 55 different ECDIS functions and their usage frequency were analyzed by using IBM SPSS v.25 by questioning 83 active navigators. Moreover, one of the goals of this study is to understand the awareness of correct usage. According to various age, qualification groups and ship types, the variety of applications of ECDIS's international standards determined by the International Maritime Organization and the frequency of usage and its functions were tested. As a result of this survey study, the frequency of usage was correlated by associating the professional competencies of the navigators. The five most basic and frequently used functions were also determined and interpreted.

Keywords: ECDIS, ECDIS functions, ECDIS features, frequency and usage of ECDIS

Introduction

In the maritime industry, the biggest question in the minds of navigators is about sailing the ship from one point to another and they always want to know where the ship is instant. The coordinates obtained through various sources such as; Celestial Navigation, Global Positioning System (GPS) and other methods were just numbers and letters for navigators to guess where is the fixing position in the world. At this point, paper charts showed them where they were visually and also showed their direction. Paper charts converted to S-57 data format as digital charts for exchanging hydrographic data among the hydrographic offices of maritime administrations (Admirality Maritime Products & Services, 2017). Hydrographic offices define the data format of Electronic Navigation Chart (ENC) for the chart producers as S-57 standard which includes all necessary data for safe navigation. As a result of this, there is one type (with defined standards) chart system used for navigation.

Electronic Chart Display and Information System (ECDIS) has its own software, so it has advanced visual capabilities more than ENCs. ECDIS is basically produced to use ENCs. However, Raster Navigation Chart (RNC) is also used on many ships, depending on the chart used, the region where the ship operates, and the preference of the company. The importance of ECDIS is revealed by the smartness of the usage of the electronic chart. The data in the chart is open to query and it has got many flexible functions. The user has the opportunity to monitor the charts and chart combinations on the screen where the answers can be received based on needs.

ECDIS warns the navigator by giving visual and audio alarms for increasing the awareness of safe navigation and protecting environment (Žuškin, et al., 2011). ECDIS is a smart system and has the planned alarm parameters and real-time monitoring functions, it creates awareness by showing all kinds of navigational obstacles that may pose a danger. On the other hand, it should be kept in mind that ECDIS is a decision support system even if the ship position appears instantaneously according to the environment.

ECDIS is integrated with other electronic equipment by its sensors. ECDIS doesn't only receive data from local sensors but also receives data from other navigation equipment (RADAR, speed log, etc.) via LAN connection. When the passage plan is prepared, ECDIS collects all data in its system in one window to plan, execute and monitor for the safety of passage. Nowadays, there are integrated computer systems such as OneOcean, which provide the passage plan by only one click/touch the system. The passage plan prepared by computer program includes route data, safety parameters, Maritime Safety Information (MSI), tide, nautical publications and so on. ECDIS allows revision and/or add/drop data in the passage plan according to ship's type, navigation area and cargo by using the manual update function. ECDIS has additional features such as "update planned route", "re-use the same route", "integrate with another route" and/or "combine with another route". Another advantage of ECDIS is its user-friendly and ergonomic design. The system (ECDIS) is easy to use for increasing situational awareness of safe navigation (Admirality Maritime Products & Services, 2020). On the other hand, ECDIS has detailed, complex and critical navigation parameters. Although ECDIS is a well successful system, it only provides a decision support system to the navigator (Acomi, 2016).

It's necessary to have an original license when ECDIS uses ENCs. The difference between ECDIS and ECS is to use the original license stipulated by SOLAS. When ECDIS uses ENCs, it should be updated for navigation. Therefore, the updated ECDIS system has been tested by IHO (International Hydrographic Organization) Presentation Library 4.0. There are various

manufacturers of ECDIS depending on the ship's type and dimensions. All of them are standardized according to IMO and SOLAS although they have different user interfaces.

The main objective of this study is to assess the frequency of usage and skills of the ship master and officers on the basic functions of ECDIS on ships. Thus, it is to understand to what extent ECDIS is used efficiently and in accordance with the purpose and method of use based on the international standards. It is also be tested whether there is a relationship between the demographic characteristics of the participants and the usage frequency of the ECDIS functions. In order to determine the used and infrequently used ECDIS functions, which are learned in the training and outputs of the audits. Determined 55 ECDIS functions for questionnaire of this study are produced based on the fundamentals of ECDIS trainings, audits and inspections given in the second part. In the third part, the methodology and the questionnaire "Survey of the Usage Frequency on ECDIS Functions" are presented. The result of this survey, demographic data of the participants and preferred/not-preferred to use ECDIS functions are determined and evaluated.

ECDIS Training and Inspections

ECDIS training was carried out on board with a short familiarization training throughout the voyage since 2011. This training was usually given by an officer to the other newly embarked officers. Weintrit (2006) proposed a new model course in operational use of ECDIS, and he has excellent experience and knowledge about ECDIS. However, later on, type-specific training was started to be given by flag states, international inspection organizations and companies in order to reduce the risks of accidents that may arise during navigation due to lack of knowledge (Lušić, et al., 2017) and experience of ECDIS. In accordance with international rules, there are three different ECDIS training models as follows.

Basic ECDIS Training

Due to the necessity of ECDIS training, equipment functions have become standard, and in the same way, all deck officers and ship masters on the duty of 500 gross tonnage (GT) and above should have detailed knowledge and ability to use nautical charts and maritime publications. This training is also called Generic ECDIS training which generally consists of a minimum 5-day training program on basic ECDIS functions and general ECDIS recognition and daily use of ECDIS (IMO Model Course 1.27, 2012). IMO has given the right to revise this period and its content to the maritime administrations.

Type Specific Training

The existence of different ECDIS brands causes different usage diversity and equipment. According to the STCW (Standards of Training Certification and Watchkeeping) convention, species-specific training and certification are required by companies in order to become familiar with basic ECDIS interfaces such as type-specific sensors, backup systems, emergency power supply, and chart update mechanisms. These certificates must be kept by the ship and company. These certificates are easy and short proof in the Port State and Coastal State control. Today, Type-Specific ECDIS training is generally prepared and certified by ECDIS manufacturers or contracted training institutions. It is recommended that the training be carried out for simulation and animation. Persons who have received type-specific ECDIS training by the manufacturer will be familiar with the interface, backup systems, usage functions, manual and automatic chart update method, type-specific route preparation method, use of sensor and alarm information of the ECDIS.

Familiarization Training

ECDIS manufacturers define the basic functions of using ECDIS by ship master and officers. Newly embarked officer receives training from the on board navigational officer on familiarization and practice, with a Familiarization Form required by international safety Management (ISM) to familiarize himself/herself with the use of ECDIS upon embarked (or in more professional companies prior to embarking). Although this training period is very short, it is important for realizing ECDIS capabilities. Ships are regularly and irregularly inspected and controlled in order to meet these required requirements. Today, with the increasing number of ships and types, the conditions sought for a ship to sail have become more stringent and inspections have become more frequent (Bhanawat, 2021).

ECDIS Functions and Features Required in Audits

Audits including ECDIS control are as follows;

- Flag State Inspections; Harmonized Survey System
- Port State Inspections
    - Initial Inspection
    - Detailed Inspection
    - Expended Inspection
    - Concentrated Inspection
- OCIMF / SIRE / CDI Inspections

It has a type approval certificate in ECDIS similar to other equipment on board. The features required in the inspections are the ECDIS usage competencies of the officers and master, as well as the compliance of the system and its content with the type approval certificate and being up-to-date. According to Jones (2000), system approval stages can be carried out by different international standards. The functionality of the system is covered by appropriate tests and procedures. The requirements sought as a result of differences in standards and some deficiencies are solved by interpretation.

Tankers are inspected within the scope of a program prepared every 6 months by Ship Inspection Report program (SIRE) audits. Shipping companies provide the inspection mechanism with major oil companies. The SIRE inspector participates in various controls together with an authorized person on board. These controls are not limited to tanker-specific controls, but also provide control of navigational equipment such as ECDIS and their users. Results from SIRE and CDI (Chemical Distribution Institute) audits are then communicated to oil and chemical companies, charterers, ship owners and operators, and insurance companies. Inspection results certify that charters, ships and operators are in a certain order and comply with the Oil Companies International Marine Forum (OCIMF) requirements and request that deficiencies be identified and corrected.

In ship inspections, a certain plan created by the related party is acted upon. Required features are prepared in a way that can be answered as YES / NO within a plan. Flag states prepare a basic plan that will meet the minimum IMO rules. However, the plans prepared vary from state to state, as flag states will vary. Port States, on the other hand, prepare a plan to meet the "Procedures for Port State Control" determined by IMO. It is aimed to standardize port state controls and inspectors by the requirements of this plan.

In order to know the responsibilities of the ship before the inspection; the required features and questions are in a booklet. This situation increases the responsibility of the ship by knowing the required features in preparation for any inspection. For example; the required features were

asked with questions and answered as in the Questionnaire (VIQ 7) published by OCIMF. The features in the questions and the correct application method of the requirement are included in the answers. Likewise, a similar booklet is used in chemical tanker CDI inspections.

According to Admiralty Maritime Products and Services (2016), the features in the auditing of ECDIS are divided into basic topics as follows;
- Charts and Other Navigational Information
- Procedures and Documentation
- Training

According to the IMO (2017), the features that should be found in the system are:
- Type approved of the system,
- Using up-to-date ENCs,
- Maintaining the system according to existing IHO standards

The competencies expected with the frequently asked questions by the auditors to the Ship Master and Officers are as follows. They are produced by the ECDIS training and audits.
- Creating and adjusting the expedition plan,
- Chart updates and confirmation,
- Symbol information used in ENCs,
- Manual determination of the position,
- Approval of Presentation Library 4.0,
- Turning isolated hazards off and on in shallow waters,
- Usage and display of safety parameters,
- Knowing the difference between the safety contour and the safety depth,
- Setting and controlling alarms according to various areas,
- Setting of safety sector and vector (Look Ahead Sector / Anti Grounding Cone)
- The use of the SCAMIN mode, its application areas where it should be closed and open.
- Knowing the compilation scale of the chart used,
- How the vector view is set and changed,
- Turning Shallow Water Pattern mode off and on,
- Use of Trust Zone Category (CATZOC) or extra data source diagram to ensure safe UKC,
- Providing sensor configuration and ECDIS backup system,
- Using the DR Mode feature,
- Manual corrections such as Parallel Index and No Go Area,
- Safety control of the route prepared for the next voyage and determination of its results,
- Adjusting the Play Back and Track settings.

Participants and Questionnaire

The target participant in this study consists of ship masters and deck officers (including deck cadets). Whilst some of the ECDIS functions are strongly recommended to ensure the sustainability of the system, there are functions which usage rate varies from person to person. Usage functions were evaluated between 1 (I don't use it at all) - 5 (I use it completely) by means of a questionnaire. The data obtained by the survey technique were analysed and interpreted by International Business Machines Corporation Statistical Package for the Social Sciences (IBM SPSS) v.25.0.

The questionnaire form was prepared in Turkish Language by using web-based questionnaire template. Related survey and its results were obtained from same web-based instrument. The questionnaire consisted of four parts. The explanation of this study was summarized in the first

part. Part two consisted of demographic data specific to the participant. The third part consists of ECDIS usage frequency questions according to the fields. In the last part, questions about the frequency of using ECDIS functions were presented.

In this study, the following hypotheses were tested;
H1: Ship masters and officers (including deck cadets) use all functions of ECDIS effectively and efficiently.
H2: The frequency of using ECDIS functions is related to the competencies of navigators.
H3: The frequency of using ECDIS functions is related to the navigators' age.
H4: The frequency of using ECDIS functions is related to the ECDIS manufacturers.

Results and Discussion

The questionnaire forms created on the web were shared in the alumni groups, social media and graduate groups to obtain a large number of participants. Among these target participants, only 83 responses were received. As a result of the reliability analysis performed with IBM SPSS v.25, the Cronbach Alpha (α) value was determined as 0.962 and it was determined that the questionnaire was very reliable.

Demographic Data of Navigators

Table 1 shows the demographic data of the participants. The percentage distribution of participants was as 22% Ship Master, 17% Chief Mate, 18% Second Mate, 17% Third Mate, and 24% Deck Cadets (who completed their long-term sea training). 35% of the navigators were under the age of 24, 28% were between the ages of 25-30, 19% were between the ages of 31-40, 16% were between the ages of 41-50, and 2% were over the age of 51, whilst 2 of them did not reply. According to the ship types, the most of navigators worked on tanker by the rate of 52%. 78% of the navigators worked on the bridge with two ECDIS. The vast majority of them, 44% received ECDIS practice training for a few days, 28% received training for a few hours, 14% for a day and 14% for a week. ECDIS, which is used by the majority of the navigators (78%), works within the Integrated Bridge System (IBS).

ECDIS Usage Frequency by Navigational Areas

The frequency of using ECDIS was asked among 1 to 5 intervals according to four defined areas [open sea, coastal area, narrow channel and strait passage (as restricted navigational area (Pietrzykowski, et al., 2011), port arrival and departure]. Accordingly, the frequency of using ECDIS according to these areas is shown in Table 2.

Whilst the percentage of navigators who preferred "never using" ECDIS functions in the open sea was 2.4%, who preferred "always using" was 50.6%, and that means 50.6% of them definitely used ECDIS in the open seas. Whilst the percentage of "never using" ECDIS functions in narrow channels and strait passages was 4.8%, the percentage of who preferred "always using" was 65.1%. Whilst the percentage of "never using" ECDIS functions in port arrival and departure was 4.8% and the percentage of participants who preferred "always using" was 66.3%. Accordingly, it was determined that more than half (50%) of the navigators always used ECDIS in all ship maneuverer operations.

Table 1. Descriptive statistics of demographic data.

Demographic data		Frequency	%
Age	≤ 24	28	35
	25-30	23	28
	31-40	15	19
	41-50	13	16
	≥ 51	2	2
Competency	Ship Master	18	22
	Chief Mate	14	17
	2nd Mate	15	19
	3rd Mate	14	17
	Cadet	20	25
Ship's type	Bulk carrier	19	24
	Container	12	15
	Tanker (oil, chemical and gas)	42	52
	Passenger	3	4
	Others	5	6
Number of ECDIS on board	1	18	22
	2	63	78
What is the ECDIS familiarization period after your embarkation?	A few hours	23	28
	1 day	11	14
	A few days	36	44
	1 week	11	14
What is the inclusion of (generally used) ECDIS in IBS (Integrated Bridge System)	Yes	62	78
	No	10	12
	I don't know	8	10

Usage Frequency of ECDIS Functions

In the present study, 55 questions were asked in the questionnaire according to the functions of the ECDIS, and the navigators were asked to answer each question on a frequency scale from 1 to 5 as shown in Table 3. In this section, it was determined that all 83 navigators answered all questions. Tables 3 also shows the frequency of all identified ECDIS functions. In addition, the top 5 questions chosen as "never using" and the top 5 questions chosen as "always using" were examined in details.

Table 2. Frequency of using ECDIS according to navigational areas.

What is your frequency of using ECDIS according to the navigational areas?	**1 Never**		**2**		**3**		**4**		**5 Always**		**Total**
	f	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**	
Open sea	2	2.4	3	3.6	20	24.1	16	19.3	42	50.6	83
Coastal area	3	3.6	1	1.2	8	9.6	14	16.9	57	68.7	83
Narrow channel and strait passage	4	4.8	2	2.4	7	8.4	16	19.3	54	65.1	83
Port arrival and departure	4	4.8	3	3.6	6	7.2	15	18.1	55	66.3	83

Table 3. Frequency of Navigators using the Identified ECDIS functions.

No	What is the usage frequency of ECDIS functions?	1 Never		2		3		4		5 Always	
		f	%	f	%	f	%	f	%	f	%
1	AIO (Admiralty Information Overlay)	9	10.8	6	7.2	15	18.1	21	25.3	32	38.6
2	Anti-Grounding Cone / Look Ahead Sector	8	9.6	4	4.8	20	24.1	21	25.3	30	36.1
3	CATZOC (port entry)	8	9.6	7	8.4	12	14.5	20	24.1	36	43.4
4	CATZOC (voyage planning)	6	7.2	0	0.0	8	9.6	14	16.9	55	66.3
5	CATZOC (during voyage)	10	12.0	7	8.4	24	28.9	15	18.1	27	32.5
6	CATZOC (port departure)	9	10.8	3	3.6	15	18.1	22	26.5	34	41.0
7	Pick Report	15	18.1	11	13.3	20	24.1	21	25.3	16	19.3
8	Hover-Over	19	22.9	10	12.0	23	27.7	19	22.9	12	14.5
9	Shallow Patter	5	6.0	2	2.4	12	14.5	17	20.5	47	56.6
10	4 Color Safety Parameter	6	7.2	4	4.8	12	14.5	15	18.1	46	55.4
11	2 Color Safety Parameter	16	19.3	11	13.3	15	18.1	13	15.7	28	33.7
12	Standard Mod Chart	16	19.3	11	13.3	15	18.1	18	21.7	23	27.7
13	RNC (Raster Navigation Chart)	49	59.0	11	13.3	6	7.2	5	6.0	12	14.5
14	ENC (Electronic Navigation Chart)	3	3.6	1	1.2	7	8.4	7	8.4	65	78.3
15	RIO (Radar Information Overlay)	13	15.7	12	14.5	14	16.9	24	28.9	20	24.1
16	SCAMIN (Scale Minimum)	5	6.0	10	12.0	23	27.7	25	30.1	20	24.1
17	User Map	5	6.0	6	7.2	12	14.5	15	18.1	45	54.2
18	Route Check (Results)	5	6.0	4	4.8	11	13.3	15	18.1	48	57.8
19	Wheel over Position	4	4.8	9	10.8	18	21.7	16	19.3	36	43.4
20	Position Verification	5	6.0	5	6.0	12	14.5	25	30.1	36	43.4
21	LOP (Line of Position)	5	6.0	6	7.2	12	14.5	25	30.1	35	42.2
22	Log Book	8	9.6	7	8.4	8	9.6	18	21.7	42	50.6
23	User Marking	3	3.6	4	4.8	15	18.1	22	26.5	39	47.0
24	Highlight	2	2.4	8	9.6	19	22.9	21	25.3	33	39.8
25	Change in Display Settings	3	3.6	6	7.2	18	21.7	25	30.1	31	37.3
26	Passage Planning by Route Planning	4	4.8	4	4.8	11	13.3	17	20.5	47	56.6
27	Table Editor	6	7.2	9	10.8	19	22.9	22	26.5	27	32.5
28	Graphic Editor	7	8.4	10	12.0	16	19.3	24	28.9	26	31.3
29	Voyage Planning by Computer Programing	20	24.1	7	8.4	20	24.1	11	13.3	25	30.1
30	Own Ship Information	4	4.8	7	8.4	11	13.3	21	25.3	40	48.2
31	Datum Changing	16	19.3	14	16.9	21	25.3	14	16.9	18	21.7
32	Multi Window Feature	21	25.3	18	21.7	10	12.0	19	22.9	15	18.1

33	**Past Track, Past Lines and Vector Changes**	7	8.4	4	4.8	15	18.1	21	25.3	36	43.4
34	**Anchor Watch Mode**	1	1.2	1	1.2	12	14.5	18	21.7	51	61.4
35	**Parallel Index**	7	8.4	6	7.2	16	19.3	21	25.3	33	39.8
36	**Alternative Route Planning**	7	8.4	3	3.6	20	24.1	22	26.5	31	37.3
37	**Alternative Route Usage**	9	10.8	7	8.4	25	30.1	17	20.5	25	30.1
38	**Magnetic Variation Symbol**	5	6.0	9	10.8	15	18.1	23	27.7	31	37.3
39	**Time Change**	7	8.4	4	4.8	22	26.5	19	22.9	31	37.3
40	**Using different mode from North Up**	20	24.1	13	15.7	17	20.5	18	21.7	15	18.1
41	**Way Point Track Mode**	14	16.9	10	12.0	18	21.7	21	25.3	20	24.1
42	**CCRP (Consistent Common Reference Point) Correction**	16	19.3	14	16.9	15	18.1	20	24.1	18	21.7
43	**Playback Features**	11	13.3	22	26.5	22	26.5	17	20.5	11	13.3
44	**Screenshot Features**	12	14.5	23	27.7	21	25.3	14	16,9	13	15.7
45	**Printing any Information in ECDIS**	18	21.7	20	24.1	16	19.3	14	16.9	15	18.1
46	**File Manager**	11	13.3	16	19.3	15	18.1	19	22.9	22	26.5
47	**Date Dependent View**	15	18.1	12	14.5	15	18.1	19	22.9	22	26.5
48	**IHO Test**	15	18.1	12	14.5	23	27.7	15	18.1	18	21.7
49	**AIS/TT**	6	7.2	2	2.4	11	13.3	17	20.5	47	56.6
50	**CPA and TCPA for AIS/TT Information**	4	4.8	1	1.2	7	8.4	20	24.1	51	61.4
51	**Port list**	9	10.8	12	14.5	17	20.5	17	20.5	28	33.7
52	**Same Route and Expedition Plan Registered in ECDIS**	4	4.8	9	10.8	13	15.7	17	20.5	40	48.2
53	**Distance Measurement Panel**	4	4.8	5	6.0	11	13.3	26	31.3	37	44.6
54	**Operating Time Information**	13	15.7	10	12.0	21	25.3	17	20.5	22	26.5
55	**ECDIS Alarm Information and Color Combinations to Alarm**	2	2.4	2	2.4	10	12.0	25	30.1	44	53.0

According to Table 3, the percentage of participants who preferred “never using” the RNC (Raster Navigation Chart) feature was 59%, whilst the percentage of who preferred “always using” was 14.5%. The highest frequency question belonging to the usage of ENC (Electronic Navigation Chart) feature by 78.3% of navigators who preferred “always using”, whilst 3.6% of them preferred “never using”.

According to the first five questions that the navigators preferred “never using” to ECDIS functions in the survey were; (8) Hover-Over by 22.9%, (13) RNC (Raster Navigation Chart) by 59.0%, (29) Voyage Planning by Computer Programing by 24.10%, (32) Multi Window feature by 25,3%, (40) using different mode from North Up by 24.1%.

Based on the first five questions in which the navigators preferred the highest “always” option out of 55 functions: (4) CATZOC feature in voyage planning was 66.3%, (14) using ENC

feature was 78,3%, (18) Route Check (result) feature was 57.8%, (34) Anchor Watch Mod feature was 61.4%, (50) AIS/TT information feature for CPA and TCPA was 61.4%.

Correlation Analysis

According to correlation analysis, a significant relation was determined between the usage frequency of ECDIS and navigators' age, competencies and the type of ship. The results given in Table 4 show that the correlation between the usage frequency of ECDIS and navigators' age in function 37 was weak and positive (r = 0.28), similarly it was weak and positive (r = 0.24) for the competency. There was negative and weak correlation for the function 38 determined for the competency (r = 0.33) and for the age (r = 0.33).

Table 4. Significant correlated ECDIS functions.

No	Functions	Competency	Age	Significance
37	Way Point Track Mode	0,27872447	0,236916	$p < .000$
38	CCRP Correction	-0,3302217	-0,33244	

Usage Frequency of ECDIS Manufacturers

According to this study, ECDIS manufacturers frequently used in Turkish commercial vessels were; Furuno (28.92%), JRC (26.51%), Transas (12.05), Simrad (7.23), Kelvin Hughes (3.661), and Danelec (2.41%). In Table 5, the frequency and percentage of navigators were shown based on these manufacturers.

Table 5. Usage Frequency of Navigators by ECDIS Manufacturer.

Manufacturer	Frequency	%
Danelec	2	2.41
Furuno	24	28.92
JRC	22	26.51
Kelvin Hughes	3	3.61
Maris	2	2.41
Sam Electronics	3	3.61
Simrad	6	7.23
Transas	10	12.05
Wartsila	2	2.41
WECDIS	2	2.41
Not replied	7	8.43
Total	83	100.00

When the average of usage frequency was determined by the navigators according to voyage operation areas based on the manufacturers, it was determined that the lowest usage frequency was Furuno with an average of 3.82. It was also interesting to see that the Furuno manufacturer was also the most used ECDIS brand by the navigators (28.92%). The second smallest usage frequency was belonging to Transas with an average of 3.91, and the average of the usage frequency of manufacturers stated to be used by all navigators was above 4 in 5.

Conclusion

ECDIS is indispensable for the professional development and safety of ship masters and officers. ECDIS is very important for ship navigation whether it is suitable for its purpose and whether all functions are used. However, an efficient training and implementation process is required for the effective usage of ECDIS. It is evident from the lack of usage of many

features/functions that most of the training is usually on board. Before the correlation analysis, it was assumed that there were high and positive correlations between usage frequency of ECDIS functions and navigators' age, competency. However, there was a weak and positive correlation with the age of navigators. Because experienced officers did not increase the use frequency of ECDIS with their experience and made a weak addition to their primary training. A weak and positive correlation was determined regarding whether the usage frequency of ECDIS increased as the navigators' competency increased. This revealed that when the competency increased, the learning of new features/functions decreased. That means navigators added a little knowledge to ECDIS functions after they learned from experience and/or increased competency.

According to this study, the five highest frequencies by using ECDIS functions are determined as; in the voyage planning, AIS/TT information for CATZOC, ENC, Route Check result control, Anchor Watch Mode, CPA and TCPA. These functions are generally known to all navigators as common knowledge. On the other hand, the five least used ECDIS functions are; different modes than Hover-Over, RNC, voyage planning by a computer program, Multi Window feature, North Up. Because some of these functions are not available in all ECDIS software and some do not need to be used frequently. According to the survey, ECDIS is always used more than 50% of the time in the open sea, coastal area, narrow channel and strait passage and port arrival and departures in terms of the voyage operation areas.

In summary;
- H1 hypothesis (Ship masters and officers (including deck cadets) use all functions of ECDIS effectively and efficiently) is rejected. Accordingly, it was determined that navigators did not use all the functions of ECDIS effectively and efficiently.
- H2 hypothesis (The frequency of using ECDIS functions is related to the competencies of navigators) is accepted.
- H3 hypothesis (The frequency of using ECDIS functions is related to the navigators' age) is accepted.
- H4 hypothesis (The frequency of using ECDIS functions is related to the ECDIS manufacturers) is accepted.

Investigation on the effectiveness of more/less frequently used ECDIS functions on groundings is encouraged in further studies which is the aim of authors as a next step in future.

Ethical approval
No ethical approval needed for this study.

Informed consent
Not available.

Data availability statement
The authors declare that data are available from authors upon reasonable request.

Conflicts of interest
There is no conflict of interests for publishing this study.

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Contribution of authors

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