

# COMPARISON OF DEVELOPED IN “EFFICIENSEA2” PROJECT PLATFORM “BALTICWEB” WITH STANDARD ECDIS

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## ABSTRACT

The paper examines the definition and concept of Electronic navigation (e-navigation), Electronic Chart Systems (ECS) and Electronic Chart and Display Information System (ECDIS). In paper are provided compare of positive and negative aspects for alternative e-navigation platform “BalticWeb”, developed in “EfficienSea2” project with certified, internationally approved and accepted Electronic Chart Display and Information System (ECDIS) using on the STCW based criteria about electronic chart system. In addition, the paper represent new evaluation algorithms’ testing methods created in Latvian Maritime Academy as part of “EfficienSea2” project. Paper is intended to familiarize wide range of specialists with positive and negative sides for last developed ECDIS, ECS and e-navigation systems and demonstrate subsequent possible ways of development for those systems. The discussion is about a good practice of exploratory testing and cooperation between higher education institutions and research institutions in developing, testing and implementing new digital devices that will be needed by the employer. As a result, the student got new knowledge and as the future worker has participated in the development of future work tools, expressing an opinion on their added value in practice.

## KEYWORDS

ECDIS, e-Navigation, EfficienSea, BalticWeb, Exploratory Testing, IT Knowledge

## 1. INTRODUCTION

E - Navigation trends are developing fast enough today. This is due to the advancement of technology and the ability to provide faster data transmission, or the availability and quality of the internet on the ships. This direction improved with every moment. The e-navigation concept, as one of the basic ideas, is to create a linked system, with unified data access to users and, as soon as possible, to retrieve instant information in the system. Establishing such a unified system with a well-designed interface that enables the operator (navigational officer) to filter the information provided so that there are no inconsistencies due to the amount of excessive information that could potentially reduce the human factor impact on collisions, grounding etc. Within the framework of this research, the author had the opportunity to work with the European-supported project “EfficienSea2” e-navigation platform “BalticWeb” and the previously created platform “ArcticWeb”.

During the research, it became clear, that these two platforms were not evaluated on a single scale, taking into account the functions and capabilities provided by the platforms. Therefore the authors decided to carry out a practical part study with a system analysis only for the platform “BalticWeb”, but to give the respondents the opportunity get acquainted with the platform “ArcticWeb” and its functions. Involving students of Latvian Maritime Academy in research process enables the development of collaborative learning methods and gives students the opportunity to express their views on future technology devices in their professional careers after completing their studies.

## 2. DEFINITIONS

Electronic Chart and Display Information System (ECDIS) is a computerized navigational system meeting the requirements of the International Maritime Organization that can be applied as an alternative to paper navigational charts. Obtaining information on-line, it continuously updates ship's position in respect of the coastline, conspicuous objects, navigational marks and invisible objects (IMO, 2012), (IECP, 2008). An ECDIS that does not comply or follow the relevant performance standards is classed as an Electronic Chart System (ECS).

Electronic Chart System (ECS) – This system is not certified as a 'type approved' ECDIS and does not meet or comply with IMO/SOLAS performance standards. The ECS may allow the use of Electronic Navigational Charts (ENC) and Raster Navigational Charts (RNC) with comparable functionality to a 'type approved' ECDIS, but should not be solely relied upon for navigation as the system is not tested nor certified.

E-navigation is defined as "the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment." (IMO, 2009).

The e-navigation not only as physical installation, nor merely as provision of a service but as a strategic framework for the development of current and future technological infrastructure on board and ashore. Thus, the term "e-navigation" currently includes systems and services, but the e-navigation user requirements have evolved and it is intended that the term also include an increased focus on more material elements. It should be noted that in the absence of e-navigation, systems and equipment diversity would continue to evolve provided with various degrees effectiveness. E-navigation development and elaboration is a way to optimize this development and to ensure attention to the further development of a holistic approach to safe navigation (IMO, 2009).

Exploratory testing - An approach to software testing that is concisely described as simultaneous learning, test design and test execution. Cem Kaner, who coined the term in 1984, defines exploratory testing as "a style of software testing that emphasizes the personal freedom and responsibility of the individual tester to continually optimize the quality of his/her work by treating test-related learning, test design, test execution, and test result interpretation as mutually supportive activities that run in parallel throughout the project" (Kaner, 1988).

### 2.1 "BalticWeb" Platform

The developed platform, called "BalticWeb" at this moment exist in Beta version (shown on Figure 1), was introduced in the project "EfficienSea2". It looks and works like conventional Electronic Charts Display and Information System (ECDIS), but not all ECDIS functions are implemented, as system is going to be a maritime map-centric portal. The site will aggregate relevant maritime data and information:

- Notices to Mariners and Navigational Warnings;
- Sea Traffic - Live Vessel position and information (AIS);
- No-Go area service. (The service is fully operational but the UI is being changed and improved);
- Satellite imagery service from NASA;
- Nautical Charts from Sjöfartsverket and Geodatastyrelsen;
- Simulated Route planning, optimization and exchange service;
- OpenSeaMap.org overlay.
- It is advisable to keep all the given values.

For a closer look on the "BalticWeb" functionality, data and display please follow below link: <https://balticweb.e-navigation.net/> (see Figure 1).



Figure 1. "BalticWeb"

## 2.2 Development of Testing Algorithm

Because of adopting at 2012 requirements for ECDIS mandatory use at certain types of vessels, IMO guidelines aimed at facilitating the transition from paper charts to Electronic Chart Systems was developed as for shipping companies, as well as for vessel's command. It is called "Transitioning from paper chart to ECDIS navigation. Usage of ECDIS as the primary means for navigation, in general, is different process, comparing with using paper charts. Important on-bridge work processes have changed especially route and route planning control. These processes need special attention." (IHO, 2010). The electronic chart system evaluation algorithm is based on the use of the STCW Convention, the 2010 Manila amendments, which describe requirements for seafarers in respect of ECDIS education use. The amendments cover full range of possible actions, which must be able to carry out ECDIS operator (IMO, 2010). Requirements for training of seafarers were revised for generating electronic chart system's evaluation criteria. Evaluation criteria summarize individual chapters in relation to their application. Rating scale is designed individually, so that it can be universally applied to all evaluation criteria and for calculating total mark. To test usefulness of the evaluation, algorithm was used to compare the "BalticWeb" e-navigation systems, ECDIS systems "Navi-Sailor 4000" and ECS systems "NaviFisher" and "iSailor".

The aim was to develop a universal evaluation algorithm, which may be used for evaluation of any electronic chart systems and examine this algorithm's effectiveness during testing of various Electronic Chart Systems. The testing being done on the basis of developed evaluation algorithm, it is compile structured set of tasks to be met by using an Electronic Chart Systems. In order to maximize objectivity and accuracy of results, in addition to officially approved by IMO and IHO ECDIS, were evaluated "Navi-Fisher" and "iSailor" systems. They were selected to examine the evaluation algorithm as for certified systems as well as for non-certified or partly certified systems, it is necessary to clarify the evaluation algorithm usefulness.

## 2.3 Background of Exploratory Testing

All exploratory testing based on knowledge, but some of this knowledge is gained during the testing. Other knowledge is already in the tester's possession. Other differences across exploratory testers are "styles" of exploration – 1) Subject matter experts who come up with scenarios that rely heavily on use of product and 2) Technique experts who know certain techniques and look for situations to use them in (Tinkham, Kaner, 2003). J. Lyndsay says that most commercial testers make use of unscripted techniques. Their unscripted approaches are most often undisciplined, and hidden from individuals outside the immediate team. He has also found that an individual tester typically makes use of a single style of unscripted testing, or focuses on a single type of target. This second characteristic can potentially be addressed with explicit exposure to a wider range of exploratory techniques (Lyndsay, 2006). G.M. Weinberg describes some abstract machines and makes observations, some based on stimulus. The observations are analysed, and a hypothesis reached and tested (Weinberg, 2001).

### 3. OBJECTIVE OF THE RESEARCH

The goal of the research was to compare the alternate e-navigation platform "BalticWeb" with a certified, internationally approved and accepted Electronic Chart Display and Information System (ECDIS) using an algorithm for the evaluation of the electric chart system developed on the basis of the STCW, developed in the Latvian Maritime Academy. For testing purposes was created two focus groups consisting of 12 persons. In groups were included students of Latvian Maritime academy as well as Captains with work experience more than ten years. For every person was issued the same scoring algorithm. During development procedure of algorithm was gathered data from 2010 Manila amendments for the STCW Convention: requirements of the training of seafarers working with Electronic Chart Systems. Data was processed to obtain full list of requirements for electronic chart functions and features. Requirements were used to draw up the criteria for the evaluation algorithm.

#### 3.1 Research Description

The work was completed in 4 stages, which took place at the Latvian Maritime Academy in navigational stimulator laboratory premises. Respondents were given two copies of the assessment criteria, a task sheet and a questionnaire, on the e-navigation platform.

##### 3.1.1 The 1st Stage - Analysis Of The Platform "BalticWeb"

During the first stage of the work, respondents were divided up into navigational stimulator booths and using laptops, 50 minutes were considered for all the functions offered in the "BalticWeb" platform and subsequently according to the evaluation criteria, evaluation of the offered functions and full analysis of the platform. The author did not introduce respondents to the alternative e-navigation platform interface, so that it would be possible to evaluate the complexity of the platform (see Figure 2).



Figure 2. Respondents are testing the "BalticWeb" platform

##### 3.1.2 The 2nd Stage - Identical Evaluation Algorithm

In the second stage, respondents were assigned by navigational stimulator booths and were given the task of analyzing the available features and capabilities of the ECDIS Navi Sailor 4000 system using an identical evaluation algorithm that was used in the first part of the practical part. For this task, respondents were given 30 minutes.

### 3.1.3 The 3rd Stage - Analysis of the ECDIS Navi Sailor 4000 System

In the third stage, respondents were given the task of setting up a small passage plan with four waypoints on the ECDIS Navi Sailor 4000 system and using the "EfficienSea2" platform "BalticWeb" as an additional program. In response to this exercise, respondents assessed whether this platform could be an additional navigation tool that could be used together with the ECDIS system while navigating in the region. After completing this part, respondents looked at the features and capabilities offered by ArticWeb.

### 3.1.4 The 4th Stage - Analysis of the Platform "ArcticWeb"

As part of the fourth part of the work, was filling in a questionnaire on the operation of the "EfficienSea2" "BalticWeb" platform. For evaluation to be as objective as possible, whether the e-navigation platform to be tested meets the standard requirements, the evaluation criteria are divided into 13 chapters covering a specific function: (1) Risks of disinformation; (2) Detection of misrepresentation of information; (3) System performance and accuracy, access to primary information source; (4) Setting up and maintaining display; (5) Operational use of electronic charts; (6) Route Planning; (7) Route Monitoring; (8) Alarm indicators; (9) Manual correction of a ship's position and motion parameters; (10) Ship's electronic log; (11) Chart updating; (12) Operational use of electronic navigational systems where radar/ARPA is connected; (13) Operational use of electronic navigational systems where AIS is Connected.

There were 5 marks on the rating scale:

- Implemented (I) – Described task/option is implemented and is fully operational and independent from other options; (4 points)
- Defective (D) -Described task/option is implemented but is not available under certain circumstances; (3 points)
- Restricted (R) – Described task/option is implemented, but restricted in access or dependent on other functions; (2 points)
- Not Reliable (NR) – Described task/option is implemented, but is limited in functionality or is inaccurate; (1 points)
- Not Implemented (NI) – Described task/option is not implemented; (0 points).

Grades can be applicable to all criteria. In order to facilitate the progress of system's evaluation, each mark has been granted number of points and, after each criterion checking, for each function was calculated definitive number of points. The maximum points score for all marks is 508 points, which means 100% of the system compliance with the criteria. All criteria are equivalent; scoring algorithm does not provide preferences for concrete function. At the end of the evaluation is given to mark the entire system. Scoring algorithm is used to compose the tasks list and evaluate the electronic chart system after receiving results of testing. The objectives were drawn up so that the test should considering all criteria.

## 3.2 Results of the Study

The first "EfficienSea2" platform "BalticWeb" was evaluated according to the developed algorithm. As respondents worked for the first time with this platform, they were given 50 minutes. The compiled criteria were not translated into Latvian so that there would be no incompatibilities when translating professional terminology. Summing up the results, the "BalticWeb" platform got an average of 21.8%, against the 100% algorithm used for evaluation criteria. The responses provided by respondents were different, with percentage rates varying from 14.8% to 25.2%. The average percentage score of 21.8% is obtained by adding the final score of all 12 respondents and pulling out the average number (see Table 1).

Table 1. Comparison of “BalticWeb” with the evaluation algorithm. The result in percentage

Respondents	Percentage
1	14,8%
2	16,2%
3	22,8%
4	22,0%
5	21,1%
6	21,9 %
7	23%
8	24%
9	25%
10	25,1%
11	25,2%
12	21,0%

These final ratings were obtained by adding up all the results from each of the 13 chapters. On the chart number 2, the percentage of the average results from each respondent's answers is compiled by each chapter. Accordingly, it will be able to judge which department has received the most negative / most positive assessment (see Chart 1).

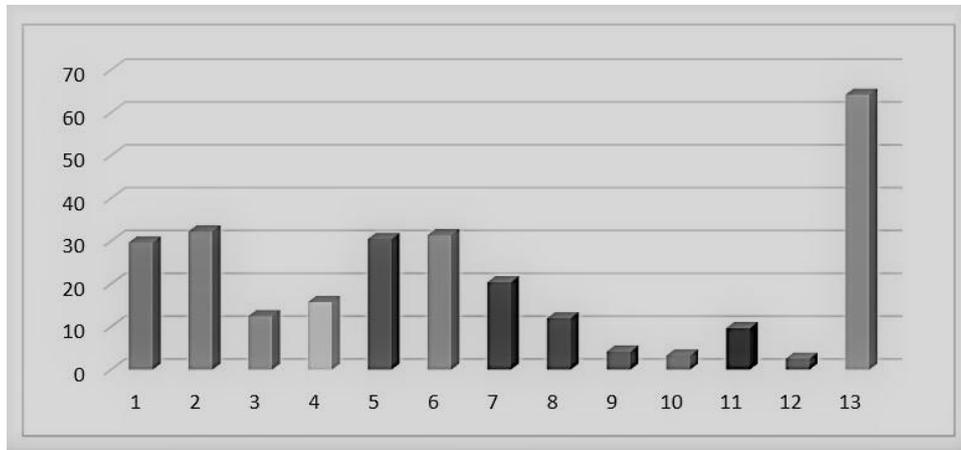


Chart 1. Average rating of “BalticWeb” Chapters

As can be seen from Chart 1, the lowest ratings in the “BalticWeb” platform have been received from Chapter 9 - Vessel position monitoring and correction, Chapter 10 - Vessel logbook and Chapter 12 - Operational use of electronic maps in total RLS / ARPA. Compares all 13 chapters in total, with the maximum possible score that could be obtained, it can be concluded that Chapter 13 - Operative use of electronic charts with attached AIS is the only one department that has received more than 50 percent.

In the second stage, the ECDIS Navi Sailor 4000 system was tested. The features and capabilities of this system are well known to respondents, since all of them are ECDIS certified users. Respondents were given the task of using an identical evaluation algorithm as it was used in examining the “BalticWeb” platform. As with this system, all respondents had worked, then 30 minutes were spent on doing this work. Summing up all the results, ECDIS "Navi-Sailor 4000" won 89.5% on average, against the 100% benchmark algorithm used.

The responses provided by respondents were different, with percentage variables ranging from 83.8% to 92.3% (see Table 2).

Table 2. Comparison of ECDIS with the evaluation algorithm. The result in percentage

Respondents	Percentage
1	86,8%
2	86,0%
3	83,8%
4	91,0%
5	90,9%
6	91,3%
7	92,3%
8	90,5%
9	89,9%
10	89,7%
11	89,6%
12	92,0%

As can be seen from results, all chapters are estimated relatively equally, with the lowest rating of 84.8%, which was received by Chapter 12 - Operational use of electronic maps in total RLS / ARPA (if added) and with the highest result for Chapter 9 - Control and correction of the position of the vessel. When evaluating all results, it is logical that the results of all chapters are about 90% because ECDIS "Navi Sailor 4000" is an IMO approved electronic chart display and information system.

In the third phase of the practical work, it was planned that respondents would be given the task of creating passage plan in Danish strait on the ECDIS system and using the "BalticWeb" platform in addition. Initially, each respondent set up the passage plan individually for the navigator bridge simulator. Later the installation of the "BalticWeb" platform on one of the monitors in the navigation simulator was created. In the third part of the practical work, it was possible to make passage using directly in parallel with the ECDIS system and the "BalticWeb" platform. When one of the respondents set up a passage plan, each respondent was given the opportunity to use the ECDIS system with the "BalticWeb" platform and create an identical passage as it was done with the ECDIS system only. Thus, the respondent was able to compare two types of workplaces.

In the fourth phase of practical work, respondents were provided with questionnaires for evaluating the "BalticWeb" platform. The results of the survey are summarized in diagrams. After completing the third part, respondents were given an opportunity to be acquainted with the features and capabilities of the "ArcticWeb" platform. Such a subtle study was not conducted for the analysis of this program, since the possibilities and functions offered by the ECDIS Navi Sailor 4000 are not in the same ranking criteria table. Respondents acknowledged that the "ArcticWeb" platform had a well-developed and functional ice and meteorological report that would significantly help navigate the Arctic regions. Otherwise, the "ArcticWeb" platform cannot be a complement to the ECDIS system.

Summarizing the results of the evaluation algorithms performed by respondents, where the "BalticWeb" platform was compared with the ECDIS system, it is evident that this new platform needs many improvements. Compared to "ArcticWeb", based on the "BalticWeb" platform, the latter has far more advanced improvements. The options that are responsible for marking the "No-Go" region, where 66% of respondents rated this option as highly efficient, 17% needed improvements and 17% that this feature does not help, are of high quality. As the next option, portraying navigation alerts and notices to seamen, 34% of respondents said that this option worked great, but 66% rated that a well-functioning option, but where minor improvements were needed and an option with an identical score, where 66% of respondents rated it as good, requiring minor improvements, and 34% said that this option works great as the AIS function for obtaining information on other ships. From this, it can be estimated that the "BalticWeb" platform is a potential auxiliary program for the ECDIS system in the Baltic region, as 66% of the respondents assessed that this platform could be an additional program for the ECDIS system only after improvements.

According to diagrams „Navi-Sailor" system meets compiled criteria up to 90.3%, „Navi-Fisher" comply with 86.9%, „iSailor" comply with the to 48.9% and BalticWeb corresponds to 59.4%. „NaviSailor" and „Navi-Fisher" Electronic Chart Systems have been already certified for large vessels by IMO and IHO, thereafter gained more points during the examination. But the system "iSailor", used for yacht and small boats navigation scored significantly fewer testing points, when newly developed, and at this moment not officially certified, BalticWeb system. Whereas certified systems have shown better results, we can be

conclude that evaluation algorithm shows the difference between Electronic Chart Systems with various level of functioning. So algorithm is useful and can be used to estimate the electronic chart system. Developed evaluation algorithm is not intended for resolving opportunity of certification for tested electronic chart system, it can be applied only for evaluating of examined systems' functional level.

#### **4. CONCLUSION**

The "BalticWeb" platform, after several improvements in the system, could be accepted as a future e-navigation program, which would complement the Electronic Chart Display and Information System for the Baltic Sea Region only. According to the results of the evaluation algorithm it is observed that the "BalticWeb" platform has potential as a supplement to the ECDIS system in the Baltic Sea. Potentially, the "BalticWeb" can become an additional program for the ECDIS system, due to the user interface that is easy to see and easy to use. There is no need to install specialized navigational technical equipment hardware, you need a computer or tablet computer with secure Internet access.

Involving students in the project as testers gives them an educational effect in mastering the course for ship navigators. The four-level testing with the final questionnaire is in line with the above-mentioned researcher scenarios for system testing. Collaboration during testing with experienced masters who practice different types of navigation maps extends the student's vision and provides insight into future work environments where it will be possible to work with different types of navigational charts.

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