Implementation of Ecdis In Navigation In Traffic Separation Schemes (Tss): A Case Study On The Mv. Ocean Sukses

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Abstract.
The increasing density of shipping traffic in the Traffic Separation Scheme (TSS) requires the use of navigation technology that can improve shipping safety and efficiency. The Electronic Chart Display and Information System (ECDIS) is an electronic navigation system that plays an important role in supporting real-time shipping planning and monitoring. This study aims to analyze the application of ECDIS, evaluate the understanding of the officers regarding its use, and assess the effectiveness of ECDIS in improving navigation safety in the TSS on the MV. Ocean Sukses. The study used a qualitative descriptive approach. The study population was all officers involved in ship navigation, while the research sample consisted of the captain, Chief Officer, Second Officer, and Third Officer who were selected purposively. The research instruments included interview guidelines, observation sheets, and documentation. Data were collected through observation, interviews, and documentation, then analyzed using the Miles and Huberman model through data reduction, data presentation, and conclusion drawing. The results showed that ECDIS was used optimally in route planning, ship position monitoring, safety alarm settings, and integration with AIS and radar during shipping in the TSS. In addition, most officers had a good understanding of the ECDIS features. The research conclusion shows that the implementation of ECDIS effectively improves navigation safety, situational awareness, and decision-making quality, although its effectiveness remains dependent on user competence and regular system updates.

Keywords: *Electronic Chart Display and Information System, Maritime Navigation, Navigational Safety, Traffic Separation Scheme, Vessel Traffic Management.*

I. INTRODUCTION

The maritime industry plays a crucial role in global trade, as more than 80% of global goods are distributed by sea. Increasing shipping activity and increasing ship traffic demand the use of modern navigation technologies that improve operational safety and efficiency. One such technology is the Electronic Chart Display and Information System (ECDIS), which has become the international standard for supporting shipping planning and monitoring (Hermawan *et al* ., 2020; Jang *et al* ., 2023).

The role of ECDIS becomes increasingly important when ships navigate Traffic Separation Schemes (TSS), shipping lanes with high traffic density. Despite the continued advancement of navigation technology, maritime accidents caused by human

error still frequently occur, primarily due to crews' lack of understanding of how to optimally operate ECDIS (Cao-Feijóo *et al* ., 2024; Vojković *et al* ., 2024).

Various studies have shown that ECDIS can improve navigation safety through more accurate route planning, real-time navigation information presentation, and support for decision-making on the ship's bridge. Furthermore, the integration of ECDIS with e-navigation concepts is considered to improve ship operational effectiveness if supported by adequate user competency (Jang *et al* ., 2023; Palma *et al* ., 2023).

However, previous research also shows that the success of ECDIS is determined not only by the system's sophistication but also by the user's ability to understand and operate it. Errors in alarm settings, electronic chart updates, and interpretation of navigation information are still contributing factors to maritime accidents (Ibáñez & Abiega, 2023; Vu *et al* ., 2024).

Most previous research has focused on the technical aspects and development of ECDIS systems, while studies on their application in real-life operational conditions, particularly when ships cross TSS, are limited. Therefore, research is needed to examine the relationship between pilots' understanding, ECDIS implementation, and their effectiveness in preventing collisions during navigation (Ponomaryova, 2024; Li *et al* ., 2024).

Based on these conditions, this study aims to analyze the application of ECDIS in navigation activities on the MV. Ocean Sukses, evaluate the understanding of the pilots in its use, and assess the effectiveness of ECDIS as a means of avoiding the risk of collision when crossing the TSS. This study is expected to contribute to improving shipping safety and the development of navigation training based on modern technology.

II. METHODS

This study uses a qualitative descriptive approach to deeply understand the application of the Electronic Chart Display and Information System (ECDIS) in ship navigation activities when crossing Traffic Separation Schemes (TSS). This approach was chosen because it allows researchers to examine phenomena naturally based on real conditions in the field through observation, interviews, and documentation, thus obtaining a comprehensive picture of the alignment between theory and practice of navigation on board ships.

The research was conducted during the researcher's sea practice (Prala) period on the MV. Ocean Sukses from September 5, 2024, to June 17, 2025. Data collection was conducted during the implementation of watch duty on the ship's bridge, especially during navigation activities involving the use of ECDIS.

The research data consists of primary and secondary data. Primary data was obtained directly through interviews with the captain, second officer, and officer on watch (OOW) involved in ECDIS operations. Meanwhile, secondary data was obtained

from books, scientific journals, company documents, maritime regulations, and previous research relevant to the research topic.

Data collection techniques included interviews, observation, and documentation. Interviews were used to obtain information regarding the crew's understanding and experience in operating ECDIS. Direct observations were made of navigation activities and ECDIS use during the voyage. Documentation was used to collect supporting data in the form of photographs, field notes, navigation documents, and activity recordings related to the research object.

The research informants consisted of the captain as the key informant, the second officer as the primary informant, and the officer on watch (OOW) as the supporting informant. The informants were selected based on their direct involvement in the operation and supervision of the ECDIS system during the voyage.

Data analysis was conducted qualitatively, referring to the Miles and Huberman model, which includes data reduction, data presentation, and conclusion drawing and verification. Data reduction was carried out by selecting and simplifying information relevant to the research focus. Furthermore, the data was presented systematically in narrative form for easy understanding and analysis. The final stage was conclusion drawing and verification to ensure the validity of the research findings in answering the problem formulation regarding the implementation, understanding, and effectiveness of ECDIS use in supporting navigational safety when crossing TSS.

III. RESULTS AND DISCUSSION

Data Presentation

1. Observation

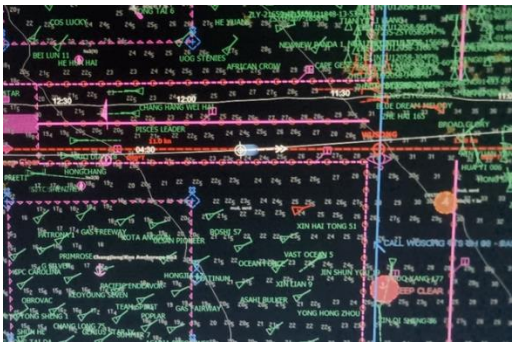


Fig. 1 Route Display on ECDIS

Observations showed that the officer on duty always planned the route using ECDIS before the ship entered the TSS area. The designed route complied with the TSS corridor according to IMO regulations and took into account factors such as ocean currents, weather conditions, and the movement of other vessels in the area. The plan was carefully prepared and approved by the captain before departure. This demonstrates effective cooperation between the crew and the implementation of navigation procedures that adhere to international standards.

Fig. 2 ECDIS supervision by the Duty Officer

During the voyage in the TSS area, the officer on watch consistently monitors the vessel's position through the ECDIS display by utilizing various important features, such as AIS overlay to identify other vessels in the vicinity, warning alarms when the vessel approaches the TSS lane limit, as well as weather and sea depth information layers that help avoid risky areas.

During the observation, no violations of the TSS lane boundaries were observed, and all maneuvers were executed safely and according to procedure. This indicates that the ECDIS was being utilized optimally as the primary navigation aid.

Fig. 3 Ecdis Features

During the observation on MV. Ocean Sukses, the author noted that the watch officer not only used ECDIS to plan the route and monitor the position, but also utilized various advanced features such as Safety Contour/Depth settings, functions, Route Checking, as well as AIS and radar overlay integration, which demonstrated a high level of mastery and capability in using ECDIS.

The active use of these features demonstrates that the officer on watch is striving to maximize technology to improve safety and efficiency, while also emphasizing the importance of ECDIS as an integral part of modern navigation on board the MV. Ocean Sukses.

2. Interview

Fig. 4 Interview with an officer

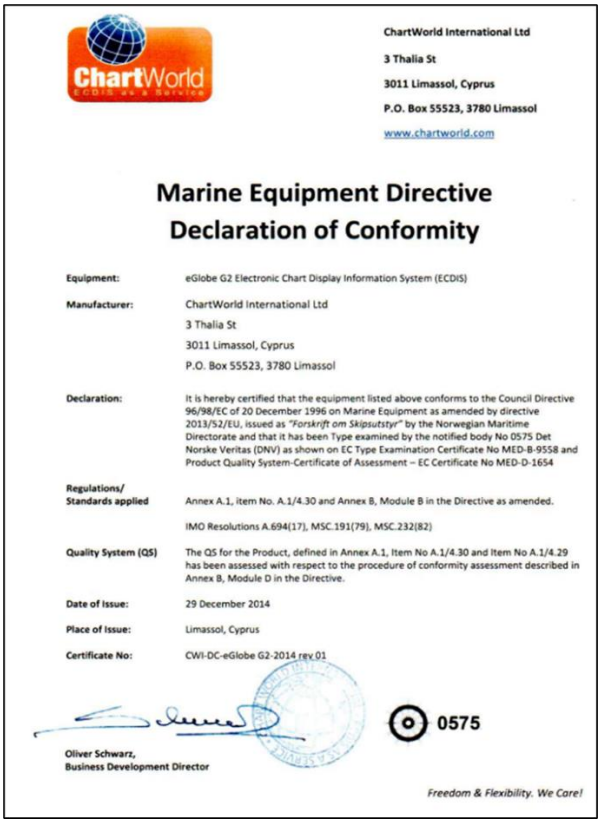
In this study, the author interviewed several watch officers on the MV. Ocean Sukses, including the First and Second Officers, to determine their level of understanding regarding the use of ECDIS in navigation on the TSS.

Table 1 Interview with officers

No.	Position	Question	Conclusion
1.	Chief Officer	According to the Chief, how important is ECDIS in supporting navigation in TSS, how does the chief involve Ecdis in navigating the shipping lane?	Three perspectives show that ECDIS is crucial for navigation in TSS because it provides fast, accurate, and real-time track information. The Chief Officer emphasized routes, safety alarms, and AIS and radar integration to avoid collisions; the Second Officer highlighted effectiveness in creating routes according to traffic lanes, safety contours, and time and fuel efficiency; while the Third Officer emphasized electronic chart updates, position monitoring, and cross-checking with radar and AIS. In conclusion, ECDIS is a key tool for maintaining safety and efficiency.
2.	Second Officer	Answer I believe ECDIS is crucial for navigation in the TSS. It's much faster, more accurate, and more real-time than traditional paper charts. I use ECDIS this way: create a route based on the TSS, set safety alarms, and then monitor the ship's position live while sailing, overlay AIS to see other vessels, and combine it with radar to avoid collisions. If there's an early warning, I act immediately. I can easily navigate the ship through fishing nets. ECDIS is very helpful in making navigation in shipping lanes safer and easier, but it still needs to be combined with basic navigation knowledge. To what extent is the role of ECDIS important in supporting navigation in the Traffic Separation Scheme (TSS), and	

No.	Position	Question	Conclusion
3.	Third Officer	how can ECDIS be utilized in regulating shipping in this channel? Answer As a Second Officer, I believe ECDIS is crucial for supporting navigation on the TSS. It's much faster, more accurate, and more real-time than traditional paper charts. I actively incorporate ECDIS into my navigational flow, allowing me to create routes based on TSS traffic lanes, set safety contours and alarms, overlay AIS to monitor other vessels, and combine it with radar to avoid collisions. This allows me to easily navigate a cluster of objects without having to circle around areas that can waste time and fuel. How does ECDIS contribute to the effectiveness of navigation in TSS, and to what extent does the Third Officer use it in sailing practice? What challenges does the Third Officer face when using ECDIS in TSS, and how do you overcome them? Answer I find ECDIS very helpful in navigating the TSS because it provides a clear path, complete with boundaries and real-time vessel traffic information. As Third Officer, I typically use ECDIS to ensure the vessel stays on course and avoids clutter like fishing nets and vessels. I also cross-check with radar and AIS to accurately monitor the positions of other vessels. Furthermore, I'm also responsible for updating electronic charts to ensure they're up to date with the latest Notice to Mariners, ensuring more accurate and safer navigational decisions.	

3. Documentation



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Marine Equipment Directive
Declaration of Conformity

Equipment:	eGlobe G2 Electronic Chart Display Information System (ECDIS)
Manufacturer:	ChartWorld International Ltd 3 Thalia St 3011 Limassol, Cyprus P.O. Box 55523, 3780 Limassol
Declaration:	It is hereby certified that the equipment listed above conforms to the Council Directive 96/98/EC of 20 December 1996 on Marine Equipment as amended by directive 2013/52/EU, issued as *"Forskrift om Skipsutstyr"* by the Norwegian Maritime Directorate and that it has been Type examined by the notified body No 0575 Det Norske Veritas (DNV) as shown on EC Type Examination Certificate No MED-B-9558 and Product Quality System-Certificate of Assessment – EC Certificate No MED-D-1654
Regulations/ Standards applied	Annex A.1, item No. A.1/4.30 and Annex B, Module B in the Directive as amended. IMO Resolutions A.694(17), MSC.191(79), MSC.232(82)
Quality System (QS)	The QS for the Product, defined in Annex A.1, Item No A.1/4.30 and Item No A.1/4.29 has been assessed with respect to the procedure of conformity assessment described in Annex B, Module D in the Directive.
Date of Issue:	29 December 2014
Place of Issue:	Limassol, Cyprus
Certificate No:	CWI-DC-eGlobe G2-2014 rev 01

0575

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Business Development Director

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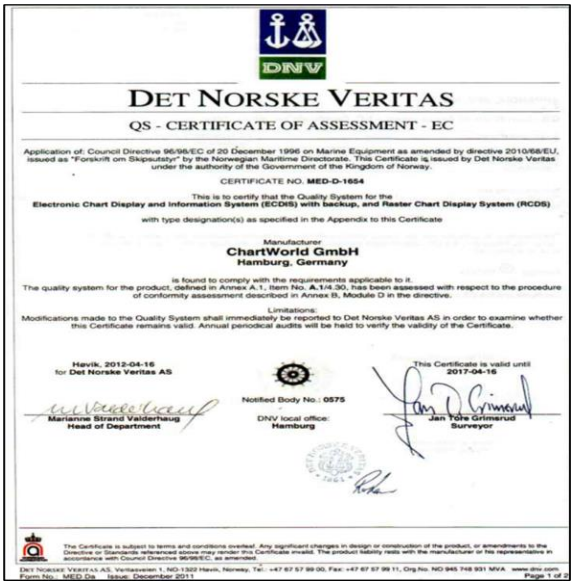
Fig. 5 ***Declaration of Conformity*****which certifies the eGlobe G2 ECDIS meets the main SOLAS/IMO navigation standards**

In Figure 5, this Declaration of Conformity states that the eGlobe G2 ECDIS made by ChartWorld International Ltd has met the requirements of the Marine Equipment Directive (MED) according to Annex A.1 Item No. A.1/4.30 and Annex B, Module B & D. This equipment has been checked by Det Norske Veritas (DNV) and complies with IMO Resolution MSC.191(79) and MSC.232(82), so it can be used as the main electronic navigation system according to SOLAS Chapter V regulations. Certificate No. CWI-DC-eGLOBE G2-2014 rev 01.



DET NORSKE VERITAS

QS - CERTIFICATE OF ASSESSMENT - EC

Application of: Council Directive 96/98/EC of 20 December 1996 on Marine Equipment as amended by directive 2010/68/EU, issued as "Forskrift om Skipsutstyr" by the Norwegian Maritime Directorate. This Certificate is issued by Det Norske Veritas under the authority of the Government of the Kingdom of Norway.

CERTIFICATE NO. **MED-D-1654**

This is to certify that the Quality System for the
Electronic Chart Display and Information System (ECDIS) with backup, and Raster Chart Display System (RCDS)

with type designation(s) as specified in the Appendix to this Certificate

Manufacturer
ChartWorld GmbH
Hamburg, Germany

is found to comply with the requirements applicable to it.
The quality system for the product, defined in Annex A.1, item No. **A.1/4.30**, has been assessed with respect to the procedure of conformity assessment described in Annex B, Module D in the directive.

Limitations:
Modifications made to the Quality System shall immediately be reported to Det Norske Veritas AS in order to examine whether this Certificate remains valid. Annual periodical audits will be held to verify the validity of the Certificate.

Høvik, 2012-04-16
for **Det Norske Veritas AS**

Marianne Strand Valderhaug
Head of Department

Notified Body No.: **0575**
DNV local office:
Hamburg

This Certificate is valid until
2017-04-16

Jan Tore Grimsrud
Surveyor

The Certificate is subject to terms and conditions overleaf. Any significant changes in design or construction of the product, or amendments to the Directive or Standards referenced above may render this Certificate invalid. The product liability rests with the manufacturer or his representative in accordance with Council Directive 96/98/EC, as amended.

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Fig. 6 ECDIS Certificate of Assessment as proof of the seaworthiness of the MV system. Ocean Sukses

Figure 6 shows the contents of the ECDIS Certificate of Assessment for MV Ocean Sukses, which states that the ECDIS system has been assessed and tested according to the safety and operational standards set by the classification society or maritime authority.

Fig. 7 Route Display on ECDIS

Figure 7 shows the navigation route planned via ECDIS as the vessel entered the TSS area. This route was designed according to the TSS corridor as stipulated by IMO, taking into account ocean currents, weather conditions, and the movement of other vessels in the vicinity. This demonstrates that the officer on watch effectively utilized ECDIS as a navigational aid to ensure safe navigation.

Data analysis Observation

During his internship on the MV. Ocean Sukses, the author directly observed the use of ECDIS (Electronic Chart Display and Information System) when crossing TSS

(Traffic Separation Scheme) areas. From the various navigation activities observed, the author was able to identify aspects that were and were not in accordance with IMO regulations, which will be explained in the following analysis:

1. Variation in the Level of Understanding of the Officers on Duty

Although most watch officers understood the proper use of ECDIS procedures, differences in understanding were found between senior and junior officers, particularly regarding alarm settings and the anti-grounding feature. This indicates a difference in ECDIS functionality among them, particularly when navigating in TSS with heavy maritime traffic.

2. Sometimes Less Than Optimal Routes in TSS

Routes designed using ECDIS generally follow IMO-approved TSS corridors. However, sometimes adjustments to the position of other nearby vessels or changes in ocean currents are not immediately made. This highlights the need for improved coordination between visual observations, radar, and ECDIS data to ensure optimal and safe routes.

3. Monitoring Limitations During Heavy Traffic

When navigating in the densely trafficked TSS area, simultaneous monitoring using ECDIS, radar, and visual observation is often required, which is difficult to achieve. When officers must focus more on a single source of information, the risk of human error increases, particularly in predicting other vessels' movements and making sudden route adjustments.

IV. DISCUSSION

In an effort to implement the use of ECDIS in TSS in accordance with IMO provisions, specifically SOLAS Chapter V Regulation 19 on electronic navigation, this article discusses the effectiveness, obstacles, and opportunities for improvement in the implementation of ECDIS in TSS. The author highlights various obstacles and practices during the voyage of MV Ocean Sukses. This discussion focuses on the effectiveness of ECDIS use and the challenges in ensuring navigational safety.

1. How is ECDIS implemented in route planning and monitoring in TSS?

The use of ECDIS on the MV. Ocean Sukses was carried out in a gradual and systematic manner. The officers on watch planned the route before entering the TSS, taking into account the IMO corridor, ocean currents, weather, and vessel traffic density. During the voyage, the vessel's position was monitored in real time via ECDIS, radar, and visual observation. While sailing through the TSS Cape Leeuwin area, Australia, known for its strong currents and currents, all officers on watch were required to be continuously informed and recorded regarding any course changes or maneuvers performed by the vessel. In general, the use of ECDIS improved navigation accuracy, facilitated decision-making, and reduced the risk of accidents in the densely trafficked TSS.

2. How do the sailors understand how to use ECDIS during navigation activities?

Overall, a ship's understanding of ECDIS operation is crucial and is reflected in their ability to visualize routes in real time to anticipate potential hazards more accurately than conventional methods. A well-versed ship's flight attendants are able to effectively integrate ECDIS data with radar, AIS, ocean currents, depth, and weather information. This allows them to quickly assess the risk of collision or grounding, particularly when navigating in high-traffic areas such as Traffic Separation Schemes (TSS).

In the process of navigating in high-risk, congested waters like the Singapore Strait Strait, a key indicator of a watch officer's professionalism is reflected in their analytical ability to interpret early warning features on the navigation system. Highly qualified watch officers possess mature decision-making abilities under pressure. When a vessel is observed approaching the operational danger radius of another vessel, the watch officer intuitively and procedurally takes the necessary corrective action—such as deviating course or modifying the vessel's speed to ensure safe navigation and compliance with collision prevention regulations. Furthermore, they are proficient in using ECDIS to plan optimal sailing routes, minimize sudden maneuvers, and utilize automatic digital recording features for navigation safety evaluation, reporting, and auditing purposes.

Ultimately, while ECDIS is designed to reduce human error and improve situational awareness, its effectiveness depends entirely on the depth of the pilot's understanding. This understanding includes the pilot's ability to regularly update electronic charts (ENCs), mastery of backup procedures in the event of system failures, and application of knowledge gained from routine navigation training and simulations.

3. How effective is ECDIS in improving navigation safety in TSS?

Overall, ECDIS is highly effective in enhancing navigational safety in TSS areas because it provides the officer on watch with the ability to visualize the route in real time and anticipate potential hazards more accurately than traditional methods. The system not only electronically displays the vessel's position but also integrates data from radar, AIS, ocean currents, depth, and weather conditions, allowing the officer on watch to quickly assess the risk of collision or grounding. Key features such as proximity alarms, anti-grounding, and automatic route checking provide early warnings when a vessel approaches a lane limit or danger area. When navigating narrow and congested areas such as the Changjiangkou TSS in China, corrective actions such as adjusting the vessel's course and speed can be immediately executed. Furthermore, the use of ECDIS significantly assists the officer on watch in planning the best route, taking into account traffic density, thereby minimizing sudden maneuvers and ensuring a safe distance between vessels is maintained.

The automatic logging and digital documentation of ECDIS also facilitate navigation evaluations, safety audits, and reporting of incidents or route changes. With its data integration capabilities and responsive alarms, ECDIS significantly reduces the risk of human error, improves situational awareness, and helps officers on watch make faster and more informed decisions in heavy traffic, bad weather, or unstable sea currents. However, its effectiveness still depends on crew competence, electronic chart

updates (ENCs), and the readiness of backup procedures in the event of system failures. Therefore, regular training and navigation simulation exercises are crucial to ensure ECDIS maximally supports safety in TSS.

V. CONCLUSION

This study shows that the implementation of the Electronic Chart Display and Information System (ECDIS) on the MV. Ocean Sukses has supported the effective implementation of navigation when crossing Traffic Separation Schemes (TSS). ECDIS is utilized in route planning, real-time monitoring of ship positions, and navigation decision making through integration with radar and the Automatic Identification System (AIS). The results also show that the captain's understanding of ECDIS features plays a crucial role in improving shipping safety, particularly in identifying potential collision hazards, keeping the ship on the designated course, and taking corrective actions quickly and precisely. The presence of early warning, route checking, and safety contour features has been proven to help improve situational awareness and reduce the risk of human error during navigation in areas with heavy traffic.

However, this study still has limitations because it was conducted on only one vessel with a limited number of informants, so the results cannot be generalized to all types of vessels and sailing conditions. Furthermore, this study used a qualitative approach, so it was not able to quantitatively measure the effectiveness of ECDIS in reducing the risk of navigational accidents. Therefore, further research is recommended to involve more vessels, shipping routes, and respondents and combine qualitative and quantitative approaches to obtain more comprehensive results. Practically, the findings of this study indicate the importance of improving training, navigation simulations, and periodic competency evaluations of watch officers to ensure that all ECDIS features can be optimally utilized. These efforts are expected to improve shipping safety, ship operational efficiency, and compliance with international navigation standards in the TSS area.

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