

Investigation of Overcoming the Faults Facing Electronic Chart Display and Information System User in Tanzania

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Abstract: *The Tanzanian shipping industry is fighting to achieve the efficient application of modern navigation equipment. The failures associated with electronic chart display and information system (ECDIS) users on modern ship in Tanzania, and their solutions, are main concern of this article. Based on the literature review and opinions of professional navigators investigated, the present faults faced by ECDIS users in Tanzania are identified. The frequent failures of ECDIS include the fluctuation of the information data due to the lack of constant electrical power, stop working, broken of ECDIS, failures of display information on the screen, ink problem on the screen and the lack of committed training etc. In addition, the findings show that, most departments do not operate by professional personnel, lack of service at light time of recommended, lack of validation of knowledge to crews, lack of modern merchant vessels equipped with ECDIS undertaking coastal shipping and lakes in Tanzania waters, and lack of qualified officers to use ECDIS. Based on the findings, this article concludes that modern systems for technology such as the ECDIS are particularly important in maintaining safeties and reliability of marine transport, however, the incapability to apply ECDIS in ships to make accurate marine transport in the context of a rapidly changing technology is also causing risk.*

Keywords: Electronic chart display and information system (ECDIS) ECDIS, Faults Investigated, Fault Cause Analysis , Solutions to ECDIS problem, Marine transport of Tanzania.

1. Background

Situated at south of the equator, Tanzania has a long coastline of approximately 1,500Km along the Indian Ocean as well as three inland lakes (that is Victoria, Tanganyika and Nyasa) navigable by ships, which is the maritime sector in Tanzania. Tanzania is heavily dependent on shipping, plus with 75 per cent is international trade going through the seas. Moreover, the maritime sector offers Tanzania numerous growth opportunities through economic initiatives. Offshore fishing, marine transportation, tourism, oil, and gas are examples of marine activities that fuel Tanzania's economic growth. Recognized as one of Africa's most maritime powers in East Africa and central Africa, Tanzania is a major sea outlet for many African countries, such as the Republic of Zambia, Burundi, Malawi, Rwanda, Uganda, Zimbabwe, and eastern parts of the Democratic Republic of the Congo. The country is also a convenient link for freight to the Middle East and the Far East, Europe, Australia and America.

In the 1980s, International Hydrographic Organization (IHO) created a digital data exchange committee that laid down the foundation of the future electronic chart systems, thus enabling the beginning of a long process of PNC digitization (Cole and Asyli, 2018). Nevertheless, ECDIS requires users to have a clear understanding of the system, in order to address any controversies that may arise. According to Rutkowski, (2018) the navigator has to be aware of the system limitations and should always crosscheck displayed information on the ECDIS with available and suitable sources due to the risk that the safety of navigation is compromised by infrequently utilizing basic safety settings. In addition, the lack of standardization of system parameters, displays, functions, and terminology among manufacturers has negatively affected navigation safety. With reference to the above point, ECDIS should not see only in terms of positivity. The difficulties encountered by the user need to be observed and documented.

Therefore, despite being the motivating force of the Tanzania socio-economic undercurrents, the country maritime industry struggles to achieve the effective application of modern navigation equipment in terms of its capabilities and overall performance in the ship with the requirements of safety of navigation. This paper intended to analyses the existing faults in the application of ECDIS in Tanzania. The paper will offer solutions to current failures to make the application of ECDIS in Tanzania become more reliable.

2. Methodology

The study applied qualitative research and was carried out in Tanzania. The study employed the data collection techniques which comprised in-depth interviews and documentary review to generate data. Purposive sampling was used to get respondents who participated in interviews. The selection of respondents was based on those who can provide detailed and reliable information on the topic under study. For example, officials from various agencies that have connection with matters under the study (Marine transportation) such as TPA, TASAC TEMESA, FISHERIES, MARINE POLICE, MARINE SERVICE and TPDF NAVY. Using the content analysis guide, the interviews were transcribed into small meaningful units or themes. By examining the presence or repetition of certain words and phrases in these texts, the researcher was able to make inferences to ascertain the values and attitudes of the respondents and the information gathered through other methods. In addition, information gathered from secondary sources was synthesized using the same guide by referring to important themes. Making preceded conclusions by a detailed description of the data in connection to other people writings on the same topic. This was important in that it guarantees validity and representation of the data.

3. Findings and Discussions

This section presents the findings in relation to challenges facing ECDIS in Tanzania and elucidates the recommendations for the current uses of ECDIS and future uses. It further explains implications of those challenges for the quality applications of ECDIS in Tanzania. The section thus provides a detailed overview of the marine transport experiences in adoption to the contemporary technological advancement and skills development. The discussions based on the improvement on facilitating reliability, efficiency, and effectiveness of ECDIS practices in Tanzania and suggestion for future improvement.

3.1 Development projects of uses of ECDIS in Tanzania.

The currently status Tanzanian government implemented a number of development projects, which were designed to further modernize the government ship and construction of new ships in the lake and in the sea, also as well as improving and upgrading of the old ship. The project includes a new five modern fishing ship, Cargo and passenger ships. These ships will operate in the sea and Lakes of Tanzania's navigable water. Some ship will have an integrated bridge system where ECDIS is the core. The ECDIS will allow monitoring of a ship's position in real-time throughout the voyage and integrates information from GPS/DGPS, radar, AIS, autopilot, NAVTEX, Log, radar display and other navigational equipment into a single display see figure 1 describe.



Figure 1 ECDIS system configuration



Figure 2 ECDIS Power on/chart plotter

3.2 Setting rules of maritime community Analysis

Maritime transport is now recognized, as one of the most important means of facilitating the movement of people and goods in Tanzania. Meanwhile, with the technological change's adoption of electronic nautical chart as representative modern navigation equipment, seem to fasten success related to the similar modern, digital navigation equipment to promote progress of the Tanzania future. The maritime community at the beginning has introduced the culture of compliance by setting up rules, regulations, guidelines, and codes relating to the construction of ships and the safety equipment to be carried on board ships (IMO Resolution A.741 (18)). It is not fortunate enough to reduce the accidents, as analysis shows that 80% of the accidents caused by human error. Moreover, 75% out of human related accidents caused, by lack of or poor management to improve the safety standard on board passenger ships. Recognized that the quality assurance as a good system for preventing, the problems and quality management as the method by which it carried out to achieve the goal (CMA, 2007). The same analysis observed by Scott and Terrance (1998) that the development of the equipment to be used on-board must match the development of the one to be used in ports, thus utilizing the available resources and increasing the efficiency and safety. Therefore, in the rapid development of globalization, modern electronic ship, it is particularly important to study challenges associated ECDIS users and how to overcome it which is the endeavor of this study. This is since its application is still novel in developing countries such as Tanzania, the study of its experience and applicability will provide a dimension for future uses.

3.3 The Electronic Navigation Equipment User's faults in Tanzania

The electronic navigation equipment users in Tanzania faced with different faults. Some of the faults caused by the technology itself, some due to human resources and other are due to poor infrastructure to facilitate ECDIS uses. Respondents in the interviews discussed how this belief continued and was important to their lives. They held that,

"Many workers are not able to use ECDIS because it is not found in many ships, even in our technical college's they are not taught ECDIS" (Mr B.A., IDI, 17/12/2020). Employer of the one organization revealed the same observation during the field interview:

"Workers in my organization not much aware about ECDIS because most of them they are working in small vessels like tugs and boats which those named vessels not fixed with ECDIS, so apart from study ECDIS in class practically they are not deal with it" (Mr. N.M, IDI, 16/12/2020)

The analyses from the field reveal the need of ECDIS training in technical college so that to be familiar to many workers who employed in the marine transport sector. Further analysis revealed that some ships do not use ECDIS, something that risk the life of passengers and other people working on board ship. The responses analysed emphasize on the need of considering ECDIS education in technical college education. The findings concur with Weintrit and Stawicki (2008) that considering the navigational rank engagement and interaction with the system, a continuous need to adopt ECDIS Education and Training (EET) for an individual rank has appeared. The risks of overreliance, lack of situational awareness, and other subtle problems should not be disregarded, literature review and evidence from the field outline the following technical problems.

- i. Frequency breakdown of modern navigation equipment on board
- ii. ECDIS ball track pointer stack
- iii. ECDIS fluctuation of information date due lack of constant power supply
- iv. Stop working for navigation equipment sensor on board
- v. Broken of ECDIS
- vi. Lack of committed training ECDIS
- vii. The majority of errors made on the ECDIS are in the user's interpretation of how the ECDIS the user given the freedom to present the chart in a number of ways: as such without a thorough understanding of how the system works, there may be some confusion in what the system in presenting.
- viii. Inadequate maintenance of spare parts support
- ix. Failures of ECDIS to display information in the Screen
- x. Damage of color display and ink problem (see figure 2 above and figure 3 below)



Figure 3 ECDIS power off



Figure 4 damaged wire cable of HF.

(**Figure 2&3**) demonstrate the ECDIS have damage of color display and ink problem caused by high temperature due to Tanzania's warm equatorial climate modified by variations in elevation. The high amount of solar radiation throughout the year is associated with a limited seasonal fluctuation of temperature: the mean monthly variation is less than 41 °F (5 °C) at most stations. Ground frosts rarely occur below 8,200 feet (2,460 meters). Electronic equipment kept under 10 degrees centigrade to keeps its efficiency but in East Africa, especially Tanzania the temperature is mainly above 25 to 39 degree centigrade in coastal region such as Dar es Salaam city and Mtwara region some. So in order to keep the efficiency of equipment it needs air conditions, which affected also by power interruption. Because the temperature weakens, the Resistance of equipment such as, screen and wire cable covers (**see figure 4** describes the HF cable cover got damage due to high temperature.

The main common current challenges in Tanzania are power instability, terminal power supply frequently shut down that lead tendency of ECDIS to loose position (position of cursor) demonstrated in **figure 5** below. In addition, burn ship's chart plotter card. The Solution for ship auxiliary power fluctuation which some, it should be possible to operate ECDIS and all equipment necessary for its normal functioning when supplied by an emergency source of electrical power. In accordance with the appropriate requirements of SOLAS Chapter II-1 and Changing from one source of power supply to another or any interruption of the supply for a period of up to one hour should not require the equipment to be manually re-initialized.

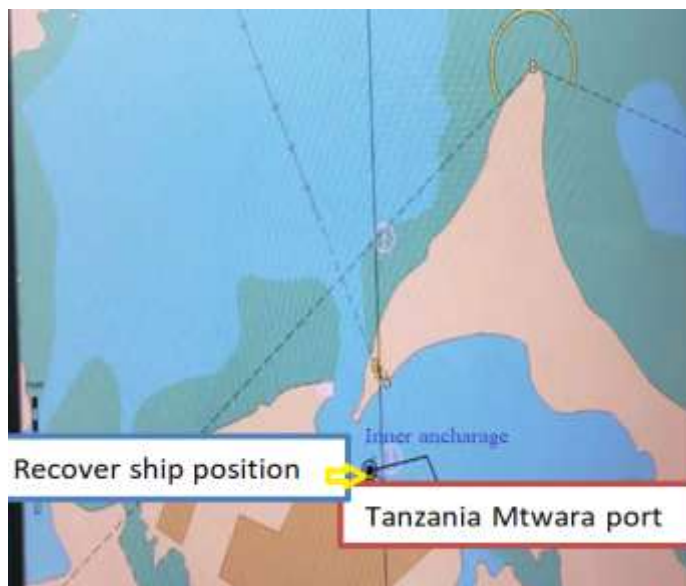


Figure 5 before recover point lost position

Figure 6 after recover point lost position

Figure 5 describe the wrong position point in red circle on Atlantic Ocean, while the right ship position is on Indian ocean Tanzania, this caused due to power interruption and an untimely chart update. **Figure 6** demonstrates recover point, Simple procedure for recover ship position in the ECDIS that had lost ship position. Switch on GPS compass-switch on ECDIS- goes to service tool-recover point-recover configuration. Alternative: Restart the ECDIS, and then switch on ECDIS the position will recover automatic.

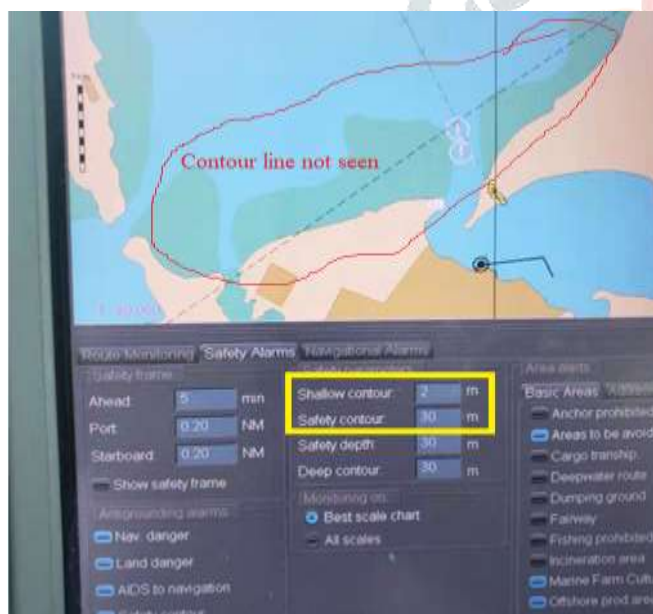


Figure 7 Contour line is not seen

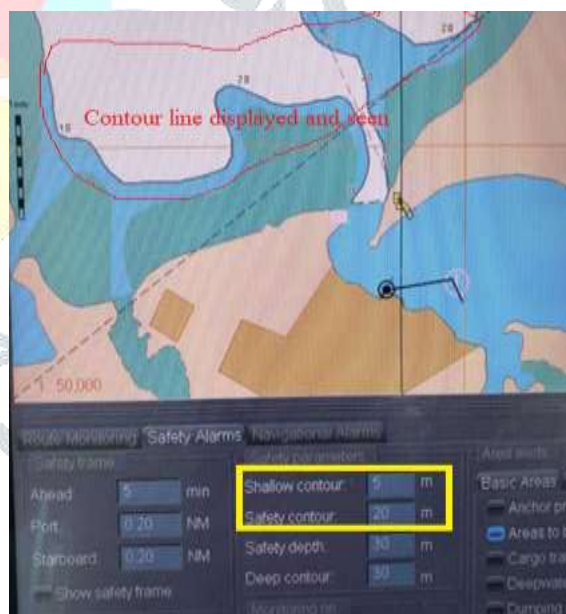


Figure 8 contour line is seen

Because of figure 7 describe the chart do not display the information feature specifically contour line is not seen because the chart is out of date. We see that when some time even if the chart is out of date. If the setting of contour line is, two meter for shallow contour and 30 meter for safety contour. The ECDIS will not show the features. Nevertheless, in figure 8 the contour line displayed after setting has changed to 5 meter for shallow contour and 20 meter for safety contour. Meanwhile the user has to input the parameters for both depths. When the passage is checked and any hazards are present along the proposed route then activated alarms will be. ECDIS manufacturers meet these requirements by allowing users to specify a safety area for the vessel, effectively contained by the following parameters depth, by the safety contour and Shallow contour.

3.4 Navi- sailor 4000 ECDIS analysis

Navi- sailor 4000 ECDIS should be used in combination with S-57 format charts issued by the national hydrographic offices and updates (In the way determined by the hydrographic offices) with the latest available corrections if the NS uses chart of other formats, the following should be noted. All displayed charts must be used in conjunction with a recognized nautical paper chart of a scale appropriate to the area being navigated the data on the fully corrected to be more reliable. SSE 27-ENC GB302927 is not up to date a new edition re issue or update for this call is missing and therefore must not be used for this cell has expired this call may and must not be used for navigation.

3.5 Contributing factors to technical problems

This section presents various contributing factors for technical problems in Tanzania. The technical problems in many failures of operating modern navigation equipment in Tanzania is an absence of essential modern navigation equipment Technician which at the most can troubleshoots the root cause(s) of a known failure from an apparently endless list of possible failure mechanisms. Other factors include those related to training, equipment, personnel and working environment. Results indicate that knowledge on ECDIS uses are a key predictor of problem – solving performance and account for a significant of the other in contributing factors to technical problems. Most of the contributing factors to technical problems, accelerated by the difficulty of handling ECDIS properly, the participant observation during interviews with experts from different agencies revealed as the following below.

- i. Lack of service of modern navigation equipment
- ii. Poor working environment of modern equipment
- iii. Lack of technician personnel
- iv. Misallocation problems in personnel quality
- v. Lack of budget to manage and maintain modern navigation equipment
- vi. Lack of time update navigation software equipment
- vii. Lack of trainee and training material/equipment of electronic navigation
- viii. Technical solving problem
- ix. Effective training for specific equipment
- x. ECDIS should have internal power at least for 5hrs storage of charge
- xi. Training for Equipment technical to service equipment
- xii. Training should base in the digital navigation equipment
- xiii. The Tanzanian ship owner should make sure that all crew are trained and have enough knowledge

Many respondents complained on poor working environment of modern equipment, which affect their capability in ECDIS uses because the environment is not friendly hence, they underperformed. There is need for investing in the working environment so that to facilitate the effectiveness and efficiency environment for the better performance. As indicated above, lack of technical personnel also contributes to the technical problems. According to one of the participants during an interview, lack of technical personnel affects the uses of ECDIS as many personnel are not well trained for that purpose. Technical college in Tanzania is not invested in training people about ECDIS which results people to learn through others and by using experience. The study calls for more investment in the training so that to increase the number of trained personnel and reducing technical problems associated with lack of training. Another contributing factor for technical problems which was also reported during an interview is a budget deficit. The budget for maintenance and managing modern navigation equipment are high compared to non-modern equipment. For local investors in marine transport, it became difficult for them in handling ECDIS in their ships. As a result, difficulties in generating profits that could run the modern equipment system smoothly led to technical problems repetitively.

4 Tanzania's dynamic need for Integrated Navigation system on board ship

Integrated Navigation system a combination of equipment and software, which uses interconnected controls and displays to present a comprehensive set navigational information to the mariner.

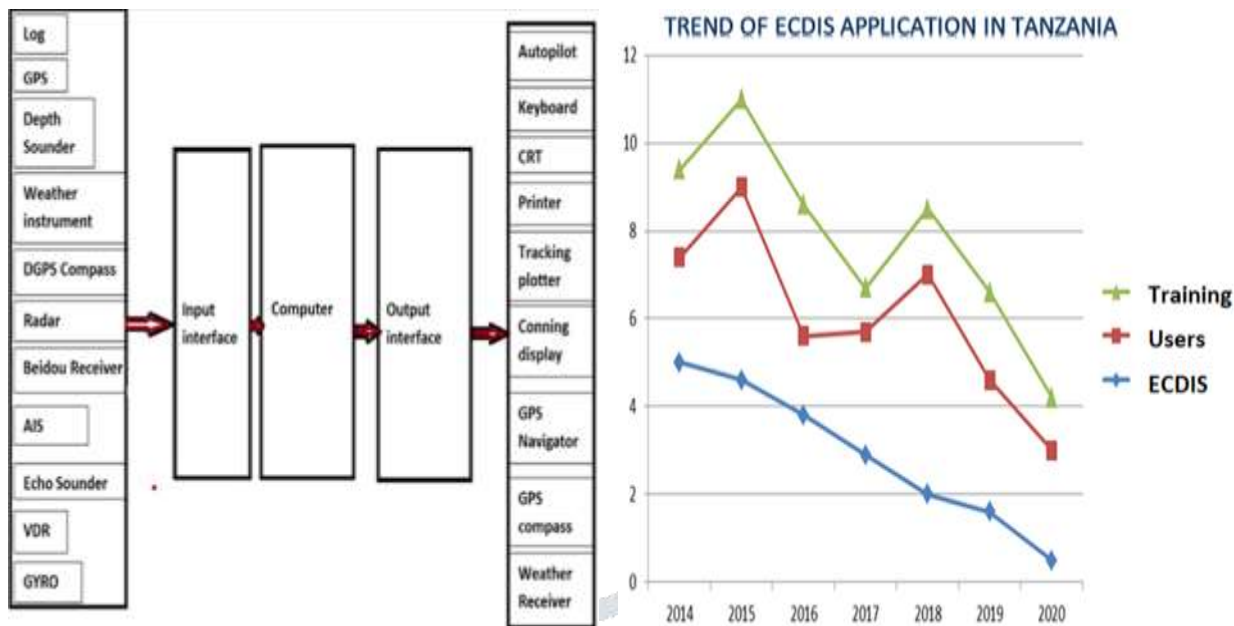


Figure 9 Constitution of integrated navigation system **Figure 10** graph of ships fitted with ECDIS Tanzania. (This comment applies to all graphs and tables)

Figure 10 describe the decline of application of ECDIS on the ship fixed with ECDIS, training in Tanzania are formal on use of ECDIS and practical knowledge on how to use it. Still using normal GPS and sometime chart plotters which are not into details as compared to ECDIS few or undetailed navigation information using normal electronic navigation system. Always use old version and lack update, not in time. All officers are aware through theoretical and few are less capable due to most of the vessel in coastal navigation are not using ECDIS. Some of them they use in practical in school but in reality, when no you going on board you found only GPS and plotter. In addition, some are much not aware about ECDIS because most of them they are working in small vessels like tugs and boats. In addition, ECDIS become out use when there are lack of care for navigation equipment.

Manufacturers summarize important key tasks (in accordance with the industry recommendations) if necessary and are therefore vital to read manuals prior to using ECDIS and to always keep on hand. Manuals often contain information on critical operations, including setting under keel clearance, or man overboard. Martek handle the whole process, from assistance specifying the right product to installation of it, providing ongoing after-sales support. Martek continual access to highly trained support staff means that customers benefit from our ECDIS experts understanding of marine legislation, combined with vast experience, all of which will give you the foundations you need to feel confident and competent using ECDIS. Just pick up the phone is you have an ECDIS related query and a member of the team will be right back to you. In many shipping companies recognize the requirements of ECDIS familiarization and are starting to arrange hand-over periods, which are long and more detailed. Extended handovers done in this way, can last for an entire voyage if needs be, and allow an officer joining the ship to gain familiarity with the features of the ECDIS, along with other safety critical systems, to maximize offshore safety.

It is not objective the ECDIS suppliers who are busy doing their bit to advance navigation safety; also, the governments of related maritime navigable water should play their part too of safer navigation through improved hydrographic data. To establish an inland ECDIS services. Stakeholder involvement will play an important part in the development of modern navigation equipment suitable for navigation in Tanzania. All potential Training institute stakeholders are encouraged to participate in expert technician development. Non-IHO stakeholders are needed to ensure that navigable water will be suitable for the widest possible for application ECDIS user.

4.1 Designed and modernize the analysis

Construction of and improvement of dock and other infrastructures at Mwanza port this will enable them to speed up the building of new the ship. Moreover rehabilitation of MV Victoria, MV Liemba, MV Butiama and MT Sangara. Upon the completion of rehabilitation, these vessels will come back to life that will improve business and offer high Quality and reliable services to people, has demonstrated in (figure 11&12) below.

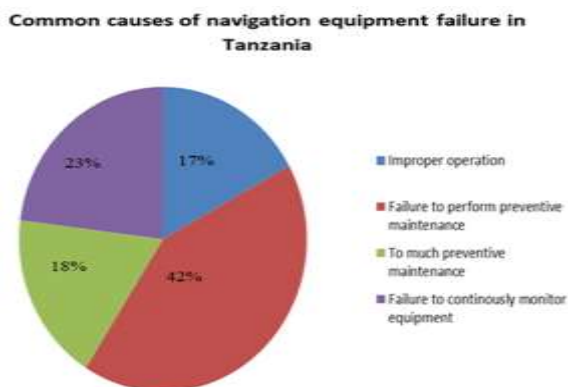


Figure 11 analysis of navigation failure



Figure 12 MV Victoria

Table 2 analysis of Building New ship

Ship	Navigable water	Integrated bridge system
MV MWANZA HAPA KAZI TU	Lake Victoria	10%
WANGONI FERRY	Lake Victoria	10%
Five Fishing Ship	Indian ocean	10%
TANK SHIP	Lake Tanganyika	10%
Cargo ship	Lake Tanganyika	10%
Cargo ship	Indian ocean	50%

Table 2 describe building new ship, on cargo ship in ocean going vessels flying the Tanzania flag, from Tanzania to Comoro, which will be fitted with 50% of integrated bridge system, while other ships that will operate in domestic navigable water will be fitted with 10% of IBS. The navigable water specifically in Lakes does not support ECDIS application because water bodies not surveyed.

4.2 Preventing maintenance failures analysis

This section presents the results of preventative maintenance failures and explains common causes in the context of relations with Tanzania. The study observed as it is shown in table 3 below explain several causes of ECDIS failure, which arises during operations, maintenance, equipment, and bad culture.

Table 3 Common causes of ECDIS failure Tanzania

Common causes	Percentage
Improper operation	16%
Failure to perform preventive maintenance	40%
Too much preventive maintenance	17%
Failure to continuously monitor equipment	21%
Bad (or no!) reliability culture	6%

The table 3 demonstrates Preventing Maintenance failures of modern navigation equipment. Causes by varies factors such as a lacking room temperature condition (ice), negligence of not follow the recommended operation principle and manual instruction of modern electronic equipment, use of weakness spare parts for replacement of broken spare. Replacement of spares sometimes causes the failure in efficiency, which means when the replaced one is not from the originator (manufacture). It means the efficiency is different from the original so it will cause poor efficient compared to the original one, sometime damage the system. The impacts of other inadequate safeguards tools and so on are difficult enough to meet the daily maintenance needs, failure to import genuine spare parts because of low

economic to buy it, mostly departments not operate by right professional personnel, no service at light recommended time and lack of validation of knowledge to crews. In addition, prevention efforts must be comprehensive and cover all areas from which problems may arise, such as personnel, maintenance practices, hardware, and systems. However, they used to keep a manager focused on all aspects of maintenance.

4.2.1 Software Maintenance and failure analysis test

The uses of Software Maintenance in Tanzania may be the best way of overcoming failure of modern electronic navigation equipment. Software maintenance is the process of modifying a software product that has delivered to the customer. The main purpose of software maintenance is to modify and update software application after delivery to correct faults and to improve performance. Also will analyze data collected to determine root cause of failure from the data collected and determined root cause. Normally, failure analysis test done mainly in two ways as follows

- i. Destructive testing: Require the altered product in order to examine cross-sections or thermal behavior.
- ii. Non-Destructive testing: Keep a product intact with no form of alteration.

4.2.2 Motives for failures breakdown and maintenance of navigation equipment

The age of equipment, the lack of maintenance or repair records, any prior damages or electrical or mechanical failures. During an investigation of a root caused by equipment or personal fault, the most important questions that always must answered by an operator or manufacture of navigation equipment are there any contributing factors that led to the failure? Therefore, that he/her can be able to:

- i. Defining helpful schedules for product letdowns
- ii. Improving manufacturing developments and competences
- iii. Removing the risk of physical damage from product letdowns
- iv. Avoid comparable letdowns in the future
- v. Reducing economic costs connected with letdown

4.2.3 The fundamental categories of maintenance analysis

These categories of maintenance are vital for high-priority equipment, which is needed for the normal operation of the company and operators. In fact, the higher the risk associated with a particular malfunction, the greater the need for preventive maintenance to increase the asset's lifetime and reduce unplanned downtime. See table 4 describe. Instead of waiting for the malfunction to occur, this type of maintenance aims to prevent it from happening. Preventive maintenance occurs in a cyclical and programmed manner, regardless of the condition of the quality.

Table 4 Types of maintenance

Types	Explanations
Corrective Maintenance	Comprises modifications and updates done in order to correct or fix problems, which either discovered by user or concluded by user error reports.
Adaptive Maintenance	comprises modifications and updates applied to keep the software product up-to date and tuned to the ever changing world of technology and business environment.
Perfective Maintenance	Comprises modifications and updates done in order to keep the software usable over long period, it includes new features, new user requirements for refining the software and improve its reliability and performance.
Preventive Maintenance	It includes updates and modifications to prevent future problems of the software, aimed to attend problems. Those are not significant at this moment but may cause serious issues in future.

4.3 Countering challenge of ECDIS over training and familiarization assessment

ECDIS training is essential for higher navigational safety and aims to ensure that navigators can use and understand ECDIS in the context of safe navigation and can demonstrate all competencies contained in and implied by the International Convention on Standards of Training, Certification, and Watch keeping for Seafarers Convention (STCW) 2010. Such training should ensure that the navigator learns to use ECDIS and can apply it in all aspects of navigation, including the knowledge, understanding and proficiency to transfer that skill to the particular ECDIS system(s) actually encountered on board, prior to taking over navigational duties. This level of training should deliver the competencies at least equivalent to those given in IMO Model Course 1.27. To ensure a safe voyage, you must be familiar with all equipment on the bridge before the pilot and master rely on your expertise as they start to conn the vessel, but the various (ECDIS) systems you have used in the past are all different to the one on this ship.

Being competent in the use of ECDIS is not just a recommendation; it is a legal requirement to ensure the highest levels of navigational safety. When working on a new ship, even when trained and experienced using ECDIS, it is possible to be faced with a system that works very differently to the system you have been trained on. This is where the importance of ECDIS familiarization comes in (which is also now a mandatory requirement under ECDIS regulations). Familiarization should cover initial preparation;

- i. Basic operations
- ii. Charts
- iii. Navigational tools and functions;
- iv. Route planning and route monitoring

Familiarization includes any relevant information required for the safe operation of the ECDIS, including all updates and alterations and companies should have clear procedures for using ECDIS and assisting the navigators in completion of the familiarization process.

4.4 Training and Valuation of Knowledge Goals

Table 5 training and familiarization assessment

Training outcome	ECDIS familiarization outcome
• Understand the K-Bridge ECDIS system Overview	• familiarization with available functions
• Operate the system with all available functions in order to navigate safely under all conditions	• familiarization with the menu structure and Updating of software
• Explain the system's menu structure	• display setup
• Explain and utilize the system's display setup	• setting of safety values
• Set safety values	• recognition of alarms and malfunction indicators and action to be taken
• Recognize alarm and malfunction indicators and actions to be taken	• route planning
• Planning and validating routes	• route monitoring
• Monitor routes on the system	• changing over to backup systems
• Changeover to backup systems Install and update charts and licenses	• loading charts and licenses

Training and assessment in the use of ECDIS is not required for those who serve exclusively on ships not fitted with ECDIS. This limitation shall be reflected in the endorsements issued to the seafarer concerned (refer to tables A-II/1 and A-II/2 of the STCW Code)

4.5 ECDIS Maintenance and Inspection Analysis

The service life of ECDIS is depend in maintenance and inspection, maintenance will ensure that the ECDIS is kept in optimum condition and updates to the ECDIS may reach the ship in various ways, depending upon the capabilities of the service provider and the onboard communication facilities. On data distribution media, Digital Optical Disc (DVD), as an email attachment Satellite Communications (SATCOM), as a broadcast message via SATCOM plus additional communication hardware and as an internet downloads. In addition, inspection of ECDIS may prevent it from malfunctions. Limitation for user does not allow to attempt to check or repair the inside of the

equipment. Because checking or repair by an unqualified person may cause a fire or an electrical shock. It recommended to contact ECDIS manufacture head officer or near branch or local office to request servicing. This make the cost of maintenance is high. In addition, undocumented changes often may cause more conflicts in future. Changes made can easily hurt the original structure of the software, making it hard for any subsequent changes. The standard age of any software considered up to 10 to 15 years, but in Tanzania considered less than standard age is about 2 to 4 years. As technology advances, it becomes costly to maintain modern software. They challenging against newly coming enhanced software on modern hardware. Figure 13 describe estimating Modern software navigation equipment maintenance found that the cost of maintenance is as high as 79% of the cost of entire other factors in the chart area.

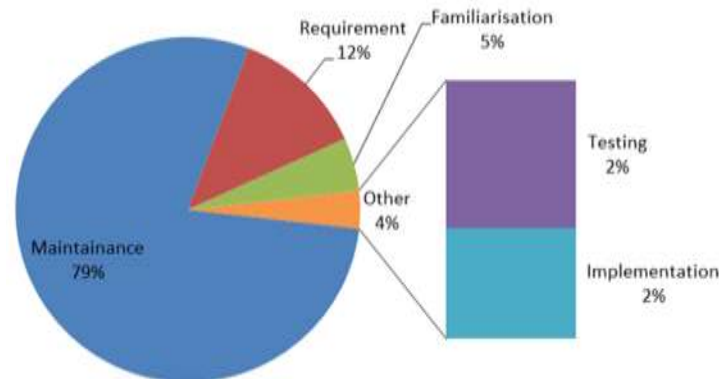


Figure 13 Maintenance Cost Chart

5. The steps associated with the uses of ECDIS for current and future technology

In light of the above understanding, ECDIS uses in Tanzania have gaps, which require aggressiveness to address them. This is reflected in several faults with respect to its uses in Tanzania. This section of the article describes some of the steps needed to address the problems associated with the uses of ECDIS for current and future uses of the technology. These recommendations require the attention of various stakeholders in government institutions, manufacturers, training institutions and other partners. For this reason, the study recommends the following.

- i. Tanzanian government as a key stakeholder should called to take the necessary corrective actions, which would lead to best uses of ECDIS in the country. She should invest in modern domestic ship navigating in Tanzania water bodies.
- ii. The country should promote and attract ECDIS training investors in maritime institutes in Tanzania. In addition, make joint with other ECDIS training centers in the world. Since the knowledge about ECDIS are important in sustaining marine transport the investment in personnel training will help to cope with the human error in operating ECDIS. This could be in the form of its integration with formal systems of education, such as the school system, or through more interactive seminars and workshop,
- iii. Policy makers also need to be sensitive on ECDIS uses in marine transportation particularly for regulatory authority should ensure that every ship in Tanzania have ECDIS which may serve as important mechanisms for reducing accident and other form of risks. This may include designing policies advocating ECDIS uses.
- iv. Manufactures companies should construct ECDIS Display screen, which is resistance to Temperature in tropical zone specifically Tanzania navigable waters. Because ECDIS is not as clear or reliable as we would like it to be and ECDIS, operation is a skill that perishes far quicker than paper chart work.

6. Conclusions

The study highlight challenges that need for continued training in ECDIS and the importance of ECDIS specific training for all new and existing navigators on board ship. The modern study applies the overcoming the ECDIS user to prioritize the fault facing ECDIS in Tanzania. The application of the ECDIS enables to determine the impact of each failure to the objective at hand. The essential failures, which are critical for ECDIS user in Tanzania revealed and presented. ECDIS was noted to be failed by several factors, but most importantly being frequency breakdown of modern navigation equipment on board, ECDIS ball track pointer stack, ECDIS fluctuation of information date due lack of constant power supply, stop working for navigation equipment sensor on board, broken of ECDIS and lack of committed training. The forward future work will be analysis of the accuracy of maintenance and marine modern navigation equipment improvement in Tanzania.

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