

# Analysis of New Standard ECDIS to Mitigate Marine Navigation Disaster in Tanzania

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**Abstract:-** The country is situated in south of the equator, Tanzania hopes to be able to improve its economic status through maritime trade in the future. Because the country is a major maritime power in East Africa requires marine modern navigation equipment which in many ways i.e. ECDIS. This research paper is aimed to study the factors that hinder the safety of marine navigation, and the requirement of new standard ECDIS to mitigate marine navigation disasters as have been analyzed. The paper uses data of Tanzania's Indian Ocean, Lake Victoria, Lake Tanganyika and Lake Nyasa. The research analyzes data qualitatively, tables and charts descriptively based on the collected data. The analysis shows that there is limitation and failures of ECDIS application due to the lack of the following surveyed water, modern navigation equipment, ECDIS on the ship below 150 tons navigating in lakes, the scale to keep track of weight limits for small boat, investment in modern navigation equipment and meteorological equipment for inland water bodies. Therefore these are factors contributing to poor performance of maritime transport industry and hence decline of maritime safety navigation. The paper recommends establishing of National Maritime Bureau or the Waterway Bureau and these of UPS to protect the sensitive electronics from variations in the voltage supplied to them. For sustainable development of marine navigation and hence facilitating shipping trade in Tanzania.

**Keywords:-** ECDIS, Marine, Navigation, Tanzania.

## I. INTRODUCTION

The demand for modern navigation equipment in Tanzania's multi-faceted shipping is in great contradiction to the current situation of ECDIS practical application. Therefore the necessity of this paper is to promote the application of modern navigation equipment in Tanzania for the future and to establish the characteristics of Tanzania's shipping demand which is different from other countries.

## II. ANALYSIS OF DISASTERS IN TANZANIA

### 2.1 Problems analysis.

Tanzania has the problem of shipping in large lakes, which other countries do not have. Current status is that, there is a large number of ships less than 150 tons (both at sea and lakes), most of which are not loaded with ECDIS. In the past years, there were approximately 30 light and unlighted aids to navigation in lakes, but they have almost all disappeared. Today there is no "officially" sanctioned aid to marine navigation on Lake Victoria. Navigating in the lake has become a matter of trial and maritime error with ancient navigation routes dating back to the 19th century. Missing course, lights and clogged piers, the lack of equipped weather stations also make it difficult to predict weather patterns in order to take safety precautions.

The Lake Victoria is in the East Africa sub-region that has high occurrence of severe and hazardous weather (Thierry et al., 2016). This is associated with the local circulation patterns due to the differential heating between land and water surfaces and their interactions with the large-scale (synoptic) circulation patterns. The fishermen are possibly the major navigators on the lake, which often take greater risk on fishing from using unsuitable vessel such as canoes and small boats below 150 tons.

**Table 1.** Navigation analysis in Tanzania

Navigation area	safety	Uses of ECDIS	Disaster
Indian Ocean	75%	40%	25%
Lake Victoria	10%	0%	90%
Lake Tanganyika	30%	0%	70%
Lake Nyasa	20%	0%	80%

The main conclusion about table 1 is as follows: Lake Victoria is the largest lake in Africa and chief reservoir of the Nile, lying mainly in Tanzania and Uganda but bordering on Kenya. It is the second largest lake among the freshwater lakes of the world. Its shores, save on the west, are deeply indented. It should be considered as a sea from

the point of view of the safety of navigation. Figure 1 demonstrates the navigation water in the East Africa region. There are numerous vessels navigating on the lake such as cargo ships and passenger ferries, it is also a key resource for the people of East Africa. Despite interests in efficient

exploitation of the natural resources, Lake Victoria is one of

the most dangerous waterways in the world (see Figure 2)

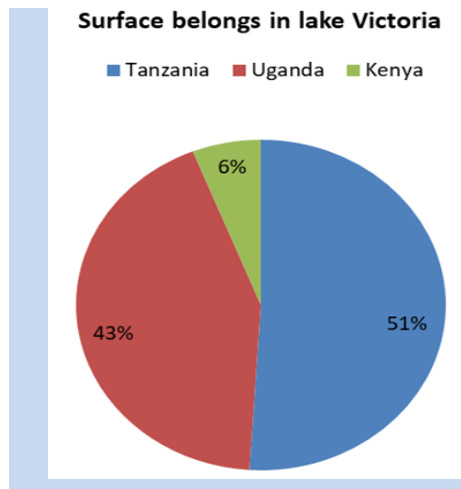


Figure 1. Navigation water in East Africa



Figure 2. M V Bukoba disasters

2.2 Navigation disasters analysis accidents involving transport and vessel

Table 2.Lake Victoria

Vessel	years	Events	Death toll & cargo
M.V Bukoba	May 1996	capsized	800 deaths
M.V Kabelega	May 2005	sank	800tons
M.V Thor	March 2006	ground	300,000 liters of petroleum
M.V Nyamageni	April 2006	Capsized and sank	28 deaths
Passenger boat	July 2010	capsized	50 deaths
M.VNyerere	September 2018	capsized	228 deaths

Table 3.Tanzania’s Indian Ocean

Vessel	years	Events	Deaths toll % cargo
M.V Islander 1	September 2011	sank	Over 1000 deaths
M.V Skagit	July 2012	capsized	Over 222 deaths
M.V Alafatt	Jun 2013	Electrical fire	Tons of cargo loose

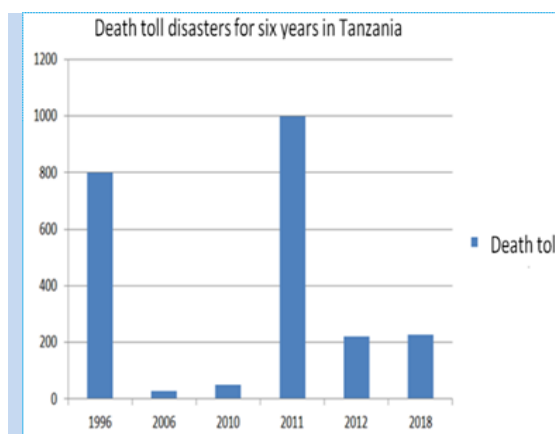


Figure 3. lake Victoria and Indian ocean

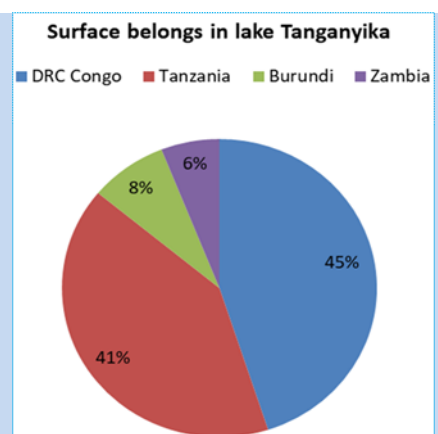


Figure 4.Navigable water East and Central Africa

ECDIS is available only in vessels navigating in Indian Ocean which meets the IMO/SOLAS requirements of safety navigation for the electronic chart system (modern navigation equipment). However, old navigation equipments is still being used in waterways.Lake Tanganyika is the second largest of all African lakes and the second deepest lake in the world.Figure 4 showing surface belongs of four countries.Lake Nyasa is the African Great Lake, located between Tanzania, Malawi and

Mozambique, it is in the southernmost in the East African Rift valley and Lake Nyasa is the ninth largest lake in the world and the third largest lake in Africa.

**Table 4.**List of largest lake in two countries.

Countries	Lake	Area	Length
Tanzania	Victoria	68870 sq.km	322km
Tanzania	Tanganyika	32600 sq.km	676km
Tanzania	Nyasa	29500 sq.km	579km
China	Qinghai	4489 sq.km	105km
China	Khanka	4190 sq.km	90km
China	Poyang	3210 sq.km	170km

The table 4 demonstrates that Tanzania has large area of navigation which of course require to be utilized by modern navigation equipment but it is not done until now due to many factors mention in the previous paragraphs.

**2.3. Causes of disasters.**

Overloading ships and manually powered fishing boats have no scale to keep track of weight limits. Moreover smaller boats are more prone to overloading, they are structural integrity of boats declines with age. Newer boats are made of asbestos but they are much fewer in number than wooden boats. The fishermen felt fatigue and exhausted which often cause accidents, particularly during storm weather. Underwater currents drift fishing boats and nets to disaster. Also there is occurrence of Tornado which adds difficult in navigation.

**2.4. Causes of an accidents and hazards**

**Table 5.** Reason for sank and capsized of vessel in Tanzania

Cause situations	percentage
Storms	28.8%
Strong winds	14.9%
Strong waves	13.3%
Trial and error	4.6%
Poor seamanship	3.7%
Lack of equipment for weather parameters inland waterways	11%
Lack modern navigation equipment on board	21.3%
Missing course and lose of direction	2.4%

Table 5 describes the deficiency of modern navigation equipments on board by 21.3% and lack of weather equipment parameter by 11% causing sinking and capsizing of vessels.

**2.5 Unsafe navigation in Tanzania water bodies.**

- Lack of Surveyed water in Indian coastal water and inland waterways.
- Lack of Training and familiarization of modern navigation equipment on board.
- Lack of knowledge in operating navigation equipment.
- Lack of updated nautical chart and fishing map in lakes.

Figure 5 show the old nautical chart in Lake Victoria, actually many data information is not correct. For example: sounding, island names, and figures are not clear. The chart published in London United Kingdom on 23<sup>rd</sup> March 1908 under the Superintendence of Rear Admiral A. Montya Field F.R.S. Hydrographic of the Navy, still in use.



**Figure 5.** Victoria title chart



**Figure 6** Nautical charts in Lake Victoria

### III. TANZANIA'S URGENT NEED FOR MODERN NAVIGATION EQUIPMENT.

Tanzania is a maritime country whose overseas trades and economic demand is relied on marine modern transportation technology. Tanzania's navigation technology has not been modernized for a long time. The main navigational equipment is still fishing map, navionic chart, nautical chart, radar /radar plotter and magnetic compass. Due to nature and characteristics of Tanzania water bodies in inland; these equipment's still do not simplify the safety and development of navigation. Tanzania needs modern navigation equipment such as ECDIS which relates to digital navigation equipment in order to promote progress for Tanzania's future to save lives from sea disasters and strengthen its capacity for tourism, transportation and exploitation of marine resources.

#### 3.1 Exploitation of marine resources.

Tanzania is a coastal state endowed with fishery resources that has both marine and inland fisheries potential. Marine water covers 64,000 square kilometers and Exclusive Economic Zone which covers 223,000 square kilometers. Figure 7 explains the Sketch of Tanzania map, showing the location of navigable water. The country has coastline, about 800 km declared as its Exclusion Economic Zone but has not yet exploited because of the lack of modern navigation equipment to meet the safety navigation on the sea.

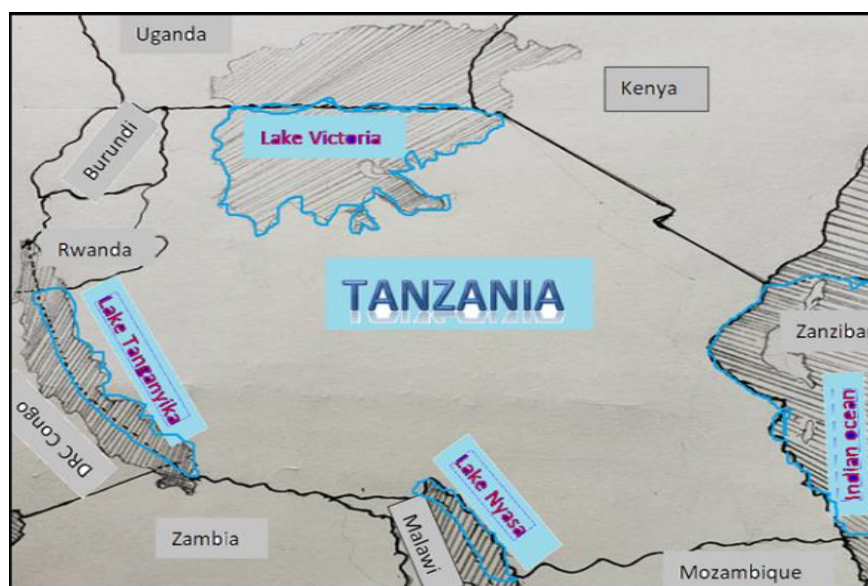


Figure 7. Sketch of Tanzania map show the location of navigable water

### IV. TECHNICAL ANALYSIS OF ECDIS TO SOLVE PROBLEMS OF NAVIGATION IN TANZANIA.

ECDIS is the contemporary marine navigation equipment technology which emerged after the 1960s. Due to the transition challenges the development of ECDIS is a continuing process based on user needs. In 2014 and 2015 several international standards related to ECDIS (IEC 61174 Standard, i.e. edition 4.0; IHO S-52 Presentation Library, i.e. edition 4.0; IHO S-64 Test Standard, i.e. edition 3.0) underwent revisions. This was done in order to reduce implementation irregularities, increase clarity of the standards, and improve the overall usability of ECDIS.

New ECDIS Standards now is specifying which objects have to be treated as navigational hazard, areas for which special conditions exist and safety-contour-related objects. Also the new function has been added to the software development kit (SDK) and now the ECDIS can:

- Reflect the revised system and new definition for the chart and mariner's settings, i.e. display categories, viewing group layers, and so-called display selectors.
- Display a chart's status at any past time or time interval, based on the applied chart updates.
- List those objects in a pick report which are displayed according to the chart settings.

ECDIS requires special Hydrographic data from surveyed water with specified chart areas like Indian Ocean. Failures are due to power supply results in unreliable operation of equipment, incorrect operation of ECDIS and lack of training over modern navigation equipment and limitation because of lack of surveyed water. Table 6 demonstrates the possibility of application of ECDIS in Tanzania's water.

**Table 6.** Analysis of new standard ECDIS

Navigation area	performance	Failures	limitation
Ocean	85%	5%	10%
Inland Waterways	15%	35%	50%

#### 4.1 Basic failures of new ECDIS

- a. Failure to display navigation feature correctly, such as:
  - Navigation area as recently recognized by IMO such as PSSA and ASL;
  - Navigation light with complex characteristics;
  - Underwater features and isolated dangers.
- b. Failures to detect objects by route checking in voyage planning mode;
- c. Failures to manage a number of alarms correctly;
- d. Not able to correct other errors from sensor.

#### 4.2 Limitation of new ECDIS to Tanzania water

ECDIS requires a type of Electronic Navigational Chart (ENC) which is “vector chart” officially authorized by the National Hydrographic Office (NHO) for those charts areas. All the hardware and software for the ECDIS system need to be designed and certified for navigational onboard ships and must meet international performance standards to ensure they are safe and reliable. Tanzania has no NHO and uses NHO Dehradun of India and most of waterways in Tanzania have no hydrographic information for ECDIS system.

#### 4.3 The keys point Analysis.

- Alarm functions must be minimized to avoid too much disturbance in the bridge.
- ECDIS should be stored and able to reproduce certain minimum elements required to reconstruct the navigation and verify the official database.
- Data shall be recorded at 45minutes to ensure ship's last track record time, position, heading, and speed.
- Also should be ensured to use the record of official data: ENC source, edition, date, cell and update history.
- ECDIS should record the complete track for the entire voyage, with time marks at intervals not exceeding 3 hours before handover watch, if watch hours are 4hours.
- ECDIS should be connected to systems providing continuous position-fixing, heading and speed information.
- The ECDIS must be updated to the latest version of the IHO standards.
- Highly sophisticated anti-grounding, anti-collision alarms and settings make ECDIS an indispensable safety tool on the bridge too, particularly when combined with weather forecast.

#### 4.4 The Latest trends in ECDIS technology

- High specification products, innovative features and ground-breaking technology.
- More advanced ECDIS systems, such as Martek Marine's IECDIS™, is easy to operate offers multiple chart update options, including email, DVD, and CD-ROM.
- There is no need to manually update charts.
- The newly patented 4G mobile antennae automatically updates charts every time the vessel enters dock, which means charts will never be out of date.
- No ongoing maintenance fees because it has no moving parts.
- They are designed to cope with harsh maritime conditions.
- The systems even come with a top of the range, glare-resistant screen as standard.

### V. INITIATIVES MOBILE MARINE NAVIGATION TECHNOLOGIES IN TANZANIA WATER BODIES.

Navigation is being carried out by connecting Laptop, Tablet or ipad to the G Star IV GPS receiver. G-Star is the fastest GPS that can be used for many purpose enrollments to get an accurate location of Aadhaar Centers. USB wired GPS for Aadhaar Kit used to determine Latitudes and Longitudes. Figure 8 gives photo of the GPS receiver.





Figure 8. GPS Receiver

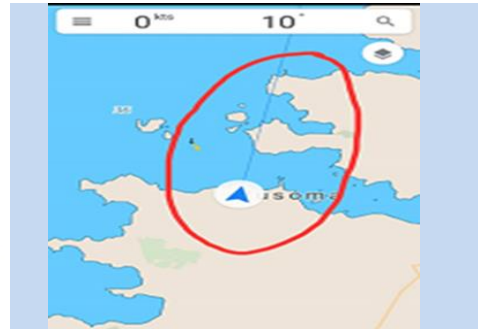


Figure 9. C-Map application inlake Victoria

Acquiring ENC by downloading its application from internet or copying from someone who already has it or buy the ENC SD CARD, and using ENC on display system i.e. laptop, tablet, and iPad, connected to GPS antenna to support accuracy on positioning. Synchronization of ENC with other electronic navigation system will be carried out i.e. radar, echo sounder and AIS are connected with C-map as shown in Figure 9.

**5.1Victoria marine charts**

Victoria marine charts are available on iBoating: Australia Marine & Fishing App. Marine charts applications now support multiple platforms including Android, iPhone/iPad, MacBook, Blackberry®, Blackberry Playbook, and Windows. The Marine Navigation App provides advanced features of a marine chart plotter including adjusting water level offset and custom depth shading. Fishing spots and depth contour layers are available in most Lake Maps. Nautical navigation provides features including advanced instrumentation to gather wind speed direction, water temperature, water depth, and accurate GPS with AIS receivers (using NMEA over TCP/UDP). Example nautical chart title and scale (see table 7).

Table 7. Victoria marine charts

Nautical Chart Title	Scale
Australia - Victoria - Port Phillip - The Rip	1:12000
Australia - Victoria – Warrnambool	1:8000
Victoria - Apollo Bay Boat Harbour	1:4000

**5.2Practical difficulties analysis**

Challenges for the marine navigation application of C-map, GPS chart plotters, mobile and G Star IV GPS Receiver does not show soundings. Also automatic routing and accuracy positioning require high sensitive internet data. Low internet data with less accurate positioning, running cost is high goes up to \$35 per month. An unstable network at high sea. There is also no training about the use of such application under the terms of the ISM Code. And it does not meet international performance standards to ensure safety and reliable navigation in lakes which is not surveyed for long time. These types of navigations are still prominent problems of safety of navigation.

**5.3Meteorological services.**

Mobile Weather Alerts is the project that uses mobile technology as a sustainable warning service to reduce casualty tolls and the vulnerability of communities in the Lake Victoria region due to the bad weather. It is important to have modern navigation equipment which is able to provide, weather parameters around the inland Tanzania’s water bodies. Thiery et al. (2017) have complemented ongoing early warning efforts based on numerical weather prediction, by developing a new satellite data-driven storm prediction system, the prototype of Lake Victoria Intense Storm Early Warning System (VISEWS), but predictive power is high and independent of the type of input dataset. Thiery et al.’s study results suggest that regression-

based models that are motivated through process understanding have the potential to reduce the vulnerability of local fishing communities around Lake Victoria.

**VI. RECOMMENDATION**

Lacking of higher quality of initiatives that utilizes mobile technologies and lower operational costs, it is advised related Chinese’s marine industries to develop the modern equipment such as:

- Scale to keep track of weight limits for small boat;
- Equipment for weather parameters on lakes and on board ships;
- Low cost, high-performance, small-tonnage of ECDIS equipment to the vessels and fishing boats for fishermen that will reduce fatigue and exhaustion which often causes accidents;
- Light and unlighted aids of navigation in East and Central Africa lakes.

**6.1National Maritime Bureau.**

Tanzania is the obliged to produce her survey equipment and train personnel, she should establish Maritime Bureau or the Water way Bureau. The body which will carry out survey of relevant waters and to curb the safety of people, vessels as well as cargoes. Since Tanzania and China are very closely and Traditional long-lasting friends, Tanzania has to seek close cooperation from China

Government or any other companies to reach at that extent. This will be achieved Through Chinese Belt and Road Initiative.

### 6.2 Uninterruptible power supply (UPS).

Due to the high temperature in tropical region especially in Tanzania. The life span of led battery is short sometimes it is caused by the failure of charging system, due to unstable power generated by auxiliary engine or shore power. In this case most of navigation equipment fails to provide accurate data. Therefore the ECDIS should be separated from the main power to other components. Battery backup devices must be manufactured with varying degrees of backup ability. Therefore there is a need for a reliable supply of electricity. There are three versions of the UPS: standby, on-line and line interactive. An on-line UPS is normally most expensive of standby UPS and line-interactive UPS. Line-interactive UPSs are very similar to standby UPSs but are better designed for areas that have frequent voltage drops, such as Tanzania. They cost a bit more than a standby unit but not as much as an on-line UPS. Higher-end battery backup will feature LCD screens that will be displaying information about the amount of battery charge the power being used and how long will the power last. Though Line-interactive UPSs is useful but it is recommended to be used with the combination of solar energy in order to guarantee the stability of power flow at least for half an hour if there is any emergency occurrence.

## VII. CONCLUSION

This research paper has reaffirmed the high level of importance placed by the development of new standard ECDIS considering the new technology advancements as a requirement under the SOLAS Convention. The analysis has identified a need for enhanced outreach by displaying information providers to the ECDIS to overcome major obstacles in the geographical information, which still have some failures and limitations in some countries like Tanzania, where most of waterways are not surveyed. The study has reinforced the need for the lakeside weather/climate information to be available in the vessel. The navigation disaster over Indian Ocean and Lake Victoria exhibit maximum contribution in need of providing a new sight regarding the potential physical mechanisms that ECDIS equipment must include in formulating actionable user of all vessels for safety navigation.

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