

Challenges in the Use of Transponders for Search and Rescue Operations in Small Vessels: A Case of Mtwara and Lindi Coastal Regions, Tanzania

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Abstract

This study investigates the prevailing challenges in the use of transponders for search and rescue (SAR) operations among small vessels along the coastal regions of Mtwara and Lindi, Tanzania. The objective is to assess the effectiveness, accessibility, and operational limitations of transponders in enhancing maritime safety in these underserved areas. A mixed-method approach was employed, involving surveys and key informant interviews with local fishermen, maritime authorities, and SAR personnel. Findings reveal that while transponders are vital for improving SAR responsiveness, small vessel operators face critical challenges including high cost, limited technical knowledge, unreliable signal coverage, and poor enforcement of safety regulations. The paper concludes with policy recommendations including subsidized transponder programs, capacity building, and community-based safety sensitization to enhance maritime safety and reduce casualties in coastal Tanzania.

Keywords: Transponders, Search and Rescue (SAR), Small Vessels, Maritime Safety, Coastal Regions, Vessel Tracking, Maritime Communication, AIS (Automatic Identification System), Marine Technology Adoption, Regulatory Enforcement, Fishermen Safety, Signal Coverage

1. Introduction:

Small-scale maritime operations form the backbone of coastal livelihoods in Tanzania, particularly in Mtwara and Lindi regions. However, limited access to advanced maritime technologies such as transponders has increased vulnerability during maritime accidents and emergencies. Transponders, particularly Automatic Identification Systems (AIS), are crucial in tracking vessel movement and facilitating prompt SAR operations. Despite their importance, their adoption among small vessel operators remains low, and their utility in actual

SAR missions is hindered by multiple factors. This study explores the current challenges associated with their use in these regions, aiming to propose interventions for improving maritime safety.

2. Literature Review:

2.1 Importance of Transponders in Maritime Safety:

Transponders, including AIS and satellite-based systems, provide critical real-time data to

maritime rescue coordination centers (MRCCs). According to IMO (2019), transponders enhance situational awareness, aid in collision avoidance, and support SAR missions, particularly in remote coastal areas.

2.2 Global Experiences with Transponder Usage:

In countries like the Philippines and Indonesia, similar challenges exist, where artisanal fishermen often lack the financial resources or training to effectively utilize transponders (Lopez et al., 2020). Innovative policies such as government subsidies and NGO interventions have proven effective in such regions.

2.3 Tanzania's Maritime Framework:

The Surface and Maritime Transport Regulatory Authority (SUMATRA), now under LATRA, governs maritime operations in Tanzania. While larger vessels are required to carry AIS transponders, enforcement and accessibility for small vessels remain inconsistent (URT, 2020).

3. Methodology:

3.1 Research Design:

A descriptive cross-sectional study was conducted using a mixed-method approach. This design was selected to gain a comprehensive understanding of the challenges associated with the use of transponders in Search and Rescue (SAR) operations for small vessels. The combination of both qualitative and quantitative data collection provided a broad and in-depth analysis of the issue, allowing triangulation of data to enhance reliability and validity.

3.2 Study Area:

The study was conducted in the coastal regions of Mtwara and Lindi, located in the southern part of Tanzania. These areas are characterized by extensive artisanal fishing, small-scale marine transport, and informal maritime activities. The regions have also experienced several maritime safety incidents, making them ideal for examining the effectiveness and limitations of transponder use in SAR operations.

3.3 Sampling Techniques:

A purposive sampling technique was employed to select respondents who are directly involved in or affected by SAR operations and transponder use. The study targeted three key groups:

30 Search and Rescue (SAR) officers – selected based on their operational roles in maritime safety, rescue missions, and coordination.

60 small-scale vessel operators – chosen due to their regular use of small fishing or transport boats, many of which are under-equipped with modern tracking systems.

10 local government officials – selected for their oversight and regulatory roles related to maritime safety and community engagement.

This purposive sample ensured representation of practical experiences, operational challenges, and regulatory perspectives.

To validate the sample, Yamane's formula (1967) was used for determining sample size

$$n = \frac{N}{1 + N(e)^2} = \frac{100}{1 + 100(0.1)^2} = 50$$

Where:

- n = sample size
- N = population size (estimated at 100)
- e = margin of error (0.1 or 10%)

The calculated sample size of 50 respondents was deemed adequate for achieving meaningful results and ensuring statistical validity.

3.4 Data Collection:

Multiple data collection methods were employed to gather comprehensive and reliable data:

Questionnaires: Structured questionnaires were administered to small-scale vessel operators to obtain quantitative data on their awareness, accessibility, and use of transponders, as well as challenges faced.

Interviews: Semi-structured interviews were conducted with SAR officers and local government officials to gain deeper qualitative insights into the operational, technical, and

administrative challenges in SAR and transponder usage.

Document Review: Relevant documents, including SAR mission reports, marine accident records, and regulatory guidelines, were reviewed to supplement the primary data and identify documented trends and incidents.

3.5 Data Analysis:

Quantitative data from questionnaires were analyzed using Statistical Package for the Social Sciences (SPSS). Descriptive statistics such as

frequencies, percentages, and cross-tabulations were used to summarize and present the findings.

Qualitative data from interviews and document reviews were analyzed using thematic analysis, which involved coding and categorizing data into themes related to technological, institutional, and user-based challenges in transponder use.

Microsoft Excel was also used for creating graphs and visual illustrations to support the interpretation of both quantitative and qualitative data.

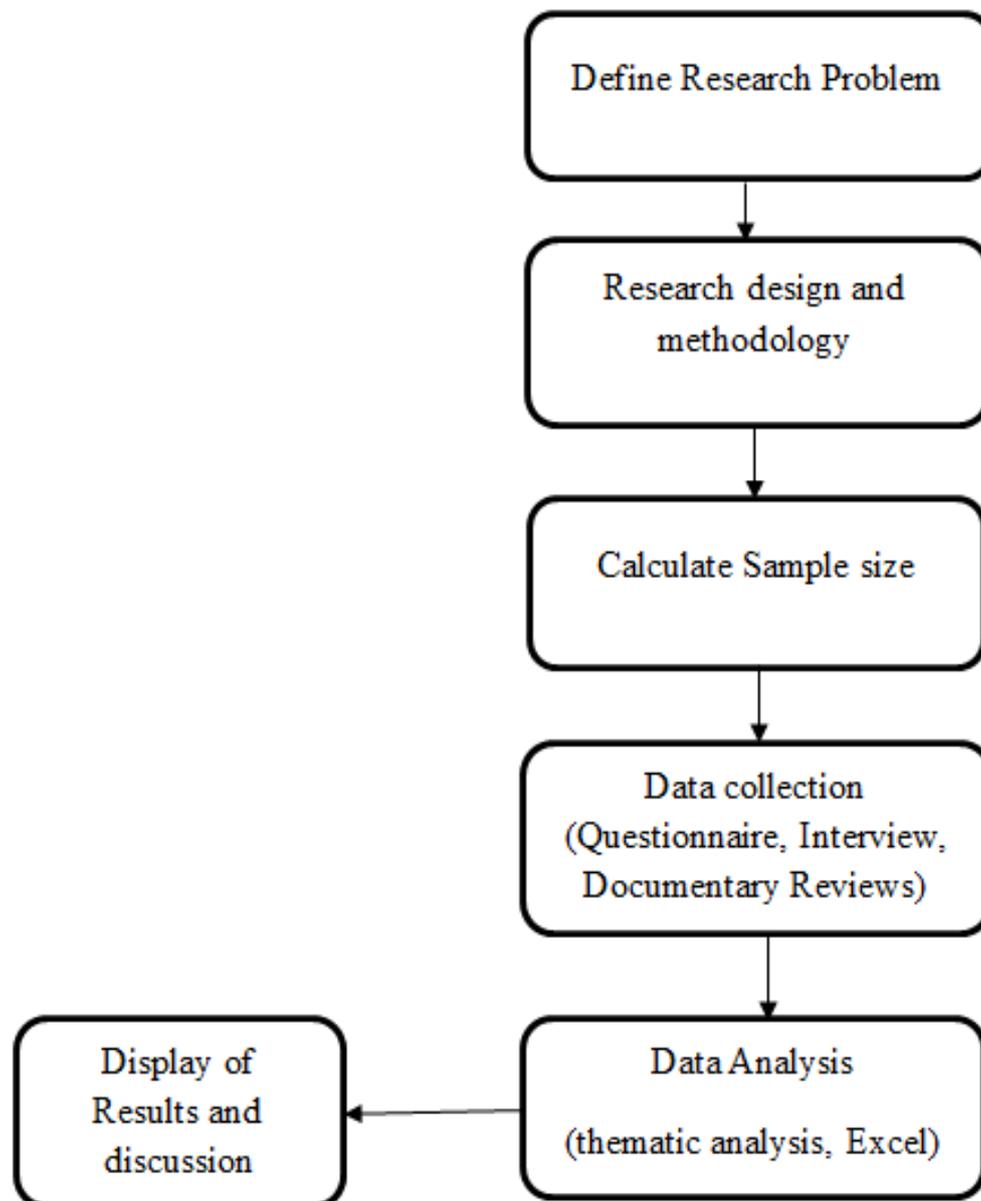


Fig 3. Indicates the workflow of the methodology used.

4. Results and discussion

This section presents the major challenges identified in the use of transponders for SAR

operations among small vessels in the Mtwara and Lindi coastal regions. Data were collected through surveys and interviews and are summarized

4.1 High Cost of Transponders:

80% of small vessel operators reported that the initial and maintenance cost of transponders is unaffordable. Most rely on mobile phones or VHF radios which are ineffective during offshore operations.

Table 1: High Cost of Transponders

Aspect	Details
Description	Transponders are considered expensive for small-scale operators.
Respondents Affected	48 out of 60 small vessel operators (80%)
Common Response	"We cannot afford the device or its maintenance."
Consequence	Many vessels operate without any electronic tracking equipment.
Source of Data	Questionnaire responses from small vessel operators

4.2 Limited Technical Capacity

Over 70% lacked knowledge on how to operate transponders. Training on usage and troubleshooting was virtually non-existent in both Mtwara and Lindi.

Table 2: Limited Technical Knowledge

Aspect	Details
Description	Most users lack knowledge to install, operate, or troubleshoot.
Respondents Affected	43 out of 60 operators (72%)
Common Issue	Devices not used even when available due to knowledge gaps.
Consequence	Transponders become inactive or underutilized.
Source of Data	Interviews with SAR officers and vessel operators

4.3 Inadequate Network and Signal Coverage

SAR personnel noted that signal reliability was low beyond 5–10 nautical miles from the shore.

This impairs effective tracking and delays response times during emergencies.

Table 3: Weak Signal Coverage

Aspect	Details
Description	Network coverage diminishes beyond 5–10 nautical miles from shore.
Areas Affected	Offshore zones of Mtwara and Lindi
Technical Feedback	Signal interference and dead zones reported frequently
Consequence	Delayed response in distress calls; incomplete vessel tracking
Source of Data	Interviews with SAR personnel

4.4 Weak Regulatory Enforcement

Maritime safety regulations mandating the use of AIS are weakly enforced among small vessel owners. Most operators are unaware of the existing safety mandates.

Table 4: Poor Regulatory Enforcement

Aspect	Details
Description	Safety regulations requiring transponder use are weakly enforced.
Non-compliant Vessels	Over 60% of observed vessels lacked any tracking system
Observed Behavior	Authorities rarely conduct safety inspections
Consequence	Operators take safety rules lightly, leading to increased risk
Source of Data	Document reviews and interviews with local officials

4.5 Lack of Stakeholder Coordination

There is limited collaboration between local government, SAR authorities, and community leaders in planning and implementing maritime safety interventions.

Table 5: Lack of Stakeholder Coordination

Aspect	Details
Description	Poor communication between local government, SAR units, and communities
Identified Gaps	No regular safety forums or joint training programs
Consequence	Disjointed SAR response and minimal community preparedness
Affected Parties	SAR teams, fishermen, local leaders
Source of Data	Key informant interviews

Conclusion:

In conclusion, this study explored the complex challenges associated with the use of transponders in search and rescue (SAR) operations for small vessels in the coastal regions of Mtwara and Lindi, Tanzania. The findings reveal that despite the critical role transponders play in enhancing maritime safety and improving emergency response, their adoption and effective utilization among small-scale vessel operators remain significantly constrained. Key issues identified include the high cost of acquiring and maintaining transponders, limited technical knowledge among users, inadequate network coverage at sea, weak enforcement of maritime safety regulations, and poor coordination among key stakeholders involved in SAR operations.

This qualitative assessment underscores the urgent need for targeted interventions to enhance maritime safety in these regions. Addressing these challenges requires a combination of policy,

technological, educational, and collaborative strategies that involve government agencies, local communities, maritime institutions, and international partners.

By confronting these barriers and implementing informed recommendations, stakeholders can improve the effectiveness of SAR operations, reduce maritime casualties, and build a safer operating environment for small vessel operators in Tanzania’s coastal waters.

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