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A Mixed-Methods Analysis of Stakeholder Perceptions, Institutional Frameworks, and Operational Realities in Nigeria's Ferry Transport System

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Abstract

Inland ferry transport in Nigeria has great potential to reduce congestion in cities, but it is seriously underused because of ongoing safety problems and operational inefficiencies. Even with regulations in place, gaps in enforcement, cooperation among stakeholders, and the adoption of technology hinder progress. This study looks at how stakeholder perceptions, institutional policies, and operational realities interact to identify barriers and find ways to create sustainable ferry transport in Nigeria. A convergent parallel mixed-methods design was used. Quantitative surveys gathered safety and efficiency perceptions from 5,000 passengers across five busy ferry routes and 25 operators from five selected companies. Qualitative interviews involved 10 regulators from Lagos State Waterways Authority (LASWA), National Inland Waterways Authority (NIWA), and Nigerian Maritime Administration and Safety Agency (NIMASA). Secondary analysis included accident reports from 2010 to 2024, and operational records were collected. Data were analyzed with descriptive statistics, the Relative Importance Index (RII), and thematic coding. Results show that passengers see ferry safety as seriously lacking and service quality as inconsistent. Interestingly, 89% noticed technology use, like   Global Positioning Systems (GPS) and e-tickets, while 90% supported AI safety alerts, showing a willingness to embrace innovation despite widespread distrust. Operators face ongoing operational and regulatory challenges: 52% used reactive maintenance, 60% depended on informal crew training, and 60% reported infrequent regulatory inspections. About 69% thought enforcement was unfair or inconsistent, and self-assessments of route safety were low, with only 17% rating routes as "very safe." Financial issues took precedence for operators, overshadowing safety investments, with an RII of 1.09. The results also showed that operational challenges are scattered among various stakeholders. The causes of accidents indicated that mechanical issues accounted for 24% of incidents, which stem from poor maintenance practices and outdated fleets.

Keywords: Ferry safety, Operational efficiency, Stakeholder perceptions, Regulatory fragmentation, Mixed methods, Lagos waterways, Transport policy.

1 | Introduction

Inland waterway transportation is a crucial part of multimodal transport systems in developing countries, especially in areas with complex river and coastal landscapes like Nigeria. As urban congestion grows on roads

and rail transport lags, ferry transport provides a practical alternative for moving passengers and cargo over short to medium distances [1]. Lagos State, Nigeria's commercial center, has over 22 million residents and a complex network of inland waterways. However, ferry services are still underused and face safety, regulatory, and performance problems [2].

Over the past decade, several ferry accidents and passenger deaths have exposed weaknesses in Nigeria's water transport system. For instance, in 2022, a ferry accident on the Igbogbo-Baiyeku route in Lagos resulted in multiple fatalities. Another tragedy in 2023 took the lives of 15 people along the Badagry corridor [1]. These incidents often arise from factors like poor vessel maintenance, overcrowding, inexperienced operators, lax enforcement of safety rules, and a lack of navigation aids [3].

Despite the existence of regulatory bodies such as the Lagos State Waterways Authority (LASWA), National Inland Waterways Authority (NIWA), and the Nigerian Maritime Administration and Safety Agency (NIMASA), concerns are growing about how well policies are being implemented and overseen. The ferry transport environment is fragmented, with overlapping jurisdictions, insufficient data for planning, and limited involvement from stakeholders [4]. According to [2], these systemic problems have resulted in inconsistent performance standards and diminished public confidence in ferry services as a reliable mode of transport.

Studies in similar developing economies, such as Xiao et al. [5], Jensen and Wu [6], show that safety and operational efficiency in water transport can improve significantly through clear policy frameworks, ongoing stakeholder consultation, and the use of performance metrics. However, such approaches are often missing in Nigeria, where policies are either outdated or poorly enforced. This study seeks to close the knowledge gap by providing an assessment of ferry transport safety and operational efficiency in Nigeria's inland waterways. It uses a mixed-methods approach to examine how ferry passengers, operators, and regulators view current safety conditions and operational challenges, as well as how existing policies affect operational practices. By combining stakeholder insights with institutional knowledge and operational data, the study aims to produce recommendations for policy reform and strategic investment in the sector.

2 | Literature Review

2.1 | Ferry Transport in Developing Economies

In many developing countries, inland waterways act as essential routes for transporting passengers and goods, especially in urban and nearby areas. Calderón et al. [7] established that ferry systems are cost-effective, use less energy, and can ease the strain on crowded road networks [8]. However, their operation in Africa often faces serious safety issues, poor infrastructure, and weak regulation [9]. In Nigeria, ferry transport is underdeveloped, even though the country has extensive coastal and inland water systems [10]. While cities like Lagos have taken steps to improve water transport, many people still worry about safety and the reliability of services.

2.2 | Passenger Perception and Public Trust in Ferry Services

Passenger perception plays a crucial role in how people use and accept ferry transport services. Studies like Tinali and Temba [11], Ola Aiyegbajeje et al. [4], and Mohammed et al. [2] show that safety, comfort, affordability, and reliability are the key factors influencing passenger choices in water transport. Akpudo [10] discovered that 68% of ferry users in Lagos were unhappy with safety protocols. They pointed to poor emergency preparedness and a lack of life-saving equipment. Imorataria et al. [12] perceived risks, such as overloading, mechanical failure, and unpredictable weather, impact ridership levels and affect public trust in the ferry system. Furthermore, studies indicate that perceptions are influenced not only by real experiences but also by media coverage of ferry accidents and past incidents [13].

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2.3 | Policy and Institutional Frameworks in Inland Waterway Transport

The rules governing ferry transport in Nigeria are marked by overlapping responsibilities, uneven enforcement, and disjointed policy development [12]. Institutions like LASWA, NIMASA, and NIWA share different levels of responsibility. This often causes conflicts or gaps in regulation. For instance, NIMASA looks after maritime safety at the national level while LASWA manages Lagos waterways. However, the cooperation between these agencies is often weak. This results in inconsistencies in inspection, licensing, and accident reporting. Studies of transport policy in Singapore by Olisa [13] reveal a unified, centralized approach combining land-use planning, regulation, and public transport investment to shape mobility trends, reducing car dependency and improving coherence across transport. Similarly, in Portugal, projects like PORTMOS and analyses of transport infrastructure PPPs show that when legal/regulatory frameworks are clearly defined and institutions are aligned, maritime/transport interventions are more effectively governed [14].

2.4 | Operational Performance of Ferry Services

Operational efficiency in ferry transport includes aspects such as punctuality, vessel maintenance, crew training, route reliability, and ticketing systems. Poor operational performance is commonly reported in Nigeria due to aging fleets, manual scheduling, and a lack of performance standards [15]. Studies like Olayinka Yusuf et.al [16] in Nigeria indicate that a large number of ferry (or motorboat) operators lack formal training or certification, and that many maintenance practices are reactive rather than preventive, contributing to frequent safety lapses. This leads to mechanical failures and a higher risk of accidents. In contrast, ferry systems in developed countries have implemented performance tracking with digital dashboards, predictive maintenance, and automatic route monitoring to improve reliability [13].

2.5 | International Best Practices and Lessons for Nigeria

Global literature on ferry safety and performance offers insights that apply to Nigeria. For instance, in Singapore, real-time monitoring systems use Internet of Things (IoT) and Artificial Intelligence (AI) to track vessel conditions and predict hazards [16]. In India and Indonesia, regulatory changes have streamlined licensing, safety training, and route planning. These improvements boost public confidence in ferry transport. These countries show that using passenger feedback, introducing new technology, and having strong leadership are essential for transforming ferry systems. Nigeria can gain by adopting these principles and adjusting them to local economic, social, and infrastructure realities. Based on this review, the literature identifies three main themes: 1) ferry safety in Nigeria suffers from weak institutional enforcement and low operational standards; 2) user perceptions are shaped by actual safety conditions and a lack of communication from authorities; and 3) international practices highlight the importance of technology, regulatory consistency, and public involvement. However, there is limited research that combines stakeholder perceptions, policy review, and operational metrics within a single framework. Most existing studies examine these dimensions separately, missing how policies influence practices and how perceptions reflect performance outcomes. This study addresses this gap by using a mixed-methods approach to gather data from users, operators, and regulators in Nigeria's ferry transport system.

3 | Methodology

This study used a convergent parallel mixed-methods design. It combined both quantitative and qualitative data to assess safety perceptions and the operational efficiency of ferry operations in Nigeria. The research took place in Lagos State because it serves as the commercial and maritime hub. It has the largest and most active inland waterway network and hosts corporate operators that use technologies like Global Positioning Systems (GPS), the IoT, and AI to improve safety and efficiency in ferry transport systems.

To fulfill the study's goals, both primary and secondary data were collected. For the primary data, the target population included three stakeholder groups: ferry passengers, operators, and regulatory officials. The passenger population was based on patronage data collected from five selected operators: Lagferry,

Metroferry, Seacoach, Texas Connection Ferries, and Omnibus Ferry. From a reconnaissance survey, the average weekly passenger count for these five operators was fifty thousand. A multistage sampling strategy was used. In the first stage, five busy ferry corridors operated by these companies were chosen. In the second stage, systematic random sampling selected 5,000 passengers (1,000 per terminal) for the survey, representing 10% of the population. For the operators, 25 ferry operators were chosen using stratified purposive sampling, with five crew members from each company.

In the qualitative phase, Key Informant Interviews (KIIs) were held with 10 regulatory officials from LASWA, NIWA, and NIMASA, using purposive expert sampling. For secondary data, accident reports, safety regulations from LASWA, and operational performance data from ferry companies were gathered. The data collected were analyzed using descriptive and inferential statistical methods, with Microsoft Excel 2010 as the primary analytical tool. Descriptive statistics were applied to investigate the quantitative data, including frequencies, percentages, and cross-tabulations to assess trends in passenger behavior, operator practices, and safety perception. The results were shown in both tables and graphs. To understand the significance of each operational challenge, the Relative Importance Index (RII) was used as the main inferential statistic. Since the study included qualitative elements, the analysis combined both quantitative and qualitative methods. Qualitative responses were coded and assessed using a 5-point Likert scale, which was then transformed into RII values for each factor. This method allowed for a comparative assessment of the perceived importance of each challenge as identified by the ferry operators.

4 | Result and discussion

4.1 | Demographic Characteristics of the Respondents

Table 1 shows the demographic characteristics of the respondents surveyed at selected ferry terminals in Lagos State. The gender distribution is nearly equal, with 53% male and 47% female respondents. This indicates a balanced gender representation among ferry users. The age distribution reveals that most respondents belong to the economically active groups: 26 to 35 years (34%) and 36 to 45 years (41%). Together, these groups make up 75% of the total sample. This suggests that working adults mainly use ferry transport, reinforcing its importance for daily commuting and business travel. Occupational data show that 38% of respondents work in the private sector, while 35% are traders or businesspersons. This indicates a strong reliance on ferry services for economic activities. Civil servants account for 18% of respondents, and students make up a small 4%. This suggests that ferry usage is less common among those commuting for education. These demographic findings support the decision to target high-traffic ferry routes. They also highlight that ferry operations are crucial for urban mobility and economic activity in Lagos. The significant presence of economically active individuals stresses the importance of addressing operational and safety issues since service failures can directly affect productivity and income.

Table 1. Passenger respondents' information.

Gender	Male	Female				Total
	2645	2345				5000
Percentage	53	47				100
Age	18-25	26-35	36-45	46-60	61+	
	583	1723	2050	583	61	5000
Percentage	12	34	41	12	1	100
Occupation	Student	Civil servant	Private sector	Trader/businessperson	Others	
	201	896	1902	1732	269	5000
Percentage	4	18	38	35	4	100

Table 2 highlights passenger behavior regarding ferry usage frequency and trip purposes. The results show that ferry services are not just occasional options; they are essential for many Lagos residents. A total of 54% of respondents use ferries either daily (23%) or weekly (31%). This indicates a strong reliance on water-based transport for regular commuting. Additionally, 30% of users report occasional use, and only 1% are first-time

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users. This suggests that ferry ridership remains stable but is not significantly growing among new users. The analysis of trip purposes emphasizes the economic role of ferry transport. A substantial 60.32% of trips are for business, while 26.95% are for work commutes. Together, these account for nearly 87% of all trips, confirming that ferry services are mainly used for income-generating activities. Only 10.91% of users reported using ferries for leisure or tourism, while trips for studies and other reasons were minimal (0.28% and 1.47%, respectively). These findings match the insights from ferry operators and regulatory officials, who noted that operational planning is mainly driven by peak-hour demand linked to economic activities. The low percentage of first-time users may indicate a broader issue of public trust, especially concerning safety. This theme emerged in both passenger surveys and key interviews.

Table 2. Purpose of trip.

Frequency of usage	Daily	Weekly	Monthly	Occasionally	First User	Total
	1151	1542	773	1502	32	5000
Percentage	23	31	15	30	1	100
Purpose of trip	Work	Business	Leisure/tourism	Studies	Others	
	1321	3011	546	61	61	5000
Percentage	26	60	11	1	2	100

4.2|Passenger Ferry Safety Assessment Perception

The results from *Table 3* show serious concerns about safety communication, equipment availability, and personal security while using ferry services. Only 42% of respondents said safety instructions were given before or during their trips, while 49% reported that no instructions were provided. Another 9% were unsure, indicating inconsistency in communication among routes and operators. This points to a failure to enforce basic safety briefings, which are essential in passenger transport. An alarming finding was the reported availability of life-saving equipment like life jackets. Nearly half of the respondents (47%) said life jackets were never available during their journeys, while only 15% confirmed that such equipment was always provided. These numbers reveal lapses in regulatory enforcement and operator compliance with safety standards. When asked about their overall sense of safety using ferry services in Nigeria, 68% of passengers expressed doubt about the system (47% strongly disagreed, and 21% disagreed). Only 19% felt safe. This insecurity is further reflected in views on crew readiness. A combined 70% of respondents either strongly disagreed or disagreed that ferry staff were well-trained in emergency procedures. These results support qualitative findings from interviews with regulatory officials, which pointed to insufficient training, poor oversight, and fragmented coordination as major contributors to ongoing safety risks. The data highlight the urgent need for reforms in passenger safety communication, required safety equipment, and professional crew certification.

Table 3. Passenger ferry safety assessment perception.

Do Ferry Provide Safety Instructions Before or During Trips				
Yes	No	Not sure		
42%	49%	9%		
Are life jackets or safety equipment made available				
Always	Sometimes	Never	Don't know	
15%	31%	47%	7%	
I feel safe when using the ferry service in Nigeria				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
47%	21%	13%	13%	6%
Ferry staff are well-trained in emergency procedures				
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
47%	23%	14%	10%	6%

Table 4 looks at users' experiences with ferry timeliness, service quality, and the use of modern technology. About 65% of passengers said that ferries were either always (31%) or often (34%) on time, showing a moderate level of schedule reliability. However, a significant number (36%) reported inconsistent timing, with occasional delays or rarely arriving on schedule. This highlights the unpredictability of many ferry services in

Nigeria. When it comes to the boarding and disembarkation process, 83% of respondents rated it as either very organized (33%) or fairly organized (50%). This indicates that while there is some structural efficiency at terminals, there is still room for improvement in crowd management, signage, and flow control. Passenger satisfaction with the cleanliness and comfort of the ferries was modest. Only 21% rated their experience as excellent, while a larger portion (36%) gave it a 'fair' rating. This suggests variability in service quality and points to the need for set cleanliness standards and maintenance schedules. Notably, more than half of the respondents (51%) felt that ferry staff were not helpful, while only 30% viewed the staff as professional and supportive. This is a serious concern for service quality that could further damage public trust. On a more positive note, many respondents reported the use of technology in ferry operations. A significant 89% of passengers noticed the use of modern technologies like GPS, electronic ticketing, and onboard announcement systems. Additionally, 98% supported real-time GPS tracking of ferry operations, and 90% (a mix of "likely" and "very likely") were willing to use ferries equipped with AI-based safety alert systems. These responses show a strong interest among users in adopting technological innovations to improve safety, efficiency, and service quality.

Table 4. Passenger ferry operational efficiency and technology integration perception.

Are Ferries Usually on Time According to Schedule?				
Always	**Often**	**Sometimes**	**Rarely**	**Never**
31%	34%	19%	10%	7%
How Would You Rate the Boarding and Disembarking Process?				
Very Organized	**Fairly Organized**	**Disorganized**		
33%	50%	18%		
How Would You Rate the Cleanliness and Comfort of the Ferry You Use Most?				
Excellent	**Good**	**Fair**	**Poor**	
21%	32%	36%	11%	
Are staff on board professional helpful?				
Yes	No	Sometimes		
30%	51%	19%		
Have You Noticed Any Use of Modern Technology (like GPS, Announcement Systems, or Electronic Ticketing) on the Ferry?				
Yes	No			
89%	11%			
Would you support the Use of GPS Tracking for Real-Time Ferry Monitoring?				
Yes	No			
98%	2%			
How Likely are you to choose a Ferry Equipped with an AI-based safety Alert?				
Very Unlikely	**Unlikely**	**Neutral**	**Likely**	**Very likely**
13%	3%	7%	39%	51%

4.3 | Ferry Operator Safety Assessment Perception

Table 5 offers a detailed view of ferry operators' thoughts and practices regarding safety in Lagos State's inland waterway system. The data shows that most respondents were captains (15), with additional input from crew members (4) and managers (6). Notably, no ferry owners participated directly, which suggests a possible separation between ownership and the day-to-day operations. Many respondents (12 out of 29) reported having 4 to 7 years of experience, but only 8 had more than 7 years. The lack of respondents with under one year of experience indicates a workforce with a fair amount of experience. The study finds that only 2 operators reported doing maintenance weekly, and 5 performed it monthly. Alarmingly, 13 admitted to maintaining their ferries "only when they break down," while 5 had no regular maintenance schedule. These reactive or unplanned maintenance practices reflect the high rate of mechanical failure noted in ferry accident data *Fig. 1*, highlighting concerns over vessel reliability and the effectiveness of regulatory enforcement.

Additionally, the provision of safety equipment was inconsistent. While most operators 13 claimed always to provide life-saving gear like life jackets and fire extinguishers, seven said they did so only "sometimes," and 5 provided them "rarely." Although none claimed never to offer safety equipment, the irregular availability of these essential tools poses a real risk to passenger safety in emergencies. Responses regarding training

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reveal major shortcomings. Only five operators reported having received formal safety or navigation training, while another five had not received any training at all. A significant majority relied on informal or on-the-job learning. This supports findings from Ateme [18], who argued that informal navigation methods and inadequate training continue to threaten water transport safety in Nigeria. Inspections by regulatory bodies also seem to happen infrequently. Only one operator experienced regular inspections (weekly or monthly), while most 15 reported occasional inspections, and nine rarely saw regulatory oversight. This lack of engagement from enforcement bodies like LASWA, NIWA, and NIMASA highlights broader institutional weaknesses that contribute to a poor safety culture in the sector. These findings align with insights from stakeholder interviews, which consistently pointed to fragmented inter-agency efforts and inadequate enforcement capacity. Operators voiced strong dissatisfaction with the fairness and consistency of regulatory enforcement. Eighteen out of 26 respondents either disagreed or strongly disagreed that ferry regulation is fair or consistent, while only three agreed. Moreover, operators' evaluations of passenger safety on their routes varied: only 5 rated their routes as "very safe," 12 considered them "somewhat safe," and 8 labeled them as either "unsafe" or "very unsafe." These self-assessments suggest a recognition of unsafe operating conditions.

Table 5. Ferry operator safety assessment perception.

Operator Profile				
What is Your Position on the Ferry				
Captain	Crew member	Manager	Owner	
15	4	6	0	
How many years of experience do you have in ferry operations?				
Less than 1 year	1 -3 years	4- 7 years	Over 7 years	
0	5	12	8	
Operational Practices: How Often is Your Ferry Maintained				
Weekly	Monthly	Only when it breaks down	No fixed schedule	
2	5	13	5	
Do You Provide Safety Equipment (Life Jackets, Fire Extinguishers) for Every Trip?				
Yes, always	Sometimes	Rarely	Never	
13	7	5	0	
Have You or Your Crew Received any Formal Safety or Navigation Training?				
Yes, always	No	Only informal/on- the - training		
5	5	15		
How Often Are you Inspected by Regulatory Authorities (e.g, LASWA, NIWA, NIMASA)				
Frequently (weekly/monthly)	Occasionally	Rarely		
21	15	9		
Do You Feel That Regulatory Enforcement in Ferry Operations is Fair and Consistent				
Strongly agree	Agree	Neutral	Disagree	Strongly disagree
0	3	5	10	8
How would you rate passenger safety on your route?				
Very safe	Somewhat safe	Unsafe	Very unsafe	
5	12	3	5	

4.4|Operational Challenge in Nigeria's Ferry Transport System

The insights from passengers and operators highlight the significant challenges facing Nigeria's inland waterway transport. According to *Table 6*, safety and security concerns, with an Overall RII of 0.978, stand out as the biggest issue. Passengers rank this highest (RII = 0.98), while operators place it ninth (RII = 0.64).

This significant difference shows a disconnect in what each group values. Passengers are worried about immediate physical risks, like poorly fitted life jackets and an untrained crew.

On the other hand, operators focus on systemic problems, such as financial constraints (Operator RII = 1.09, ranked 1). This gap explains why safety reforms are hard to achieve. Operators, pressed for resources, often overlook safety spending unless regulations force them to comply. Inadequate infrastructure (Overall RII = 0.97) and aging fleets (Overall RII = 0.97) follow as the second and third largest challenges. These issues appear as poor terminal facilities, missing navigational aids, and unreliable vessels, all of which contribute to accidents (*Fig. 1*). Operators' maintenance practices are reactive, with 52% performing maintenance only when breakdowns happen *Table 5*. The high cost of replacing vessels (Overall RII = 0.96) traps operators in a cycle of postponed maintenance. This problem is even worse because of Nigeria's foreign exchange issues and reliance on imports in the maritime sector. Operators see financial constraints as their biggest hurdle (RII = 1.09), as they struggle with profitability, fuel prices, and gaining capital. This financial insecurity prevents them from investing in safety technologies, such as AI alerts and GPS, even though 90% of passengers support AI-enhanced ferries *Table 4*.

Additionally, regulatory weaknesses (Overall RII = 0.80) arise from broken oversight between LASWA, NIWA, and NIMASA, and inconsistent enforcement. Only 4% of operators report regular inspections *Table 5*, which allows overloading and mechanical neglect to persist and contribute to accidents *Fig. 1*. Low public confidence (Overall RII = 0.87) both causes and results from these failures. Passengers' lack of trust, fueled by their safety concerns (*Table 3*: 68% feel unsafe), stunts ridership growth (*Table 2*: 1% first-time users). Operators understand this issue (RII = 0.90) but often lack the resources to improve their services. This stagnation limits economies of scale and increases financial instability. These findings match research in other developing countries. Olisa [13] found that aging fleets and regulatory shortcomings are common barriers. Similarly, Idongesit et al. [18] confirmed that safety concerns deter ridership in Lagos. However, this study uniquely highlights how misaligned priorities between stakeholders contribute to policy paralysis. Without solutions that address both the need for safety and the financial relief operators seek, sustained progress is unlikely.

Table 6. Operational Challenges perceived by the respondents.

Challenges	Passengers (n= 5000)			Operators (n= 25)			Overall		
	Mean	RII	Ranking	Mean	RII	Ranking	Mean	RII	Ranking
High cost of boat and engine replacement	4.6	0.96	3	4.6	0.96	2	4.6	0.96	4
Inadequate infrastructure	4.6	0.97	2	4.6	0.95	3	4.6	0.970	2
Safety and security concerns	4.7	0.98	1	3.4	0.64	9	4.6	0.978	1
Regulatory and institutional weaknesses	4.1	0.80	6	4.4	0.88	6	4.1	0.800	7
Aging and an Inadequate Fleet	4.6	0.97	2	4.3	0.85	7	4.6	0.969	3
Poor Navigational Aids	3.9	0.77	7	3.3	0.61	10	3.9	0.769	8
Skill workforce storage	3.1	0.61	10	3.3	0.61	10	3.1	0.610	11
Weather-related disruptions	3.4	0.68	8	3.6	0.71	8	3.4	0.680	9
Low public confidence and patronage	4.4	0.87	5	4.5	0.9	4	4.4	0.870	6
Environmental challenge	3.4	0.67	9	4.5	0.93	5	3.4	0.671	10
Financial and investment constraints	3.9	0.88	4	4.5	1.09	1	3.9	0.881	5
Inefficient ticketing and scheduling	3.3	0.56	11	3.6	0.71	8	3.3	0.561	12

4.5 | Causes of Ferry Accidents

Fig. 1 provides an analysis of ferry accident causes in Lagos's inland waterways from 2010 to 2024. The data divides accidents into five main categories: mechanical failure, bad weather, overloading, human error, and poor navigation. A total of 100 incidents were recorded during this period. This section looks at these findings

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in relation to institutional practices, regulatory enforcement, and safety gaps within the sector. Mechanical failure was the leading cause of accidents, making up 24% of all incidents. This trend shows ongoing maintenance issues and highlights the limited enforcement of servicing protocols by agencies like the LASWA and the NIWA. Peaks in accidents related to mechanical failure were seen in 2015 and 2024, emphasizing the urgent need for standardized vessel inspections. These results are similar to prior research by Adebanjo (2019), which found that over 70% of ferry operators in Lagos lack formal training and often rely on outdated repair methods. Bad weather was the second most common cause, accounting for 21% of accidents, with notable increases in 2015 and 2017. This suggests there is not enough use of weather data in operational planning and that reliable communication systems to warn operators of dangerous conditions are lacking. The frequency of weather-related incidents reflects broader infrastructure issues in inland navigation, including the absence of radar, real-time weather forecasts, and protocols for rescheduling voyages. These findings align with international research that points to the importance of weather monitoring in ferry safety [13]. Overloading, responsible for 20% of accidents, continues to be a significant safety concern. The trend showed sharp rises in 2019 and 2024, indicating ongoing issues with enforcing capacity limits. Interviews with regulatory officials revealed that while vessel capacity is usually marked, there is little oversight to keep operators from exceeding these limits, especially during busy times. Economic factors and the lack of real-time monitoring tools often drive this behavior. The dangers of overloading are serious, as it can lead to vessel instability and capsizing, resulting in notable fatalities in Lagos's waterways.

Human error, at 19%, and poor navigation, at 16%, were also significant causes of ferry incidents. Human error includes mistakes in judgment, lack of training, and failure to follow safety guidelines. The consistent occurrence of human error over the years indicates weaknesses in training and certification systems for ferry crews. Although poor navigation has shown a slight decline since 2014, it remains an issue, particularly in poorly mapped or crowded areas. The absence of standardized route planning, signage, and navigational aids like buoys and beacons contributes to this problem. These findings are supported by Della et al. [19], who highlighted the risks posed by informal navigation systems. A broader look at the data shows that accident causes are often interconnected. For example, an overloaded vessel operating in bad weather with a defective engine and an untrained crew creates a high-risk situation. However, the classification used in *Table 3* focuses on the leading cause reported in each incident, which might not fully capture the complex nature of actual accidents. The lack of a clear downward trend in accident rates, despite having multiple regulatory agencies, implies that coordination and enforcement remain weak. Overlaps in regulations, unclear roles, and poor data-sharing among LASWA, NIWA, and NIMASA lead to inconsistent safety results. Interviews with regulatory staff confirmed these institutional shortcomings, underscoring the need for a unified command structure or coordination platform among agencies.
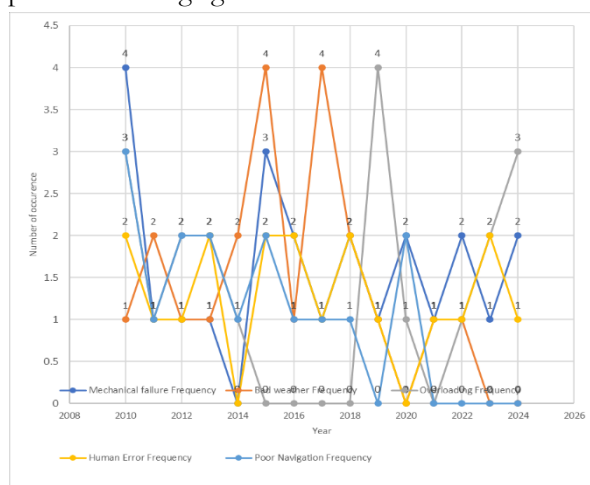

Fig. 1. Causes of ferry accidents in Lagos inland waterways from 2010 to 2024.

5 | Conclusion and Recommendations

This mixed-methods study shows significant problems in Nigeria's inland ferry system. Safety issues, operational delays, and weak organization come together to harm public trust and economic potential. Many passengers (68%) see serious safety risks. Many of them do not get safety briefings (49% never receive instructions), life jackets are often unavailable (47%), and crews are untrained (70%). Operators agree with these findings. They usually do reactive maintenance (52% fix vessels only when broken), inspections happen infrequently (60% rarely inspected), and they depend on informal training (60%). Accident data from 2010 to 2024 reveals that mechanical failures (24%), bad weather (21%), and overloading (20%) are the leading causes of accidents. These problems stem from poor regulation, old fleets, and a lack of technology. There is a significant difference in priorities between stakeholders. Passengers rank safety as their top concern (RII=0.98), while operators focus on financial constraints (RII=1.09). This mismatch, made worse by jurisdictional overlaps between LASWA, NIWA, and NIMASA, hinders progress. Still, most passengers are open to technology (90% support AI safety systems). Without comprehensive reforms, ferry transport will stay a high-risk and underused option, limiting mobility and economic growth in Lagos.

I.   To tackle significant safety issues, Nigeria must enforce unified safety protocols. This includes requiring pre-departure briefings, AI-powered overload alerts, and annual crew certification. Additionally, consolidating fragmented regulators into a single authority will streamline inspections, licensing, and accident response, reducing jurisdictional conflicts and enforcement gaps.

II. Considering the aging fleets and inadequate terminals, a public-private vessel renewal fund should subsidize 40% of new ferry costs for operators using safety technology (such as IoT sensors). This fund should also support solar-powered navigational aids and weather alert systems on high-risk routes like Badagry to improve operational resilience and reduce weather-related accidents.

III. Given the high acceptance of technology among passengers, Nigeria should expand affordable AI and IoT solutions. These can include predictive maintenance systems to reduce mechanical failures by at least 30%, e-ticketing and passenger-counting tools, and a public app for real-time ferry tracking and safety ratings. These measures will promote data-driven decision-making and transparency.

IV. To address operator-priority challenges, the government should introduce conditional subsidies linked to safety investments (like life jackets and training) and performance metrics (such as over 85% punctuality). Establishing quarterly stakeholder forums with passengers, operators, and regulators can help align priorities, share accident data, and co-design policies that balance safety with financial needs.

V.   To rebuild ridership, safety awareness campaigns through radio and social media should explain protocols and highlight technological features. Additionally, offering free introductory rides with safety demonstrations can target the 68% of passengers who feel unsafe and help close the gap between perception and reality in service reliability.

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Conflict of Interest

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Authors' Contributions

Dr. C. U. Akpudo (Maritime Management): Lead on maritime operations data collection, policy analysis, and framework development.

Prof. M. S. Stephens (Transport Planning): Oversee study design, stakeholder coordination, and integration of transport technology insights.

Dr. E. O. Ibam (Software Systems): Manage IoT, AI, and GPS technology assessments; oversee simulation modeling.

Dr. C. A. Enyinda (Accident and Safety): Analyze historical accident data; contribute to safety-focused simulations.

Mr. O. O. Abereowo (Cybersecurity): Ensure secure data collection and manage technical risks in IoT systems.

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