Risk Management in Nigerian Transportation Networks

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Abstract

As key stakeholders in the Nigerian transportation industry continue to contend with the interplay of factors contributing to risk exposure, infrastructure improvements, operational enhancements and regulatory measures, this study explores risk management in the Nigerian transportation networks with the aim of addressing the persistent challenges and enhancing safety and resilience. To guide the investigation, the study raised four research objectives. A sample of 664 was drawn from various stakeholders involved in the Nigerian transportation sector using the Cochran formula. However, 508 questionnaires returned were considered suitable for analysis. Employing a mixed-methods approach, data collected were analyzed via quantitative and qualitative means to ascertain predominant risk factors and challenges, evaluate existing policies and strategies, and identify opportunities for improvement. The findings of the study revealed that risk assessment plays a crucial role in quantifying the likelihood and consequences of identified hazards with provision of valuable insights into the risk profile of transportation systems. Findings also revealed that there are significant issues such as inadequate infrastructure, regulatory gaps, and security threats, contributing to heightened risks in land, air, and sea transport. Despite efforts to mitigate these risks, challenges persist, including funding constraints and bureaucratic inefficiencies. Overall, the study underscores the critical importance of effective risk management in ensuring efficient and safe transportation systems, essential for economic development and societal well-being in Nigeria. The study recommends investment in modernized infrastructure, strengthening regulatory mechanisms, and enhancing capacity building and public awareness.

Keywords: Capacity building, Risk assessment, Risk management, Security concerns & Transportation networks.

Introduction

The persistent challenges surrounding risk management in Nigeria's transportation networks have become worrisome especially with the country’s growing economy. Despite various efforts to reducing these risks to a controllable level, these issues continue to resurface in the sector affecting the safety, efficiency, and reliability of transportation systems across the country.

Nigeria's transportation networks are faced with different forms of challenges, including inadequate infrastructure, poor maintenance practices, insufficient regulatory oversight, and security concerns (Nwaedozie, Ugboma, Hassan & Mogaji, 2023). These antecedents contribute to an environment laden with risks such as accidents, insecurity, poor infrastructure, delays, theft, and vandalism. Lately, there's been a noticeable increase in these risks because of fast urban growth and increased economic activities. Government agencies, private sector stakeholders, and international partners have collaborated to implement policies and programs aimed at enhancing safety, efficiency, and resilience in transportation operations (Ahijo, 2022).

Notwithstanding current efforts at addressing transportation risks, significant challenges persist. These efforts focused on modernizing infrastructure, implementing technologies for monitoring and management, enhancing regulatory frameworks, and promoting public awareness and education on safety measures (Mogaji, 2020). To achieve meaningful progress in risk management, sustained commitment, collaboration, and innovation are therefore essential. Only through collective efforts can Nigeria overcome the recurrent hurdles and build a safer, more resilient transportation system for its citizens (Onokala & Olajide, 2020).

This study therefore aims to address the persistent challenges in risk management within Nigerian transportation networks, encompassing land, air, and sea. The scope includes both passenger and freight transportations, as well as public and private operators within the transportation industry. Efficient and safe transportation systems are vital for economic growth, trade facilitation, social cohesion, and sustainable development.

Research Objectives:

i. To identify predominant risk factors and challenges faced by land, air, and sea transportation networks in Nigeria.
ii. To identify the primary sources and drivers of risks within Nigerian transportation systems, including infrastructure, operational, and external factors.
iii. To assess the effectiveness of existing policies, regulations, and institutional frameworks in mitigating transportation risks and promoting safety and resilience.
iv. To identify risk management strategies for enhancement of sustainable transportation systems in Nigeria.

Literature Review

Transportation networks refer to interconnected systems of roads, railways, waterways, and air routes designed to facilitate the movement of people, goods, and information within and between geographic regions (Jetlund & Neuhäuser, 2022). It also refers to the complex infrastructural arrangements comprising physical, technological, and organizational elements that enable the efficient and reliable transfer of passengers and cargo across various modes of transportation, including road, rail, air, and sea (Rodrigue, 2020).

Transportation plays a pivotal role in facilitating economic activities, societal connectivity, and global trade. However, it is not without its inherent risks, which encompass a wide array of factors ranging from environmental hazards to human-related vulnerabilities (Ukaogo, Ewuzie, & Onwuka, 2020). The environmental risk in transportation is of a great concern contributing to pollution, habitat destruction, and climatic change. From air emissions to water contamination, transportation activities impact ecosystems and human health which affect intermodal transportation, involving the seamless movement of goods across different modes such as road, rail, air, and sea, stimulating unique risks related to coordination, logistics, and security (Gandhi, Kant, Thakkar & Shankar, 2024).

Safety is paramount in transportation, yet accidents, collisions, and infrastructure failures continue to pose threats to human life and property. Transportation infrastructure forms the backbone of mobility, but its aging, inadequate maintenance, and lack of technological features pose significant

risks to the system reliability and resilience. Resilience in transportation systems involves their ability to withstand and recover from disruptions be they natural disasters, infrastructure and system failure, or security threats (Gonçalves & Ribeiro, 2020). Transportation security is essential for safeguarding against terrorism, piracy, and smuggling activities that can disrupt supply chains and endanger lives. Supply chain risk management is crucial in ensuring the smooth flow of goods from production to consumption, addressing risks such as delays, theft, and disruptions.

Effective risk management involves various processes and strategies aimed at identifying, assessing, mitigating, and responding to potential hazards and vulnerabilities within transportation systems (Fielding, Lo & Yang, 2010). Through comprehensive hazard identification processes, transportation authorities can proactively identify and prioritize risks, enabling informed decision-making and targeted risk mitigation efforts (Sahu, Jha, Yadav & Mishra, 2023). By conducting risk assessments, stakeholders can prioritize resources and interventions to effectively address high-risk areas and minimize potential impacts on safety and operations (Fielding *et al*, 2010).

Predominant risk factors and challenges in Nigeria transportation network can be identified by looking critically at each mode of transportation. Land transportation in Nigeria is faced with numerous challenges, including poor road infrastructure, inadequate maintenance practices, and lack of enforcement of safety regulations. These factors contribute to frequent accidents, traffic congestion, and delays, posing significant risks to road users and hindering economic activities (Otuoze, Hunt & Jefferson, 2021).

In the air transportation sector, operational challenges such as outdated navigation systems, inadequate training of personnel, and inconsistent regulatory oversight contribute to safety problems. Additionally, the proliferation of unregistered airlines and substandard maintenance practices exacerbates risks associated with air travel in Nigeria (Habib & Turkoglu, 2020). Sea transportation faces its own set of challenges, including aging vessels, insufficient port infrastructure, and inadequate security measures (Kuteyi & Winkler, 2022). According to Mogaji (2020), methods of payment and disregard of regulatory measures to improve clean and safe transportation environment pose a serious risk in the sector. Also, poor road infrastructure, including potholes and inadequate signage increase the likelihood of accidents and traffic congestion. Operational practices, such as overloading of vehicles, non-compliance with safety regulations, and inadequate training of transportation personnel further compound transportation risks. Moreover, external threats such as terrorism, piracy, and natural disasters pose additional challenges to the safety and security of transportation networks in Nigeria (Agbiboa, 2022).

Current risk management strategies and regulatory frameworks in Nigeria exhibit both strengths and weaknesses. On the other hand, efforts to enhance safety regulations, invest in infrastructure upgrades, and implement technology-driven solutions demonstrate progress in addressing transportation risks (Shakeri, Vizvari & Nazerian, 2021). However, regulatory enforcement remains inconsistent, with instances of corruption and lax oversight undermining the effectiveness of risk management measures. Additionally, limited resources and capacity constraints pose challenges to the implementation of comprehensive risk management strategies across transportation sectors (Gambo & Musonda, 2021). To enhance the safety and resilience of Nigerian transportation networks, several measures and interventions can be implemented. Strengthening regulatory enforcement and oversight mechanisms, including penalties for non-compliance and corruption are crucial to ensuring adherence to safety regulations. Additionally, enhancing

collaboration and information-sharing among relevant stakeholders, including government agencies, private sector operators, and international partners, can facilitate coordinated efforts in addressing transportation risks and promoting safety across land, air, and sea modalities (Bakare, Bankole & Gbadamosi, 2020).

Theoretical Framework:

The study is anchored on the Systems theory proposed by biologist Ludwig von Bertalanffy in 1968. The theory posits that complex entities can be best understood as cohesive, interrelated whole rather than as isolated parts. This theoretical framework is important for analyzing and managing intricate structures, such as Nigerian transportation networks, by recognizing the interdependencies and interactions within the system.

In the context of risk management in Nigerian transportation, the Systems theory emphasizes a holistic approach which encompasses various transportation modes: roads, railways, waterways, and airways, each with unique risk factors like infrastructure decay, regulatory failures, and security issues. Systems theory argues that effective risk management must consider how these transportation modes interact and influence one another. For instance, poor road conditions can increase the reliance on railways and air travel, thereby amplifying risks in those sectors if not properly managed.

The relevance of Systems theory lies in its comprehensive viewpoint, which facilitates the identification and reduction of risks across the entire transportation networks, rather than in individual segments. By understanding the System as a whole, stakeholders can develop more robust and adaptive strategies to enhance safety and resilience.

However, the theory's limitation is its complexity. Applying Systems theory requires extensive data and sophisticated modeling tools, which may be scarce in resource-constrained settings like Nigeria. Additionally, the dynamic nature of transportation systems means that constant updates and adjustments are necessary, posing a continuous challenge for practitioners. While the Systems theory offers valuable insights for risk management in Nigerian transportation networks, its practical implementation requires overcoming significant resource and operational challenges.

Empirical Review

Few studies have investigated risk management in Nigeria's transportation networks. Adelekan (2020) in his study focused on understanding the risks faced by commuters in the city of Ibadan, Nigeria, with factors such as everyday hazards and disaster events. Utilizing sources such as newspaper reports, hospital records, and government databases, the study identified road traffic accidents, crime, violence, and flooding as the most serious hazards in Ibadan. The study highlighted the lack of official records for deaths and injuries related to these hazards, posing a significant challenge to effective risk reduction planning. Furthermore, it discussed how social, economic, and political structures contribute to urban risks, especially for the vulnerable groups, and drive the accumulation of risks over time (Ajayi, Bagula, Maluleke & Odun-Ayo, 2021; Onokala & Olajide, 2020; Adebakin & Raimi, 2012).

Ambituuni, Amezaga and Werner (2015) addressed the risks associated with transporting petroleum products by road in Nigeria and proposed a risk management framework to mitigate

these risks. Drawing insights from accident reports and stakeholder interviews, the study identified human factors, such as dangerous driving and speed violations, as significant contributors to accidents. The proposed risk management framework emphasized collaboration, communication, and continuous improvement to enhance safety in petroleum transportation (Akanmu & Salisu 2024; Adewumi, Suarez de Vivero & Iglesias-Campos, 2022; Adeniyi, 2021).

In 2013, Ugboaja studied the effectiveness of Nigeria's National Transport Policy (NTP) in promoting social sustainability. Employing a survey research method, the study assessed the views of transport companies and non-transport workers through questionnaires. The findings indicated a gap between the expected and observed effectiveness of the NTP, with an overall mean score lower than anticipated. The study suggested that policymakers need to reevaluate and improve the NTP to achieve sustainable transportation in Nigeria effectively (Afolabi & Akibo, 2020; Ugboaja, 2013).

Ugwueze and Asua (2021) investigated risk factors and challenges in Nigeria's transportation networks particularly in the maritime sector especially on the security concerns surrounding informal maritime transportation in Nigeria's South-South region. Using a mixed-method approach and applying the broken window theory, the study exposed the effect of piracy on commercial motorboat operators. The study argues that minor crimes, when left unaddressed, can escalate into serious criminal activities. Ugwueze and Asua (2021) pointed out that neglecting piracy in the hands of the less privileged groups has created a conducive environment for various heinous crimes, turning the South-South region into a hotspot for criminal activities. The study emphasizes the need for addressing these issues to ensure a stable economy and social sustainability, particularly by mending the broken windows that allow for such crimes to proliferate. Badiora, Wojuade & Adeyemi (2020), examined the concerns for personal safety and measures to improve the sense of safety among users of a Nigerian public transport facility. The research adopted a case study approach, collecting both quantitative and qualitative data. The findings showed significant concerns for personal safety, with thefts being the most documented crime. Enhancements to lighting were identified as the most important improvement concern. The study suggested improvements in surveillance, access control, territoriality, image management, and activity support to enhance perceived safety and increase the frequent use of the facility. The study recommendations included better environmental design, improved lighting, installation of CCTV cameras, and constant maintenance of public spaces.

Methodology

The chosen research design for studying risk management in Nigerian transportation networks is a mixed-method approach. This design combines quantitative and qualitative methods to provide a comprehensive understanding of transportation risks and their management strategies (Johnson & Onwuegbuzie, 2004). The sample for this study comprises various stakeholders involved in the Nigerian transportation sector, including government officials, transportation operators, regulatory agencies, and local communities. Sampling methods include stratified sampling to ensure representation from different regions of the country and random sampling to select participants within each stratum. Nigeria is divided into six geopolitical regions: North Central, North East, North West, South East, South-South, and South West, which were used for sampling purposes (National Bureau of Statistics, 2020). Simple random sampling was used to select a State from each region: Abuja, Yobe, Kano, Imo, Delta, and Lagos States.

The adequacy and appropriateness of the minimum sample size used for this study were determined using the Cochran (1977) standard formula. This formula was adopted because it is used for indefinite populations that are greater than 50,000 (Cochran, 1977). The sample size using the Cochran formula for a 95% confidence level and a 5% margin of error was approximately 664. However, a total of 508 responses were returned and deemed suitable for analysis. Data collection methods include interviews, surveys, and document analysis. Semi-structured interviews were conducted with key stakeholders to gather qualitative insights into risk management practices and challenges. Questionnaire was administered on a larger sample to collect quantitative data on risk perceptions, safety practices, and regulatory compliance. Pilot testing was used to ensure reliability. Ethical considerations, ensuring confidentiality of data, and adhering to ethical guidelines for research involving human subjects were observed.

Key variables under investigation include risk factors, risk management strategies, and safety outcomes in the Nigerian transportation networks. Data analysis procedures included both quantitative and qualitative techniques. Quantitative data were analyzed using statistical methods such as descriptive statistics. Qualitative data were analyzed using thematic analysis to identify recurring themes and patterns in interview transcripts.

Result of the Findings

Demographic characteristics of Respondents

Table 1: Demographic Summary of Respondents

Gender	Frequency	Percentage %
Male	290	57.09%
Female	218	42.91%
Subtotal	508	100.00%
Age		
18-24	128	25.20%
25-34	141	27.76%
35-44	103	20.28%
45-54	86	16.93%
55 and above	50	9.84%
Subtotal	508	100.00%
Educational background		
ND	51	10.04%
HND/BSC	254	50.00%
MBA/MSc	141	27.76%
PhD	62	12.20%
Subtotal	508	100.00%
Occupation		
Employed	62	12.20%
Self Employed	176	34.65%
Unemployed	76	14.96%
Student	64	12.60%
Retired	130	25.59%
Subtotal	508	100.00%
Geographical location		
North Central	115	22.64%
North East	46	9.06%
North West	59	11.61%
South South	135	26.57%
South East	40	7.87%
South West	113	22.24%
Subtotal	508	100.00%

Source: Field Work, 2024.

The presentation of findings involves summarizing and organizing the collected data from various demographic categories. Each category, including gender, age, educational background, occupation, and geographical location, is presented with corresponding frequency and percentage.

For instance, in the gender category, findings reveal that out of 508 respondents, (57.09%) were male, while (42.91%) were female. Similarly, in the age category, the majority of respondents fell within the age groups of 25-34 (27.76%) and 35-44 (20.28%). Educational background findings indicate that the highest proportion of respondents had a Higher National Diploma (HND) or Bachelor's degree (50.00%), followed by respondents with MBA/MSc (27.76%). Occupation-wise, the data show that self-employed individuals constituted the largest group (34.65%), followed by retirees (25.59%). In terms of geographical location, the South-South region had the highest number of respondents (26.57%), followed closely by the North Central (22.24%).

Objective 1: To identify the predominant risk factors and challenges faced by land, air, and sea transportation networks in Nigeria.

Table 2: Predominant risk factors in Nigeria's transportation networks

		Level of challenge					
Risk factors	**Transportation network**	**High**	**Average**	**Low**	**Not Sure**	**Total %**	**Total**
Infrastructure inadequacies	Road	180	120	158	50	100%	508
	Water	125	130	113	140	100%	508
	Air	122	118	135	133	100%	508
	Railway	135	123	90	160	100%	508
Security threats	Road	253	125	100	30	100%	508
	Water	197	129	127	124	100%	508
	Air	131	127	122	128	100%	508
	Railway	224	126	109	29	100%	508
Weather-related risks	Road	120	132	129	125	100%	508
	Water	131	123	126	128	100%	508
	Air	196	131	124	124	100%	508
	Railway	126	130	122	130	100%	508
Regulatory compliance issues	Road	128	121	134	125	100%	508
	Water	124	128	129	127	100%	508
	Air	133	129	120	126	100%	508
	Railway	123	130	130	125	100%	508
Technological failures	Road	133	123	126	126	100%	508
	Water	129	126	128	125	100%	508
	Air	127	129	130	122	100%	508
	Railway	129	125	129	125	100%	508
Environmental factors	Road	126	130	123	129	100%	508
	Water	128	128	128	124	100%	508
	Air	125	127	131	125	100%	508
	Railway	129	125	127	127	100%	508

Source: Field Work, 2024.

The findings reveal a comprehensive analysis of the predominant risk factors and challenges encountered by land, air, and sea transportation networks in Nigeria. The data collected from

stakeholders indicate varying levels of challenges across different risk factors and transportation modes. For instance, infrastructure inadequacies pose a high level of challenge, particularly in the railway sector, where 135 respondents identified it as high risk. Similarly, security threats are pronounced, with 253 respondents highlighting high risk in the road transportation network. Weather-related risks also feature prominently, especially in the air transportation sector, where 196 respondents perceive it as high risk.

Objective 2: To identify the primary sources and drivers of risks within Nigerian transportation systems, including infrastructure, operational, and external factors.

Table 3: Summary of Responses on Primary sources and drivers of risks

Transportation Network	Infrastructure factors	Operational factors	External factors	Total
Road	39%	45%	16%	100%
Water	32%	22%	46%	100%
Air	40%	37%	23%	100%
Railway	56%	40%	4%	100%

Source: Field Work, 2024.

Table 3 focuses on identifying the primary sources and drivers of risks within Nigerian transportation systems which include infrastructure, operational, and external factors. For road transportation, operational factors emerge as the primary driver of risks, accounting for 45% of the total respondents, Infrastructure factors contribute significantly as well, representing 39% of the total. External factors play a relatively smaller role, constituting 16% f the total. In water transportation, external factors are identified as the primary source of risks, comprising 46% of the total. Infrastructure factors follow closely behind, accounting for 32%. Operational factors contribute the least, representing 22% of the total. For air transportation, infrastructure factors are identified as the primary source of risks, representing 40% of the total. Operational factors closely follow, contributing 37%. External factors have the smallest impact, accounting for 23% of the total. In railway transportation, infrastructure factors are the predominant source of risks, accounting for 56% of the total. Operational factors also play a significant role, representing 40%. External factors have the least influence, contributing only 4% of the total.

Objective 3. Effectiveness of existing policies, regulations, and institutional frameworks in mitigating transportation risks and promoting safety and resilience.

Table 4: Level of Policies effectiveness on Nigeria's Transportation Networks

Transportation Network	Very Effecti	Effe ct-ive	Undeci ded	Ineffe ctive	Highly Ineffecti	Tota l	Me an	St. Deviation
Road	40	48	54	178	188	508	2.16	1.24
Water	28	20	158	100	202	508	2.16	1.16
Air	10	19	238	120	121	508	2.36	0.95
Railway	5	10	153	98	242	508	1.89	0.97

Source: Field Work, 2024.

Table 4 focuses on assessing the effectiveness of existing policies, regulations, and institutional frameworks in mitigating transportation risks and promoting safety and resilience across different transportation networks in Nigeria. For road transportation, the effectiveness of existing policies and regulations appears to be mixed. While 40 respondents perceive them as very effective and 48 as effective, a significant proportion of respondents, 54, remain undecided. Moreover, a considerable number of respondents, 178, perceive them as ineffective, with 188 rating them as highly ineffective. In water transportation, the assessment of existing policies and regulations also reflects mixed perceptions. A smaller number of respondents, 28, consider them very effective, while 20 perceive them as effective. However, a substantial portion of respondents, 158, remain undecided. Furthermore, 100 respondents rate them as ineffective, with 202 rating them as highly ineffective. For air transportation, opinions on the effectiveness of existing policies and regulations vary. Only 10 respondents view them as very effective, while 19 perceive them as effective. The majority of respondents, 238, remain undecided. Additionally, 120 respondents rate them as ineffective, with 121 rating them as highly ineffective. In railway transportation, the assessment of existing policies and regulations indicates a similar trend. A small proportion of respondents, 5, consider them very effective, with 10 perceiving them as effective. However, a significant number of respondents, 153, remain undecided. Moreover, 98 respondents rate them as ineffective, while 242 rate them as highly ineffective.

Objective 4: To identify risk management strategies for enhancement of sustainable transportation systems in Nigeria.

Table 5: Thematic Analysis for risk management strategies

Investment in Modernized Vehicles and Infrastructural Upgrades and Maintenance	not identified	Frequency	61
		Table N %	6.3%
	Identified	Frequency	447
		Table N %	87.7%
Security Improvement	not identified	Frequency	46
		Table N %	9.3%
	Identified	Frequency	462
		Table N %	90.7%
Adaptation to changing technological trends	not identified	Frequency	122
		Table N %	23.6%
	Identified	Frequency	386
		Table N %	76.4%
Strengthen Regulatory and Enforcement Mechanisms	not identified	Frequency	102
		Table N %	20%
	Identified	Frequency	406
		Table N %	80%
Investing in Capacity Building and Public Awareness	not identified	Frequency	208
		Table N %	40.9%
	Identified	Frequency	300
		Table N %	59.1%

Source: Field Work, 2024.

Table 4 shows risk management strategies for enhancement of sustainable transportation systems in Nigeria. In investment in modernized vehicles and infrastructural upgrades and maintenance, a vast majority of respondents, 447, identified investment in modernized vehicles and infrastructural upgrades and maintenance as a key strategy. However, a smaller proportion, 61, did not identify this strategy. Similarly, the majority of respondents, 462, identified security improvement as an important strategy. Only 46 respondents did not identify this strategy. A significant portion of respondents, 386, identified adaptation to changing technological trends as a crucial strategy. However, 122 respondents did not identify this strategy. A majority of respondents, 406, identified the need to strengthen regulatory and enforcement mechanisms. Nevertheless, 102 respondents did not identify this strategy. A substantial number of respondents, 300, identified the importance of investing in capacity building and public awareness. However, 208 respondents did not identify this strategy.

Discussion of Findings

Predominant risk factors and challenges faced by land, air, and sea transportation networks in Nigeria

The findings from the study on the predominant risk factors and challenges faced by Nigeria's transportation networks reveal significant insights. Infrastructure inadequacies, security threats, and weather-related risks emerge as the most pressing issues across all transportation modes, with roads and railways particularly affected by security threats and infrastructure inadequacies. The high levels of these challenges indicate weaknesses in these areas, likely due to underinvestment, poor maintenance, and governance issues.

The consistent identification of these factors across multiple studies emphasizes their importance and calls for coordinated, robust interventions. According to Adelekan (2020), the impact of poor infrastructure and city governance on transportation makes it vulnerable and exposed to hazards. This agrees with the study's findings and emphasizes the need for infrastructure development, particularly in the railway and road sectors. Also, Security threats are consistently identified as significant risks. Ugwueze and Asua (2021) agree with this by highlighting the security threats faced by commercial motorboat operators due to neglected piracy issues, stressing the need for security enhancements across all networks. Further, while Adelekan's study is more general, focusing on urbanization and environmental factors, Ugwueze and Asua study focuses specifically on maritime insecurity.

The primary sources and drivers of risks within Nigerian transportation systems

The findings on the primary sources and drivers of risks within Nigerian transportation systems reveal distinct differences across various modes of transport. For roads and railways, infrastructure factors are the predominant sources of risk emphasizing the critical issue of inadequate and deteriorating infrastructure.

The findings identify infrastructure deficiencies as a primary source of risk especially in the railway which agree with Ugboaja (2013) who noted that below-average effectiveness of Nigeria's National Transport Policy in enhancing social sustainability is probably due to infrastructure issues. The study also acknowledged poor maintenance practices and inadequate safety protocols

as substantial contributors to risk exposure. This agrees with the study of Ambituuni et al. (2015) who stated that human factors such as dangerous driving are major causes of road accidents. The findings further indicated external factors like weather conditions and security threats as critical in shaping risk profiles. These findings agree with Ugwueze and Asua (2021) who discussed piracy and its implications for maritime transport.

The effectiveness of existing policies, regulations, and institutional frameworks in mitigating transportation risks and promoting safety and resilience.

The study highlights diverse perceptions regarding the effectiveness of existing policies, regulations, and institutional frameworks in mitigating transportation risks across different transportation networks in Nigeria. For road transportation, the mixed perceptions suggest a need for more comprehensive evaluation of existing policies and regulations to address the uncertainties and dissatisfaction among respondents. Similarly, in water, air, and railway transportation, the prevalence of undecided responses and perceptions of ineffectiveness indicate significant gaps and challenges in the current regulatory frameworks. These findings agree with the study of Ugboaja (2013) who stated that Nigeria's National Transport Policy is poorly coordinated, inadequately enforced with its limited impact on social sustainability. The above call for need to develop strategies that can be impactful.

Risk management strategies to enhance sustainable transportation systems in Nigeria.

The thematic analysis of risk management strategies for enhancing sustainable transportation systems in Nigeria reveals a strong consensus on several key areas. The findings disclosed overwhelming support for investment in modernized vehicles and infrastructure upgrades. This reflects widespread recognition of the need for substantial infrastructural improvements and the adoption of modern technologies to enhance efficiency and safety. Security improvement is another predominant strategy, which agrees with the finding of Ugwueze and Asua (2021) who indicated security threat as a major risk factor in Nigerian transportation. Adaptation to changing technological trends is also identified as a key strategy, stressing the importance of integrating new technologies into transportation systems. This agrees with findings of Ugwueze and Asua (2021).

Effective regulation and enforcement are essential for ensuring compliance with safety standards and operational guidelines, which are currently seen as weak points in the Nigerian transportation networks. However, investing in capacity building and public awareness is perceived as less urgent compared to the other strategies. This suggests that while there is recognition of the need for improved training and public awareness, it is not viewed as immediately crucial.

These findings agree with the study of Badiora *et al* (2020) who emphasized the need for investment in infrastructure upgrades and modernized vehicles as a way to improve public transport facilities and maintenance. The need for improved security measures was further disclosed which aligns with Ugwueze and Asua (2021) who emphasized the importance of addressing security challenges in maritime transport. The study further stresses need for technological adaptation to enhance operational efficiency and safety which agrees with the findings of Badiora *et al* (2020) who examined personal safety and measures to improve the sense of safety among users of Nigeria public facility.

Conclusion

This study investigated risk management in the Nigerian transportation networks with the aim of identifying predominant risk factors in Nigeria's transportation networks, uncovering the primary sources and drivers of these risks, assessing the effectiveness of existing policies and regulations, and proposing strategies for sustainable transportation in Nigeria. Key findings revealed that infrastructure inadequacies and security threats are the most significant challenges, especially in road and railway networks. Operational factors also pose substantial risks, particularly for air transportation, while external threats are predominant in water transportation. The study also found existing policies to be grossly ineffective, indicating the need for comprehensive reforms. Strategies identified for risk management include substantial investment in infrastructure modernization, security enhancements, adaptation to technological trends, and strengthened regulatory frameworks. Additionally, capacity building and public awareness are crucial for long-term sustainability. Addressing these risks calls for coordinated and well-funded efforts to ensure safe, efficient, and sustainable transportation system in Nigeria.

Recommendations

Based on the findings, the study recommends the following:

i. Investment in modernized vehicles, infrastructural upgrades, and maintenance be prioritized to address infrastructure inadequacies and enhance the safety and reliability of transportation networks. This includes improving road conditions, upgrading maritime facilities, and modernizing air and rail infrastructure.
ii. Security measures be improved upon to reduce security threats and ensure the safety of passengers and cargo. This includes enhancing surveillance systems, increasing security personnel, and fostering collaboration with law enforcement agencies to combat criminal activities.
iii. Technological advancements be embraced in transportation networks to adapt to changing trends and improve operational efficiency. This involves investing in digital solutions for monitoring, communication, and incident response, as well as leveraging data analytics for proactive risk management.
iv. Regulatory and enforcement mechanisms be reformed to enhance compliance with safety standards and regulations. This includes updating existing policies, establishing clear accountability frameworks, and implementing rigorous oversight mechanisms to ensure adherence to safety protocols.
v. Investment in capacity building initiatives to enhance the skills and knowledge of transportation stakeholders, including operators, regulators, and the public. Additionally, launching of public awareness campaigns to promote safety consciousness and encourage proactive risk management behaviors among passengers and communities should not be treated with levity.
vi. Collaboration between government agencies, private sector stakeholders, and the civil society organizations be maximized to coordinate efforts and share resources effectively. These multi-stakeholders' approach can facilitate the implementation of comprehensive risk management strategies and promote sustainable transportation systems in Nigeria.

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