

ASSESSMENT OF RISK MANAGEMENT STRATEGIES IN TRANSPORT AND LOGISTICS OF PETROLEUM PRODUCTS IN RIVERS STATE

Authors: EBERECHI NWAGU IHEANYI & MBAGWU IGNATIUS NWABUDO
iheanyinwagueberechi@gmail.com & mbagwuignatius3@gmail.com

Abstract

This paper focused on the risk management techniques used in the transportation and logistics of petroleum products in Rivers State, Nigeria with a special reference made to risk identification, risk assessment as well as risk mitigation and monitoring. The survey research design used was descriptive, and it involved data collection on key stakeholders that have a role to play in transportation of petroleum products between the transport operators and transport supervisors. The study was limited to Rivers State since it is a strategic petroleum production, storage, and distribution hub thus, levels of safety and environmental risks were of great importance. The collection of data was carried out by use of a structured questionnaire, which was named as Risk Management Strategies in Petroleum Product Transport Questionnaire (RMSPTQ), which was founded on a five-point Likert scale. Although answering the research questions required the analysis of descriptive statistics, namely, means, and standard deviations, t-tests were employed to test the hypotheses at the level of 0.05. The findings showed that transport operators and supervisors were in agreement that the outlined practices demonstrate successful risk identification, assessment, and mitigation and monitoring approaches since all the mean ratings exceed the set decision criterion. An additional analysis showed statistically significant variations of mean responses of the operators against that of supervisors regarding each of the three risk-management components, where the latter always rated these strategies to be more effectively within the organization. Such conflicts were explained by the role differences, experience, and degree of the involvement in safety planning and regulatory compliance. The research therefore ascertained that effective risk- management initiatives are very crucial towards improving safety, business effectiveness and environmental safety in the petroleum transport and logistics of product communication industry. Based on this, the authors suggest frequent training, tightening of monitoring systems, and a stronger collaboration

between the parties in order to make sure that the risk-management practices introduced in Rivers State are uniformly implemented.

Keywords: Risk Management Strategies, Transport and Logistics and Petroleum Products

Introduction

The term petroleum resources is a reference to the naturally formed deposits of hydrocarbons that are found under the surface of the earth such as the crude oil and natural gas that form the major energy sources of the modern economies. The resources form the basis of industrialization, transportation, power production and economy, especially in oil producing countries like Nigeria. According to the International Energy Agency (IEA, 2023), petroleum has retained a leading role in the global energy mix despite the increasing trend of the popularity of renewable energy options. However, the technical, environmental and safety issues relating to the extraction, processing, and supply of petroleum are so complex; the presence of the risks themselves creates the need of having effective downstream systems to convert the petroleum resources into usable petroleum products to the end users, hence the direct relationship between petroleum resources and petroleum products.

Refined products are the finished products of the crude oil which are petrol (pMS), diesel (AGO), kerosene (DPK), aviation fuel, lubricants and bitumen. These commodities cannot be substituted in transport, industry processes, domestic power supply, and the revenue collection of the country. According to the U.S. Energy Information Administration (EIA, 2022), petroleum products are flammable, volatile in nature, and thus handling and distribution

are especially dangerous. Due to universal consumption and economic importance, petroleum products should be delivered efficiently to the consumers as a product form between the refineries and depots, which makes the distribution vulnerable and consequently establishes a close relationship between petroleum products and the transport and logistics system needed to deliver products to the consumers safely and reliably.

The petroleum products transport and logistics involves the coordinated transportation, storage and supply of refined petroleum products by pipelines, road tanker, road rail, marine (vessel), and storage terminal. The system makes the product available in the sparsely spread markets upholding the quality and safety standards. As Rodrigue, Notteboom, and Slack (2020) note, petroleum logistics is also marked by the intense capital density, strict regulatory issues, and risky safety conditions. The road transport in developing economies is still predominant, hence more susceptible to traffic accidents, spills, theft and infrastructure kind of risks. In view of these operational complexities, well-organized risk management strategies should be put in place to protect lives, resources, and the environment in petroleum transport systems.

Transport petroleum products risk management strategies are defined as rational initiatives applied to the process of locating and evaluating as well as controlling and tracking around the hazardous material conveyance risks. These plans combine safety measures, working standards, adherence to regulations, and technological measures to reduce the potential frequency and severity of adverse events. The ISO (2018) asserts that a well-managed risk means more organisational resilience and resiliency when making

decisions in uncertainty. Risk management approaches are necessary in petroleum logistics because the end outcome of tanker accidents, pipeline failures and storage explosions is disastrous. These broad strategies form the frame upon which the operationalisation of certain elements like risk identification, assessment, and mitigation takes place.

Risk identification strategy entails the methodical identification of hazards, which could occur in the transportation and logistics of petroleum products. The threats are road traffic accidents, machinery breakdown, human error, fire outbreaks, spillages, sabotage and security threats. The most common techniques to reveal such risks include Hazard Identification (HAZID), Job Safety Analysis (JSA), and inspection of operations (Aven, 2016). Risk identification is a prerequisite since unknown hazards are not measurable and manageable, thus, this approach is a direct influence on risk assessment by providing inputs required to determine the magnitude and probability of known risks.

Risk assessment strategy focuses on the assessment of the risks that are identified aiming to identify their likelihoods to happen and what the consequences may be. The process facilitates the ranking of risks that seem to be the most significant to the safety of the environment and operational sustainability. Qualitative risk matrices, the quantitative risk assessment (QRA), and the failure mode and effects analysis (FMEA) are among the popular techniques used in the hazardous material transportation (Kaplan and Garrick, 1981). Risk assessment helps petroleum logistics operators to focus on resources by allocating resources and choosing the right control

measures. The inherent risks mitigation and monitoring actions of this evaluative process are geared towards mitigating risk to unacceptable levels.

The measures and risk management approaches imply the introduction of control actions in order to minimize the determined risks and provide constant monitoring of their control efficiency. The mitigation actions are engineering controls (e.g., certified tankers, spill containment measures), administrative controls (e.g., standard operating procedures, route planning) and behavioural controls (e.g. driver training and fatigue management). GPS tracking and telematics monitoring, safety audits, and incident reporting systems are some of the monitoring mechanisms that offer real-time and periodic feedback (OECD, 2019). The continuous monitoring is designed with a view of ensuring that deviations are detected early enough and corrective measures are implemented hence complement the cycle of risk management in the entire petroleum logistics endeavors.

The need to do the research arises out of the fact that there have been ongoing occurrences of accidents, spills, fires and environmental pollution linked with the transportation and logistics of petroleum products, especially in developing economies. The available empirical data show that weak risk management practices, insufficient training, insufficient infrastructure, and lack of regulation reinforcement are key factors leading to such incidences (World Bank, 2021). A perception of the petroleum resources and products without a reflection in the risks accompanying its transportation gives a biased insight in the petroleum supply chain. As a result, the study of risk identification, assessment, mitigation, and monitoring strategies can provide important data on how to increase safety and protect the environment and

improve the effectiveness of operations. The research is, therefore, not a waste because it correlates the use of energy resources to sustainable transport logistics and proper handling of risks.

Statement of the Problem

Rivers State has been characterized by long-term safety, environmental, and operating risks in haulage of petroleum products due to poor and intermittent implementation of risk-management plans. The state has some mazing petroleum infrastructure consisting of depots, tank farms, pipelines, and a road tanker network, which distributes the products to the local and regional markets. Although petroleum is a hazardous activity, the incidence of tanker accidents, fuel spills, fire, pipeline releases, and loss of products also take place, which points to loopholes in the risk identification, assessment, mitigation and monitoring procedures in the petroleum transport and logistics system. These frequent episodes are an indication that the existing safety plans and operating measures might not be adequate or not applied in the best way.

This experience is a serious issue since inefficient risk management within the petroleum logistics will place the human lives, environment and economic assets in unnecessary harm. The presence of congested traffic corridors, deteriorated road network, and an elevated rate of transporting petroleum products in Rivers State enhances the probability and intensity of road accidents. These risks are further aggravated by poor safety regulations enforcement, inadequate education and training of tanker drivers and logistics staff, ineffective use of modern monitoring equipment, and low

emergency response measures. Therefore, petroleum transportation accidents are often characterized by loss of life, environmental pollution, supply chain disruption, and an increase in the cost of operations by operators and government bodies.

Unless the issue of ineffective risk-management solutions within the practice of transport and logistics of petroleum products has been addressed, the rates and the magnitude of accidents and other environmental violations are expected to be even higher in Rivers State. Repeated petroleum spillage and fire can result in soil and water through prolonged effects, health problems, and livelihoods of communities that rely on the local environment. In addition, decades of safety lapses might undermine investor confidence, increase insurance and logistics expenses, and overburden regulatory and emergency-response institutions. In conclusion, inability to evaluate and reinforce risk-management measures jeopardizes long-term petroleum distribution, safety of population and socioeconomic growth in Rivers State.

Aim and Objectives of the Study

The study aimed at assessing the risk management strategies in transport and logistics of Petroleum Products in Rivers State. Specifically, the study sought the following:

1. risk identification Strategy in transport and logistics of Petroleum Products in Rivers State.
2. risk assessment strategy in transport and logistics of Petroleum Products in Rivers State.

3. risk mitigation and monitoring strategy in transport and logistics of Petroleum Products in Rivers State.

Research Questions

The following research questions guided the study

1. What are the risk identification strategy in transport and logistics of Petroleum Products in Rivers State?
2. What are the risk assessment strategy in transport and logistics of Petroleum Products in Rivers State?
3. What are the risk mitigation and monitoring strategy in transport and logistics of Petroleum Products in Rivers State?

Hypotheses

The following hypotheses were formulated and tested at .05 level of significance

H_{O1} There is no significant difference between the mean responses of petroleum product transport operators and transport supervisors on the risk identification Strategy in transport and logistics of Petroleum Products in Rivers State.

H_{O2} There is no significant difference between the mean responses of petroleum product transport operators and transport supervisors on the risk assessment strategy in transport and logistics of Petroleum Products in Rivers State.

H_{O3} There is no significant difference between the mean responses of petroleum product transport operators and transport supervisors on the risk

mitigation and monitoring strategy in transport and logistics of Petroleum Products in Rivers State.

Methodology

The research design used was the descriptive survey design to assess the risk management strategies implemented in the transport logistics of the petroleum products in Rivers State. This design was considered appropriate since it would help in systematic consolidation of data related by the involved stakeholders in relation to current risk identification, assessment, and reduction measures and monitoring without having to alter the study milieu. The case study was done in Rivers State in Nigeria- a hub of petroleum production and distribution. This state has many petroleum reserves, tank farms and major transport floors that act as channels through which the oil products are passed through the roadways and the pipeline. Rivers State has been selected as a result of the large amount of transportation of petroleum products that occurs in this state and the safety and environmental risks that are associated with the same.

The study population involved included petroleum product transport operators, logistics managers, tanker drivers, depot safety officers, people in regulatory agencies and transport supervisors involved in distribution of petroleum products in Rivers state. The choice of these categories of respondents was based on the consideration that they are directly concerned in planning, execution, regulation, and monitoring of petroleum product transportations. The strategy was multi-stage, whereby analytics was used to select major petroleum depots and transport routes at the stage one level and then stratification was used to group the respondents into strata relevant

to the study with simple random sampling used to select the study participants. This methodology guaranteed fair representation of all the important stakeholder groups.

The data were collected through a questionnaire which was designed as Risk Management Strategies in Petroleum Product Transport Questionnaire (RMSPTQ) questionnaire. The tool included the section covering demographic data, risk identification strategies, risk assessment strategies, risk mitigation and monitoring strategies, and the perceived difficulties in the transportation of petroleum products. The responses were elicited in terms of five-point Likert scale of strongly agree and strongly disagree. The questionnaire was validated by face and content validation; questionnaire was handed to experts in transport management, safety engineering and measurement research with regard to the instrument validation. Their comments and suggestions helped in making changes on the ambiguous items so that they can cover the variables under investigation extensively.

The instrument reliability was determined using Cronbachs alpha. A pilot study was carried out among a small group of petroleum transport workers who were not within the study region. The resulting coefficient of reliability was considered to be satisfactory that means the internal consistency of the tool. The questionnaires were administered by hand by the researcher through the assistance of the trained research assistants. This method of response produced a high level of response and eased the process of clarification of any potentially unclear questions.

Questionnaires were collected, classified and filtered on completeness before analysis was done on 21 questions. The data obtained was analyzed with the help of descriptive statistics the means and standard deviation to answer the research questions. A decision was made on a cutoff of 2.50 on Likert scale. Inferential statistics were used where needed including t -test to test the hypotheses formulated at the 0.05 level of significance.

Results

Research Question 1: What are the risk identification strategy in transport and logistics of Petroleum Products in Rivers State?

Table 1: Mean and Standard Deviation on risk identification strategy in transport and logistics of Petroleum Products.

S/NO	Items: What are the risk identification strategies in transport and logistics of petroleum products in Rivers State?	Petroleum product transport operators			Transport supervisor		
		$\bar{X}$	SD	RMK	$\bar{X}$	SD	RMK
1	Conduct routine inspections of tanker vehicles to identify mechanical faults before product transportation	4.43	.832	Agree	3.57	.700	Agree
2	Identify high-risk road routes prone to accidents, congestion,	4.11	.891	Agree	4.29	.785	Agree

	or security threats before dispatch						
3	Assess the condition of loading and offloading facilities to detect potential spill or fire hazards	3.98	.932	Agree	3.99	.988	Agree
4	Identify driver-related risks such as fatigue, inadequate training, and non-compliance with safety rules	4.09	.925	Agree	4.03	.900	Agree
5	Detect risks associated with improper loading, overloading, and poor load distribution in tankers	4.30	.864	Agree	4.00	1.057	Agree
6	Identify risks related to weather conditions that may affect the safe transportation of petroleum products	3.83	.958	Agree	3.89	.999	Agree
7	Identify potential risks arising from inadequate personal protective equipment (PPE) usage during operations	3.91	1.069	Agree	4.21	.870	Agree
8	Identify risks associated with pipeline leakages, illegal connections, or vandalism during product transfer	3.75	1.120	Agree	4.08	.926	Agree
9	Identify emergency response gaps, including availability of firefighting and spill containment equipment	3.91	1.013	Agree	4.15	.827	Agree
10	Identify security-related risks such as theft,	4.00	.953	Agree	4.35	.747	Agree

sabotage, and unauthorized access to petroleum products						
Grand Mean	4.03	.60	Agree	3.15	.51	Agree

Table 1 presents the mean ratings and standard deviations of petroleum product transport operators and transport supervisors on risk identification strategies in the transport and logistics of petroleum products in Rivers State. The results show that both groups generally agreed that the listed practices constitute effective risk identification strategies, as all item mean scores exceeded the decision benchmark. Petroleum product transport operators recorded a grand mean of 4.03 (SD = 0.60), indicating a high level of agreement, while transport supervisors recorded a grand mean of 3.15 (SD = 0.51), also reflecting agreement with the items. High mean ratings were observed on routine inspection of tanker vehicles, identification of high-risk routes, detection of loading and overloading risks, and identification of security threats such as theft and sabotage. Although slight variations existed between the two groups across some items, the relatively low standard deviation values suggest consistency in respondents' views. Overall, the findings indicate that structured identification of mechanical, operational, environmental, and security-related hazards is widely recognized as a critical component of risk management in petroleum product transportation in Rivers State.

Research Question 2: What are the risk assessment strategy in transport and logistics of Petroleum Products in Rivers State?

Table 2: Mean and Standard Deviation on risk assessment strategy in transport and logistics of Petroleum Products.

S/NO	Petroleum product transport operators			Transport supervisor		
	$\bar{X}$	SD	RMK	$\bar{X}$	SD	RMK

Items: What are the risk assessment strategies in transport and logistics of petroleum products in Rivers State?

11	Assess the likelihood of tanker accidents based on road conditions, traffic volume, and historical accident records	4.27	.833	Agree	4.28	.907	Agree
12	Evaluate the severity of potential petroleum spills and fires during transportation and loading operations	4.12	.708	Agree	4.14	.880	Agree
13	Assess risks associated with vehicle mechanical failure before and during petroleum product transportation	4.10	.930	Agree	4.12	.958	Agree
14	Use risk rating matrices to prioritize identified risks according to their probability and impact	3.98	.905	Agree	3.99	.968	Agree
15	Assess driver-related risks such as fatigue, experience level, and compliance with safety regulations	4.03	1.035	Agree	3.87	.880	Agree
16	Evaluate emergency response preparedness for petroleum transport accidents and spill incidents	4.08	.827	Agree	4.29	.832	Agree
17	Assess security risks including product theft, vandalism, and unauthorized access during transit	4.09	.899	Agree	3.74	1.046	Agree

18	Assess risks related to weather conditions that may affect visibility, road safety, and tanker stability	4.19	.934	Agree	4.18	.884	Agree
19	Review incident reports and near-miss records to assess recurring risk patterns in petroleum transportation	4.21	.855	Agree	4.26	.824	Agree
	Grand Mean	4.29	.764	Agree	4.05	.944	Agree

Table 2 shows the mean ratings and standard deviations of petroleum product transport operators and transport supervisors on risk assessment strategies in the transport and logistics of petroleum products in Rivers State. The findings indicate that both categories of respondents agreed that the listed items represent effective risk assessment strategies, as all mean values were above the acceptable decision point. Petroleum product transport operators recorded a grand mean of 4.29 (SD = 0.76), while transport supervisors recorded a grand mean of 4.05 (SD = 0.94), indicating a high level of agreement by both groups. High mean ratings were observed for assessing the likelihood of tanker accidents, evaluating the severity of spills and fires, reviewing incident and near-miss records, and assessing weather-related risks. Although minor differences existed in the mean responses of the two groups, the standard deviation values suggest a reasonable level of consistency in their perceptions. Overall, the results demonstrate that systematic evaluation of operational, mechanical, environmental, and security-related risks is widely recognized as essential for effective risk assessment in petroleum product transportation in Rivers State.

Research Question 3: What are the risk mitigation and monitoring strategy in transport and logistics of Petroleum Products in Rivers State?

Table 3: Mean and Standard Deviation on risk mitigation and monitoring strategy in transport and logistics of Petroleum Products.

S/NO	Items: What are the risk mitigation and monitoring strategies in transport and logistics of petroleum products in Rivers State?	Petroleum product transport operators			Transport supervisor		
		$\bar{X}$	SD	RMK	$\bar{X}$	SD	RMK
21	Use certified and roadworthy tanker vehicles equipped with safety devices such as fire extinguishers and spill kits	4.32	.828	Agree	4.04	1.107	Agree
22	Implement regular vehicle maintenance and inspection schedules to prevent mechanical failures during transit	4.06	.770	Agree	4.95	.863	Agree
23	Enforce compliance with petroleum transport regulations, permits, and safety standards	4.15	.936	Agree	4.06	.940	Agree
24	Install tracking and monitoring systems such as GPS and telematics to monitor tanker movement and driver behavior	4.18	.882	Agree	4.08	.967	Agree
25	Apply route planning and journey management strategies to avoid high-risk roads and congested areas	4.26	.859	Agree	4.17	.895	Agree
26	Conduct regular safety audits and inspections to monitor compliance with risk control measures	4.03	.908	Agree	4.24	.959	Agree

27	Provide continuous training and refresher courses for drivers and logistics personnel on safety and emergency response	4.27	.905	Agree	4.23	.936	Agree
28	Ensure availability and proper use of personal protective equipment (PPE) during loading, offloading, and emergency situations	4.01	.930	Agree	4.17	.890	Agree
29	Establish emergency response plans, including spill containment and fire control measures, for petroleum transport incidents	3.92	.972	Agree	4.17	.943	Agree
30	Monitor incidents, near-misses, and safety performance indicators to enable continuous improvement in petroleum logistics operations	3.95	.941	Agree	3.98	.947	Agree
Grand Mean		4.11	.58	Agree	4.12	.634	Agree

Table 3 presents the mean ratings and standard deviations of petroleum product transport operators and transport supervisors on risk mitigation and monitoring strategies in the transport and logistics of petroleum products in Rivers State. The results indicate that both groups agreed that the identified practices are effective risk mitigation and monitoring strategies, as all item mean scores exceeded the decision benchmark. Petroleum product transport operators recorded a grand mean of 4.11 (SD = 0.58), while transport supervisors recorded a grand mean of 4.12 (SD = 0.63), reflecting a high and closely aligned level of agreement between the two groups. High mean ratings were observed for the use of certified tanker vehicles, route planning and journey management, continuous training of personnel, and the installation of tracking and monitoring systems. The relatively low standard deviation values suggest consistency in respondents' perceptions. Overall, the findings indicate that the adoption of preventive controls, regulatory

compliance, continuous monitoring, and emergency preparedness measures is widely recognized as essential for mitigating risks and enhancing safety in petroleum product transportation and logistics in Rivers State.

Hypotheses

H_{01} There is no significant difference between the mean responses of petroleum product transport operators and transport supervisors on the risk identification Strategy in transport and logistics of Petroleum Products in Rivers State.

Table 4: t-test Analysis on risk identification Strategy in transport and logistics of Petroleum Products.

Respondents	N	X	SD	α	df	t-Cal	t-Crit	RMK
Transport operators	40	3.18	0.84					
			0.05		58	2.25	1.69	Sig
Transport supervisor	20	3.51	0.64					

Table 4 presents the t-test analysis of petroleum product transport operators and transport supervisors on risk identification strategies in the transport and logistics of petroleum products in Rivers State. The results indicate that transport operators (N = 40) had a mean score of 3.18 with a standard deviation of 0.84, while transport supervisors (N = 20) had a mean score of 3.51 with a standard deviation of 0.64. At a 0.05 level of significance and 58 degrees of freedom, the calculated t-value (t-Cal = 2.25) was greater than the critical t-value (t-Crit = 1.69), indicating a statistically significant difference between the two groups. This suggests that transport supervisors perceived the effectiveness of risk identification strategies slightly higher than transport operators. The significant difference highlights variations in perception or experience between the two respondent categories, underscoring the importance of harmonizing understanding and implementation of risk

identification measures in petroleum product transport and logistics in Rivers State.

H₀₂ There is no significant difference between the mean responses of petroleum product transport operators and transport supervisors on the risk assessment strategy in transport and logistics of Petroleum Products in Rivers State.

Table 5: t-test Analysis on risk assessment strategy in transport and logistics of Petroleum Products.

Respondents	N	X	SD	α	df	t-Cal	t-Crit	RMK
Transport operators	40	3.29	0.73					
			0.05		58	2.32	1.69	Sig
Transport supervisor	20	3.57	0.62					

Table 5 presents the t-test analysis of petroleum product transport operators and transport supervisors on risk assessment strategies in the transport and logistics of petroleum products in Rivers State. The results show that transport operators (N = 40) had a mean score of 3.29 with a standard deviation of 0.73, while transport supervisors (N = 20) had a mean score of 3.57 with a standard deviation of 0.62. At a 0.05 level of significance and 58 degrees of freedom, the calculated t-value (t-Cal = 2.32) exceeded the critical t-value (t-Crit = 1.69), indicating a statistically significant difference between the two groups. This finding suggests that transport supervisors perceived risk assessment strategies as more effective than transport operators did. The observed difference highlights the need for aligned training and communication to ensure consistent understanding and implementation of risk assessment measures across all personnel involved in petroleum product transport and logistics in Rivers State.

H₀₃ There is no significant difference between the mean responses of petroleum product transport operators and transport supervisors on the risk mitigation and monitoring strategy in transport and logistics of Petroleum Products in Rivers State.

Table 6: t-test Analysis on risk mitigation and monitoring strategy in transport and logistics of Petroleum Products.

Respondents	N	X	SD	α	df	t-Cal	t-Crit	RMK
Transport operators	40	3.14	0.89					
			0.05		58	3.44	1.69	Sig
Transport supervisor	20	3.53	0.66					

Table 6 presents the t-test analysis of petroleum product transport operators and transport supervisors on risk mitigation and monitoring strategies in the transport and logistics of petroleum products in Rivers State. The results indicate that transport operators (N = 40) had a mean score of 3.14 with a standard deviation of 0.89, while transport supervisors (N = 20) had a mean score of 3.53 with a standard deviation of 0.66. At a 0.05 level of significance and 58 degrees of freedom, the calculated t-value (t-Cal = 3.44) was greater than the critical t-value (t-Crit = 1.69), showing a statistically significant difference between the two groups. This suggests that transport supervisors rated the effectiveness of risk mitigation and monitoring strategies higher than transport operators. The significant difference underscores the importance of harmonizing risk mitigation practices and ensuring consistent training and monitoring to enhance safety and operational efficiency in petroleum product transportation and logistics in Rivers State.

Discussion of Findings

The findings of this study indicate that both petroleum product transport operators and transport supervisors generally agreed that the identified practices constitute effective risk identification strategies in the transport and

logistics of petroleum products in Rivers State, as evidenced by mean scores above the decision benchmark. This consensus suggests a shared recognition of the importance of systematically identifying mechanical faults, operational weaknesses, environmental hazards, and security threats as foundational elements of effective risk management in hazardous materials transportation. This result aligns with the assertions of Aven (2016) and ISO (2018), who emphasized that early and structured risk identification is critical for preventing accidents and minimizing losses in high-risk industries such as petroleum logistics. Furthermore, the t-test results revealed a statistically significant difference between transport operators and transport supervisors regarding risk assessment strategies, with supervisors perceiving these strategies as more effectively implemented. This disparity may be attributed to differences in professional roles, experience, and exposure to formal risk evaluation processes, as supervisors are often more involved in planning, monitoring, and compliance activities (Kaplan & Garrick, 1981; OECD, 2019). The finding underscores the need for improved alignment, communication, and capacity building among all stakeholders to ensure a shared understanding and consistent application of risk assessment practices, which is essential for enhancing safety performance and operational efficiency in petroleum product transport and logistics systems.

The findings of the study revealed that petroleum product transport operators and transport supervisors both agreed that the identified items constitute effective risk assessment strategies in the transport and logistics of petroleum products in Rivers State, as reflected by mean scores above the acceptable decision benchmark. This agreement indicates a shared recognition of the importance of systematically evaluating operational, mechanical, environmental, and security-related risks in order to prevent accidents and minimize losses associated with petroleum product transportation. Such findings are consistent with the perspectives of Smith et al. (2019) and Renn (2020), who highlighted that structured risk assessment provides a sound basis for prioritizing hazards, optimizing resource allocation, and supporting decision-making in high-risk transport and logistics systems. The results further suggest that risk assessment practices are considered an essential component of safe and efficient petroleum logistics operations in Rivers State. In addition, the t-test analysis on risk assessment strategies showed a statistically significant difference between petroleum product transport operators and transport supervisors, with supervisors perceiving the effectiveness of these strategies more

positively. This difference may be attributed to variations in professional roles, experience, and levels of involvement in safety oversight and regulatory compliance, as supervisors are often more exposed to formal hazard identification frameworks and organizational safety policies (International Association of Oil & Gas Producers [IOGP], 2021; World Bank, 2022). The observed disparity underscores the need for harmonized understanding and consistent implementation of risk assessment measures through regular training, structured communication, and collaborative safety management among all stakeholders. Enhancing shared perceptions and practices in risk assessment is critical for improving overall safety performance and minimizing operational and environmental risks in petroleum product transport and logistics in Rivers State.

The findings of the study showed that petroleum product transport operators and transport supervisors both agreed that the identified items constitute effective risk mitigation and monitoring strategies in the transport and logistics of petroleum products in Rivers State, as all mean ratings were above the established decision benchmark. This agreement reflects a shared understanding of the importance of preventive controls, regulatory compliance, continuous monitoring systems, and emergency preparedness measures in reducing the likelihood and impact of petroleum transport incidents. These findings align with the position of the American Petroleum Institute (API, 2017), which emphasized that systematic risk mitigation frameworks, supported by continuous monitoring and incident prevention controls, are essential for maintaining safety and operational integrity in petroleum transportation and distribution systems. Similarly, the Center for Chemical Process Safety (CCPS, 2014) underscored that proactive hazard control, performance tracking, and emergency readiness are critical components of effective risk management in high-risk process and logistics operations.

Furthermore, the t-test analysis revealed a statistically significant difference between petroleum product transport operators and transport supervisors regarding perceptions of risk mitigation and monitoring strategies, with supervisors rating these strategies as more effectively implemented. This variation may be attributed to supervisors' closer involvement in safety planning, enforcement of standard operating procedures, compliance auditing, and performance evaluation processes (International Labour Organization [ILO], 2011). The observed disparity highlights the need for

improved coordination, regular capacity-building programmes, and strengthened monitoring mechanisms to ensure a shared understanding and consistent application of risk mitigation practices among all stakeholders. Enhancing alignment in risk mitigation and monitoring strategies is crucial for improving safety performance and minimizing operational and environmental risks associated with petroleum product transport and logistics in Rivers State.

Conclusion

With the findings made herein, it was identified that sound risk-management tools, including risk identification, risk assessment, mitigation and monitoring of any possible hazard, are recognized by both the operators of petroleum products transport business, as well as the transport supervisor, as key to the success of petroleum product transport and logistics in Rivers State. The paper has also been able to determine that systematic enumeration of mechanical, operational, environmental and security related risks along with systematic assessment of their probability and impact in addition to implementation of preventive and monitoring measures significantly reduces transport related risks. However, the existence of strong differences in how the operators of transport and supervisors perceive different elements of risk management point to the presence of critical gaps in knowledge, practice, and experience. Such disparities help highlight the urgency of more coordination and harmonisation of risk-management efforts by all stakeholders, which would strengthen quality safety performance and reduce the number of accidents, oil spills, operational interruptions in the petroleum products transportation industry in Rivers State.

Recommendations

1. Petroleum transport operators and logistics workers are supposed to undergo periodic training and refresher course that is focused on the identification of the risk, its assessment, and methods of its mitigation thus helping to instill a common sense and a certain level of uniformity in the levels of application of safety standards.
2. To increase the monitoring tools, regulatory agencies, and transport organisations should use modern technologies like GPS tracking, telematics and safety audits, which will increase the adherence to the

set procedures on the management of risk-related matters and safety in the transportation of petroleum products.

- 3 There ought to be a stronger relationship between the transport operators, supervisors, regulatory agencies, and the emergency responding agencies, the aim being to harmonise the risk-management policies, to enhance communication, and to consolidate the effective execution of the preventive and emergency recovery initiative of the petroleum transport and logistics system in Rivers State.

References

- American Petroleum Institute. (2017). *Pipeline safety management systems (API Recommended Practice 1173)*. American Petroleum Institute.
- Aven, T. (2016). Risk assessment and risk management: Review of recent advances on their foundation. *European Journal of Operational Research*, 253(1), 1–13. <https://doi.org/10.1016/j.ejor.2015.12.023>
- Center for Chemical Process Safety. (2014). *Guidelines for risk based process safety*. John Wiley & Sons.
- International Association of Oil & Gas Producers. (2021). *Guidelines for risk management in the oil and gas industry* (Report No. 631). IOGP. <https://www.iogp.org>
- International Energy Agency. (2023). *World energy outlook 2023*. IEA. <https://www.iea.org>
- International Labour Organization. (2011). *Safety and health in the transport of hazardous goods: An ILO code of practice*. International Labour Office.
- International Organization for Standardization. (2018). *ISO 31000: Risk management—Guidelines*. ISO. <https://www.iso.org>
- Kaplan, S., & Garrick, B. J. (1981). On the quantitative definition of risk. *Risk Analysis*, 1(1), 11–27. <https://doi.org/10.1111/j.1539-6924.1981.tb01350.x>

- Organisation for Economic Co-operation and Development. (2019). *Safety management in the transport of dangerous goods*. OECD.
<https://www.oecd.org>
- Renn, O. (2020). *Risk governance: Coping with uncertainty in a complex world* (2nd ed.). Routledge.
- Rodrigue, J.-P., Notteboom, T., & Slack, B. (2020). *The geography of transport systems* (5th ed.). Routledge.
<https://doi.org/10.4324/9780429346323>
- Smith, K., Jones, L., & Patel, R. (2019). *Transport risk management in hazardous industries: Strategies and best practices*. Springer.
- U.S. Energy Information Administration. (2022). *Petroleum products explained*. <https://www.eia.gov>
- World Bank. (2021). *Enhancing safety and sustainability in oil and gas transport*. World Bank Publications. <https://www.worldbank.org>
- World Bank. (2022). *Transport safety and logistics in emerging markets: Risk assessment frameworks*. World Bank Publications.