Greener Journal of Social Sciences

Vol. 13(1), pp. 87-100, 2023

ISSN: 2276-7800

https://gjournals.org/GJSC

Determinant Risk of Hazards in Shipwreck Removal Operations in Nigeria's Waterways

*Ofurumazi, Righteousness; Emeghara, Godfrey Chigozie; Nwokedi, Theophilus Chinonyerem

Department of Maritime Technology & Logistics, Federal University of Technology, Owerri, Nigeria. Email: righteousnessofurumazip(at)gmail.com
Department of Maritime Technology & Logistics, Federal University of Technology, Owerri, Nigeria. Email: Gcemeghara(at)gmail.com
Department of Maritime Technology & Logistics, Federal University of Technology, Owerri, Nigeria. Email: theophilus.nwokedi(at)futo.edu.ng

ARTICLE INFO

Article No.: *102723119*
***Type*:** *Research*
Full Text: *PDF, PHP, HTML, EPUB, MP3*

Accepted: *27/10/2023*
Published: *09/12/2023*

Corresponding Author
Ofurumazi Righteousness
E-mail:
righteousnessofurumazip@gmail.com

Keywords: *risks, hazards, shipwreck, removal-operations, waterways, Nigeria.*

ABSTRACT

The study evaluated the risk of hazards in shipwreck removal operations in Nigeria waterways. The objective of the study was among other things, to determine the determinant risk/hazard types influencing shipwreck removal operations in Nigeria waterways and the relative influences of the individual risk types. The study used a mixed method in which both primary and secondary data were used for the study. Primary data on the risk scores of the identified categories of risks of hazards affecting shipwreck removal operations was obtained from survey administered to the staff of Hurmer Marine Werks Ltd, the salvage company used as case study. The primary data was obtained by the use of a checklist administered to randomly selected sample of the staff of Hurmer Marine Werks Limited, Port-Harcourt, Nigeria. Secondary data was obtained from the records maintained by the safety department of the company, over the years. The statistical methods of major component factor analysis, and multiple regression analysis were used to analyze the data obtained. The analysis was implemented by the use of the SPSS version 20.1 statistical software. The result of the study indicates that technical risks/hazards, security risks and operational risk each with Eigen value greater than 1 (Eigen>1), significantly influence shipwreck removal operations and as a result form the determinant risk of hazards associated with shipwreck removal operations in Nigeria's waterways. The implications on policy development were discussed and recommendations were preferred on the basis of the research findings.

1.0 INTRODUCTION

Navigation on Nigeria's waterways over the years is viewed by many operators as very dangerous now due to the preponderance of shipwrecks. Nigerian Ports Authority (NPA), National Inland Waterways Authority (NIWA) and Nigerian Maritime Administration and Safety Agency (NIMASA) have responsibilities of removing wrecks found within the port channels, inland waterways and coastal shipping routes respectively. Over the years however, these authorities are believed to have failed to live up to their individual responsibilities to ensure wreck free navigable waters in Nigeria, leading to the preponderance of shipwrecks and derelicts' in Nigeria's waterways. Sulaimon Salau (2021) reports the existence of over 3,000 (three thousand) shipwrecks littering Nigeria's coastline alone, without extension to wrecks found in the inland waterways and within the port channels. This provides evidence the failure of previously awarded wreck removal contracts in the past years by the Nigeria Maritime Administration and Safety Agency (NIMASA) responsible for removal of wrecks in within the coastal shipping/sea routes and the safety of navigation in Nigeria maritime domain.

The ugly situation presented by the preponderance of shipwrecks in Nigeria's waters motivated the Federal Executive Council (FEC) of Nigeria to approve on 9th April 2021, the removal of shipwrecks and derelicts from Nigeria's waterways. This was done in a bid to make Nigeria's navigable waters safer for vessels and is expected to bring some relief to stakeholders in the shipping industry (Sulaimon, 2021; Nwokedi et al, 2019). Though the (FEC) approval according to Sulaimon (2021) was approved for the removal of shipwrecks from Badagry to Tincan Island waterways, it is viewed that wrecks in other sections of Nigeria's waters will subsequently be considered for removal and contracts awarded for such.

Thus, the current effort of the Federal Government to commence the removal of shipwrecks in Nigeria waters to promote maritime safety may not be successful if the risks and the related hazards associated with wreck removal operations are not identified, assessed and proactively managed to achieve a successful wreck removal operation.

In the context of this study, in line with the outcomes of the studies by Ahmad et al (2021), Pountoni et al (2001), we group and summarize the primary sources of risks of hazards (risk factors) associated with wreck removal operations basically considered in the study as shown in table-1 below:

Table 1: Primary sources of risks of hazards (risk factors) associated with wreck removal operations

s/n	Risk/hazard type/grouping	Specific/Individual risk/causes associated with each risk type/group	Associated occupational hazards and effects
1	Technical risks (TR)	i. Hazards related to poor use, inadequacy/lack of requisite equipment and tools (HTE) ii. Hazards related Lack of/poor technical know-how and experience (LTH) iii. Risks related to equipment maintainability problems (REM) iv. Risks related to poor work procedure (RPWP)	(i) Occupational Injury to operators (ii) Death (iii) Environmental damage, etc
2	Natural risks (NR)	(i) Hydrological conditions related to underwater and surface water operations in removal of wrecks in the marine environment where wrecks exist (HUSO) (ii) Geological conditions and operations (geological operations associated with the digging and excavation of sunken and underwater/submerged wrecks conditions (GESW) (iii) Atmospheric weather conditions prevailing in the marine environment to which the operators are exposed induces risk of occupational injury and death that hamper the wreck removal exercise (AWRW)	(iv) Occupational Injury to operators (v) Death (vi) Environmental damage, etc
3	Operational risks (OR)	i. Sudden failure of equipment/downtime (SFE) ii. Human error (HE) iii. Fleet traffic within operating location FTOL) Etc.	(i) Occupational Injury to operators (ii) Death (iii) Environmental damage, etc
4	Security risks (SR)	(i) Pirate attacks and kidnap for ransom (PAKR) (ii) Attack and Assault on operators (AAO) (iii) Deliberate Shooting at and killing of operators (DSKO)	(iv) Kidnap for ransom (v) Missing of crew (vi) Trauma and assault (vii) Occupational Injury to operators (viii) Death, etc.
5	Environmental pollution Risk (ER)	(i) oil pollution (OP) (ii) pollution by noxious chemical substances (PNCS) (iii) pollution by other dangerous materials types other than oil and noxious chemicals (PDMT)	(iv) environmental damage claims by third parties (v) damage to biodiversity (vi) Occupational Injury to operators (vii) Death, etc

Source: prepared by the author.

To overcome the disrupting negative influences of the identified risk types associated with wreck removal and limit the effects of the related hazards in inducing the abandonment of wreck removal operations following exposure to the hazards; wreck removal contractors and companies must be able to proactively manage the risks associated with the operations and mitigate it to their own advantage. To effectively achieve this, there is serious need that they first and foremost determine which among the groups of risks constitute the determinant risk types that significantly influence and is most rampant in wreck removal operations. This is with a view to prioritizing the wreck removal risk of hazards reduction, mitigation and elimination to ensure successful wreck removal operation based on empirical information. The hazard risk assessment drive of the wreck removal of operators in the context of this study should thus aim to rank technical risk, natural risks, operational risks, security risks and environmental damage/pollution risk in order of priority by determining which among these and other risk types form the determinant risks types associated with wreck removal operations in Nigerian waters.

Part of the many challenges to the safety of navigation in Nigerian waterways is the continual failure of Nigeria Ports Authority (NPA), the Nigeria Maritime

Administration and Safety Agency (NIMASA) and the Nigeria Inland Waterways Authority (NIWA) to ensure wreck free navigable waters in Nigeria, by successfully removing shipwrecks littered in the navigable waterways. Sulaimon (2021) notes the existence of over 3,000 (three thousand) shipwrecks littering Nigeria's coastline alone. The implication of this is that it is unsafe to navigate through such waterways having the preponderance of shipwrecks which could lead to increased frequency of the occurrence of marine accidents with the associated socio-economic implications. As a result, sustainable development of the maritime industry to contribute meaningfully to the economic aspirations and goals of the Country is hampered. In line with the position of Sulaimon (2021), closely related to the problem of preponderance of shipwrecks in Nigeria's waterways is the failure of indigenous companies previously awarded wreck removal contracts in Nigeria, to successfully execute such contracts as a result of exposure to marine perils and risks of hazards associated with wreck removal in the marine environment, but which they (the contractors) did not envisage prior to the award of the contract (Sulaimon, 2021; Chima, 2017).

There is therefore a seeming problem of lack of empirical information on the part of the contractors and the coastal authorities in Nigeria, of what constitute the significant sources of risks cum categories of risks of hazards associated with shipwreck removal operations in Nigeria and which influences the success or otherwise of wreck removal operations in Nigeria's waterways. The aim of the study is thus to assess the determinant risk factors associated with shipwreck removal operations in Nigeria and the relative influences of the identified risk types.

The specific objectives of the study are:

i. To identify the determinant risk factors associated with shipwreck removal operations in Nigeria waterways.

ii. To assess the influence of the significant risk factors on the overall success of shipwreck removal operations in Nigeria's waterways.

2. REVIEW OF RELATED LITERATURE

The Nairobi Convention of Wreck Removal (2007) defines a shipwreck as abandoned, wreckage, end-waste of a ship, representing the entirety of the hull and components of a vessel that has come to the end of her useful life, but which was abandoned in the waterways, navigation channels or deep waters, without being properly decomposed and disposed of. In the waterways, it represents a hazard and a major source of collision and accident to operational vessels navigating in proximity to the area of the wrecks. The Nairobi convention on wreck removal therefore provides that to promote maritime safety, coastal states must make regulatory provisions for the removal of shipwrecks in their territorial waters and navigation channels, based on the provisions of the convention. The majority of coastal states require a wrecked vessel to be removed and for the ship-owner and his liability insurers to pay for the removal. This is certainly the case if the vessel poses a threat to the environment or is a hazard to navigation. Wreck removal operations are therefore activities, actions and functions carried out and or implemented as part of the process of removing shipwrecks from the waters to enhance maritime safety and limit environment pollution from wrecks Nairobi Convention, 2007). It involves and encompasses all the processes and activities associated with the planning and physical action of removal wrecks from the waterways. Impact assessment, rigging, digging, and excavation, lifting exercise, breaking-up components of wrecks, hazard identification and risk analysis, risk/hazard control among other activities among the considered parts of the shipwreck removal operations. Thus, in the context of this study, we define shipwreck removal operations as activities and functions implemented by the salvor in the course of a shipwreck removal exercise as defined in the Nairobi convention, 2007.

Osha (2013) define a hazard as any source of potential damage, injury, harm, death, adverse health effects devaluation or devaluation on a person or piece of property. Basically, a hazard is the condition or system with the potential to harm or cause unpleasant adverse effect o a person or property exposed to it (Osha, 2013). For example, exposure to fire can cause injury to persons affected by it and cause economic devaluation/loss to properties exposed to it. Sometimes the resulting harm may also is referred to as the hazard instead of the actual source of the harm. Thus, the occurrence of hazards leads to harm, injury, death, loss, etc. Osha (2013) notes that risks are expressed as a probabilities or likelihood of occurrences in which it depicts a measure of the likelihood or probability that harm, injury, death, pollution, damage, etc will occur following exposure to hazards. Osha (2013) also notes that several factors influence the degree or likelihood of risk which are:

- the nature of the exposure: how much a person or property is exposed to a hazardous thing or condition (e.g., several times a day or once a year),
- how the person is exposed (e.g., breathing in a vapour, skin contact), and
- the severity of the effect. For example, one substance may cause severe injury.

Shipwreck removal operations such as lifting, digging and excavation, breaking-up of components, rigging, etc. are activities which take place in the marine environment and each is associated with specific hazard types with occurrence probabilities/likelihoods. The likelihoods of occurrence of the identified hazard

types and the associated injury and harm in the course of shipwreck removal are referred to as risk of hazards associated with shipwreck removal operations, in the context of this work. Several other definitions of risk abound. For example, Iqbal et al (2011) argues that uncertainty should be included in the definition of risk and Suggests that probability is only a tool to express or represent uncertainty and that risk is not limited to an initiating event, its consequences and the associated probabilities. Iqbal et al (2011) further discusses that probabilities assigned are based on background information and assumptions that could hide uncertainties and prevent them from receiving proper attention. Iqbal et al (2011) define risk as the "uncertainty about and severity of the consequences (or outcomes) of an activity with respect to something that humans value". ISO (2009) also includes uncertainty and defines risk as the "effect of uncertainty on objectives".

Cherniack et al (2004) stated three stages of risk assessment including risk identification, risk estimation, and risk evaluation. Malherbe, & Mandin (2007) claimed that the most important step in the process of risk assessment is the selection and definition of the risk categories, which can be weighted, compared and quantified. Cherniack et al (2004) identified the following five steps for risk evaluation:

(a). **Hazard Identification**: To determine the incident scenarios, hazards and hazardous events, their causes and mechanisms.

(b). **Consequence Analysis**: To determine the extent of the consequences of identified hazardous events.

(c)**. Frequency Estimation**: To determine the frequency of occurrence of identified hazardous events and the various consequences.

(d). **Risk Summation**: To determine the risk levels.

(e). **Risk Assessment**: To identify if the risk is tolerable/intolerable and to identify risk reduction or mitigation measures and prioritize these using techniques such as risk ranking and cost-benefit analysis. These elements are shown in the flow in Figure-1 below. The elements of the procedure are used both to generate information and as an aid to decision making in managing the risk.

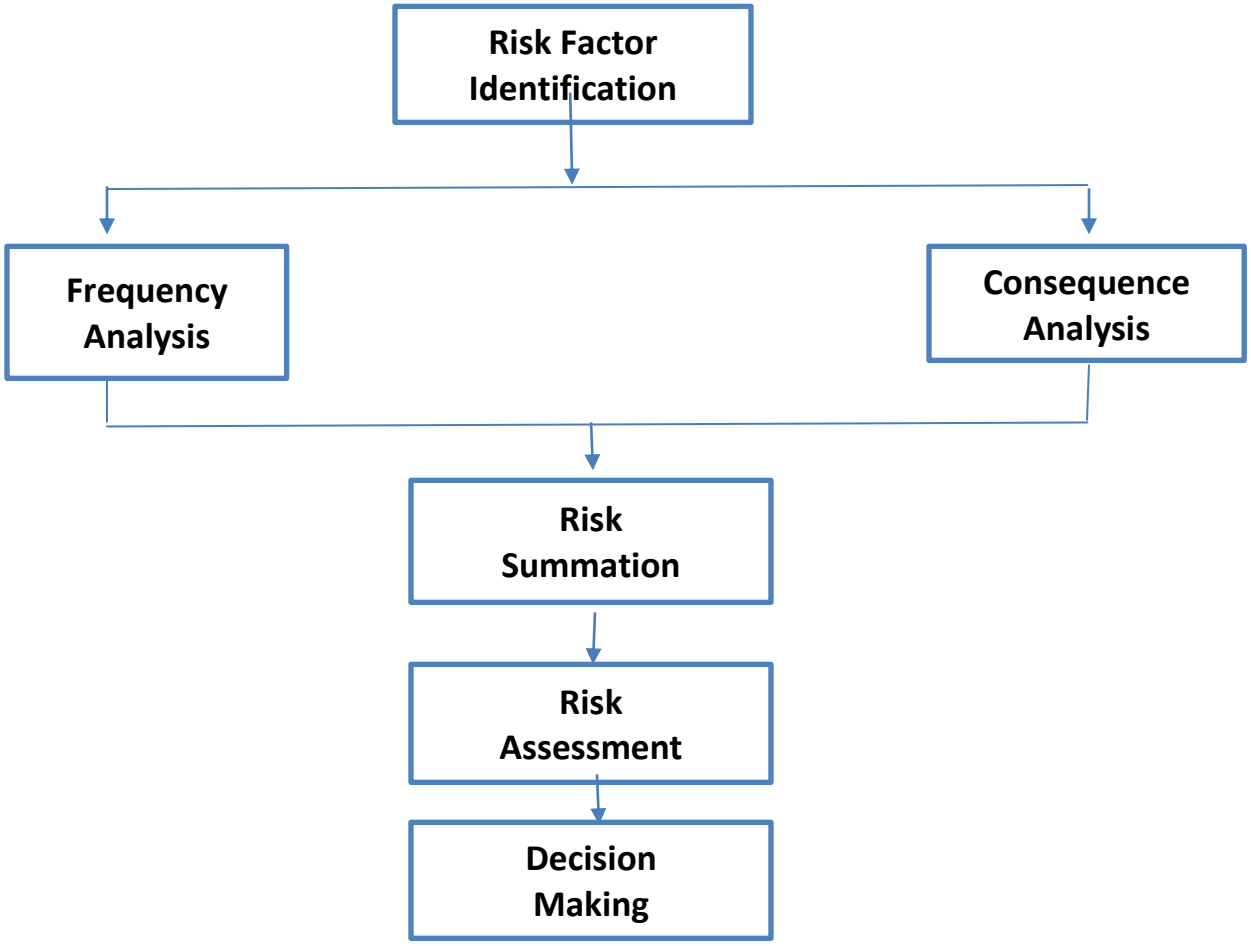

Figure 1: Risk Evaluation Process

In the implementing the first step of the risk evaluation methods, studies by Kern (2016), Ventikos et al (2014), Lee (2020) and Tsavliris (2020) have common agreement on the likelihood sources of risk of hazards in shipwreck removal operations as shown in table-3 below. Risk factor identification is the first step in the process of risk evaluation and it produces a list of risks that impacts on shipwreck removal operations (Ahmad et al, 2021, Ventikos et al, 2014), and it is an important stage in the risk evaluation process because decision-makers can become aware of the unfavorable factors in the projects by risk identification.

Ventikos, Koimtzoglou and Louzi (2014) carried out a study on 'Shipwreck: A Crisis with Challenging Solutions'. The objectives of the study among other things was to assess the methods of shipwreck removal and the risk prevalent with the use of each identified method with a view to guide workers against injury and other risks of hazards associated with shipwreck removal operations. The study employed the case study approach and survey method to illustrate the stages of involved in shipwreck removal operations as well as the parameters that affect the success of the process. Ventikos, Koimtzoglou and Louzi (2014) outlined a number of different scenarios of the most common techniques in order to demonstrate which one is the better fit for the particular case while identifying how to overcome injury risks and hazards associated with the individual methods. The generally highlighted the difficulties that arise in shipwreck removal operations and offer a structured methodology for the planning stage of such a process.

The result identified environmental hazards and weather conditions as major factors influencing the choice of shipwreck removal method as well as the success of a shipwreck removal operation. It further explained that wave action, wide force, water currents, water resistance, and buoyance levels prevailing in the marine environment greatly retard the the progress of shipwreck removal operations and could form major environmental hazards and risk factors (Ventikos, et al 2014). The result of the study also shows that mechanical lifting method of shipwreck removal is associated with the most hazards and risk of accidents as it is associated with both fall, vibration, noise, and other forms of hazards.

Kern (2016) carried out a study in title 'Wreck Removal and the Nairobi Convention—a Movement toward a Unified Framework'. The study was aimed at investigating from a legal perspective, the responsibilities of the stakeholders a shipwreck removal operation in line with the 2007 Naira Convention on Shipwreck removal. The study used the exploratory survey methods to examine from legal perspectives the responsibilities of owners and coastal authorities in a shipwreck removal operation as enshrined in the Nairobi Convention on shipwreck removal. The findings of the study shows that while the 2007 Nairobi convention on wreck removal provided the much needed framework for removal of shipwreck from navigable waters, it gives the coastal state the authority to institute regulatory measures to ensure immediate and or speedy removal of shipwrecks from the water channels while also emphasizing the it is the liability of the registered owner(s) of the ship bear the cost associated with shipwreck removal operations. Thus, the study notes that it is the responsibility of the registered owners to remove the wreck or fund the wreck removal operation while noting that the responsibility of the coastal state should be to identify the registered owner and the flag state of the ship, so that communication to remove the wreck can be communicated to the owner via the flag state. However, given the risky nature of shipwreck removal operations, the registered owners in a bid to limit the cost of wreck removal operations over the years have continued to avoid a holistic conduct of impact assessment as well as the determination of major risks of hazards associated with wreck removal operations. This has led to occurrences of severe occupational injuries to wreck removal workers and environment damages to third parties with little or no care rendered by both the registered owners and the coastal state (Kern, 2016).

Lee (2020) in another study on the ' Design of a wreck removal method considering safety and economy' assessed the ways of selected shipwreck lifting methods that will guarantee the safety of the workers and the marine environment while also offering advantages of economy and cost to the registered owner whose liability it is to remove shipwrecks. The study notes that selecting a proper lifting method for wreck removal is one of the most important procedures when planning a salvage operation. For this, both the safety and economy should be considered to prevent accidents and reduce time and cost. The study proposed that the evaluation and verification of safety and economy should be a major consideration in the choice of methods for shipwreck removal operations. It used a simulation based on multi-body dynamics is used to assess the safety of the lifting method. In particular, it used the experimental design approach and primary data to implement a model to calculate the contact and friction of the wire when lifting the ship to simulate the wire-wrapping method. In conclusion, it proposed a method of estimating the total salvage cost and an economic evaluation by comparing the results of various lifting methods.

Muhammad (2013) carried out a study on the Health hazards and risks vulnerability of ship breaking workers: A case study on Sitakunda ship breaking industrial area of Bangladesh.

The study notes that Ship breaking activities are facing both challenges and opportunities for coastal zone management in a holistic manner with increase of its demand of raw materials for re-rolling mills and other house hold purposes inspite of various negative impacts on coastal environments in Chittagong region of Bangladesh. The aim of the study was to find out the

socioeconomic condition and health hazard risks of workers due to ship breaking activities at the Sitakunda ship breaking industrial area in Chittagong region of Bangladesh. The study used a mixed method, employing both primary and secondary sources of data during the period of September 2012 to August 2013. It found that the socio economic condition of the ship breaking workers indicated that most of the workers are working at the ship yards with low facilities, risky and vulnerable by health and diseases. It was observed from the survey that most of the workers came from poverty stricken regions of Bangladesh, where opportunity of employment is very poor or less. The survey revealed that 59.59% of workers are migrated from different districts and 40.40% workers are permanently living in the study area or the Chittagong. It found that the most prevalent common hazards and risks of ship breaking activities are in five categories namely; Serious accident related hazard, Physical hazards, Mechanical hazard, Biological hazard and Ergonomic and Psychological hazard on workers as well as residences nearest the breaking yards in the study area (Muhammad, 2013).

Kutub, Nishat, Shahreen and Yasin (2017) did a research on 'Ship Breaking Industries and their Impacts on the Local People and Environment of Coastal Areas of Bangladesh'. The study notes that the coastal area of Bangladesh is one of the most ecologically productive and it contains a rich biodiversity which includes several species that are endemic to this region. It observed that much attention has been focused on ship breaking industries in the coastal areas because of the threat they pose to this thriving biological communities along with their other environmental impacts and the perilous working environment of the workers. The study adopted an exploratory survey design method. It found that the coastal environment of Sitakunda is severely contaminated by various processes related to ship breaking i.e. the disposal of different toxic wastes into the sea water, deforestation by expanding ship breaking yard, changing land-use pattern and release of toxic substance into the soil. Moreover, the workers of this industry are exposed to an extremely risky and toxic working environment which makes them vulnerable to both physical and psychological disorder as well as to accidental deaths and injury. Still, workers embrace these risks for very poor wages and most of the profits go to the already rich businessmen. Despite various negativities, this industry has gained importance due to the increasing demand of raw material for re-rolling industries and employment opportunities for the people of the coastal areas (Kutub, Nishat, Shahreen and Yasin, 2017).

Though, several empirical studies such as the works of Ventikos, Koimtzoglou and Louzi (2014), Kern (2016), Lee (2020) and Kutub, Nishat, Shahreen and Yasin (2017) have investigated shipwreck removal operations in from various perspectives. However, none of the studies has been able to provide evidence on which among the identified hazard categories and individual hazards types constitute the determinant/major hazard types that hamper the most, shipwreck removal operations, particularly in Nigeria marine environment and waterways and the relative influences of the identified risk/hazard types. There is therefore a seeming information gap on what constitute the significant sources of risk of hazards associated with shipwreck removal operations in Nigeria and ranking of the influences of each identified hazard category on the success or otherwise of wreck removal operations in Nigeria's waterways.

3.0 DATA AND METHODS

The study used a survey research design method, employing primary data sourced from Humer Marine Wreck Limited. The primary data was sourced using questionnaire as survey instrument to obtain data from the staff of the organization especially staff in the safety and operations department on their ratings and perceptions of the influences of technical risk factors, natural risk factors, operational risk factors, security risks and environmental pollution risks factors on the success of wreck removal operations. Also, their rating of the influences of individual risk of hazards in each group of risk factors was obtained through survey. The groups of risk factors and the individual risk of hazards considered in the survey instrument are as shown below:

Table 2: Wreck Removal Risk Types and the associated Hazards

s/n	Risk type/grouping	Specific/Individual risk/causes associated with each risk type/group	Associated occupational hazards and effects
1	Technical risks (TR)	i. Hazards related to poor use, inadequacy/lack of requisite equipment and tools (HTE) ii. Hazards related Lack of/poor technical know-how and experience (LTH) iii. Risks related to equipment maintainability problems (REM) iv. Risks related to poor work procedure (RPWP)	i. Occupational Injury to operators ii. Death iii. Environmental damage, etc
2	Natural risks (NR)	i. Hydrological conditions related to underwater and surface water operations in removal of wrecks in the marine environment where wrecks exist (HUSO) ii. Geological conditions and operations (geological operations associated with the digging and excavation of sunken and underwater/submerged wrecks conditions (GESW) iii. Atmospheric weather conditions prevailing in the marine environment to which the operators are exposed induces risk of occupational injury and death that hamper the wreck removal exercise (AWRW).	i. Occupational Injury to operators ii. Death iii. Environmental damage, etc
3	Operational risks (OR)	i. Sudden failure of equipment/downtime (SFE) ii. Human error (HE) iii. Fleet traffic within operating location FTOL) Etc.	i. Occupational Injury to operators ii. Death iii. Environmental damage, etc
4	Security risks (SR)	i. Pirate attacks and kidnap for ransom (PAKR) ii. Attack and Assault on operators (AAO) iii. Deliberate Shooting at and killing of operators (DSKO)	i. Kidnap for ransom ii. Missing of crew iii. Trauma and assault iv. Occupational Injury to operators v. Death, etc.
5	Environmental pollution risk (ER)	i. oil pollution (OP) ii. pollution by noxious chemical substances (PNCS) iii. pollution by other dangerous materials types other than oil and noxious chemicals (PDMT)	i. environmental damage claims by third parties ii. damage to biodiversity iii. Occupational Injury to operators iv. Death, etc

Source: prepared by the author.

Respondents were also allowed to identified and include any other risk factors or group as well as individual hazards not included above from available literature, but which they feel also affect the success of wreck removal operations in Nigeria.

3.1 Population of the Study and Sampling Technique

The population of the study consists of the about 30 workers in the company with specific attention on operational staff and staff who work in the Health safety and Environment (HSE) department of the company. From this population, samples were randomly selected and the survey instrument (questionnaire and checklist) delivered to each respondent. For the purpose of conducting the survey, the study adopted a purposive random sampling technique in which the responses of workers in the company were purposively sampled randomly. The reason for the purposive random sampling was because these employees in operational and HSE department were the ones that are most often directly exposed to the occupational risk of hazards in shipwreck removal operations more than other categories of workers who work in the offices.

The sample size was determined by the use of Taro Yammane formula for determination of sample for known population that:

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

Where :

n= sample size required
N = number of people in the population
e = allowable error (%) = 0.05
n = 27.9 = 28 employees.
The sample size consists of 28 employees mostly in operational and HSE section of the company randomly sampled.

3.2 Method of Data Analysis

3.2.1 Principal Component Factor Analysis (PCA)

The study was designed to assess the risk factors cum hazards associated with shipwreck removal operations in Nigeria. The study used a mixed design method comprised of the use of primary data from survey and secondary data obtained from company's historical records. A questionnaire was used as survey instruments to gather primary data from mostly operational and HSE staff of the organization on their perceptions of the level of influences of groups of risks of hazards associated with shipwreck removal operations in Nigeria's waterways with a view to determining the determinant risk groups/types that influence most, the successfulness of shipwreck removal operations in Nigeria. The principal component factor analysis (PCA) statistical method was used to analyze the data obtained from field survey in order to determine the determinant risk types that influence the success of shipwreck removal operations. The hazard/risk categories considered as earlier mentioned are:

(i) Technical risks (TR)
(ii) Natural risk (NR)
(iii) Operational risk (OR)
(iv) Security risk (SR)
(v) Environmental pollution risk (ER)

The individual risks/hazards that form the components of each of the above categories of risk of hazards associated with shipwreck removal operations were discussed in previous sections under table-1. The analysis was implemented using SPSS version21 analytical software.

3.2.2 Multiple Regressions

Using the multiple regression model approach, the relative influences of each group of risk factors (categories of hazard) on the overall rating of on the success of shipwreck removal operations was determined. If represent the respondents rating of the overall level of influence of the risks/hazards on the success of a shipwreck removal operation as 'OVR'. The various categories/groups of risks of hazards associated with wreck removal operation are denoted as follows:

(i) Technical risks = TR
(ii) Natural risk = NR
(iii) Operational risk = OR
(iv) Security risk = SR
(v) Environmental pollution risk = ER

Since the over influence of the hazards (OVR) is dependent on the individual influences/weights of the individual categories/groups of risk factors, we specify the multiple regression model as follows:

$$OVR_{wrecks} = \beta_0 + \beta_1 TR + \beta_2 NR + \beta_3 OR + \beta_4 SR + \beta_5 ER + \mathcal{E} \quad \text{--------- (1)}$$

Where OVR_{wrecks} = the overall influence of risk factors associated with shipwreck removal operations on the successful completion of wreck removal operations. Other variables are as earlier defined.

Normal OLS estimation may be carried out in determining the relationship between dependent variables and the independent variables and normal hypotheses testing method for OLS estimation using t-test is used to determine the significances of the impacts/relationships.

4.0 RESULTS AND DISCUSSION OF FINDINGS

Table 3: Determining the determinant categories of factors affecting shipwreck removal operations in Nigeria.

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
TR	4.1071	.95604	28
NR	2.0714	.94000	28
OR	3.9286	.89974	28
SR	3.0357	1.42678	28
ER	2.3214	1.33482	28

Communalities

	Initial	Extraction
TR	1.000	.870
NR	1.000	.791
OR	1.000	.875
SR	1.000	.935
ER	1.000	.754

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.628	32.558	32.558	1.628	32.558	32.558
2	1.355	27.096	59.653	1.355	27.096	59.653
3	1.243	24.856	84.509	1.243	24.856	84.509
4	.616	12.327	96.836			
5	.158	3.164	100.000			

Component Matrix[a]

	Component		
	1	2	3
TR	.886	-.290	.027
NR	-.046	-.397	.794
OR	-.520	.639	.444
SR	-.641	-.449	-.567
ER	.399	.709	-.303

Extraction Method: Principal Component Analysis.[a]

a. 3 components extracted.

Table-3 above shows the result of the Principal Component factor Analysis (PCA) implemented using SPSS statistical software. The result indicates the significant risk factors which form the determinant risk of hazard categories associated with shipwreck removal operations in Nigeria. The result shows that the mean weights of technical risk (TR), natural risk (SR) and operational risk (OR) that affect the successful completion of shipwreck removal operations in Nigeria is 4.1071, 2.0714 and 3.9286 respectively with respective standard deviations of 0.95604, 0.9400 and 0.89974. The respective average scores of security risks and environmental pollution risk affecting the successfulness of shipwreck removal operation is 3.0357 and 2.3214 with respective standard deviations of 1.3382 and 1.42678.

The Eigen values which indicates the significance of the effects and influences of each category of risk factors on the completion of shipwreck removal operation shows that technical risk (TR), security risk (SR) and operational risks (OR) have respective Eigen values of 1.628, 1.355 and 1.243. The Eigen values (scores) of natural risk (SR) and environmental risk (ER) is 0.616 and 0.158 respectively. Thus, natural and environmental pollution risk factors having Eigen values/scores less than 1 (i.e: 0.616<1, for natural risks; and; 0.158<1, for environmental pollution risk) are not significant. As a result, they are not determinant risk factors that affect successfulness of shipwreck removal operations in Nigeria's waters.

Similarly, technical risks, security risks and operational risk each with Eigen value greater than 1 (Eigen>1), significantly influence the success of shipwreck removal operation and as a result form the determinant risks/hazards associated with shipwreck removal operations in Nigeria's waterways.

The policy implication is that for any shipwreck removal operation in Nigeria's waters to be successfully implemented, the operators must prioritize the implementation of risk control, reduction and elimination measures on the determinant risk factors which include technical risks, security risks and operational risks factors. This will ensure that the impacts and effects of the occurrence of risk of hazards under the categories of the determinant risk factors identified above cannot cause or lead to the abandonment of the wreck removal operation as it happened in the past years. While it is important to also implement risk control, reduction and elimination measures on the non-determinant risk factors such as security and environmental risks, the most attention should be concentrated on the significant/determinant risk factors.

The figure-4.1 below shows the presentation of the Eigen scores showing the influences of the various groups of risk factors associated with shipwreck removal operations in Nigeria waters.

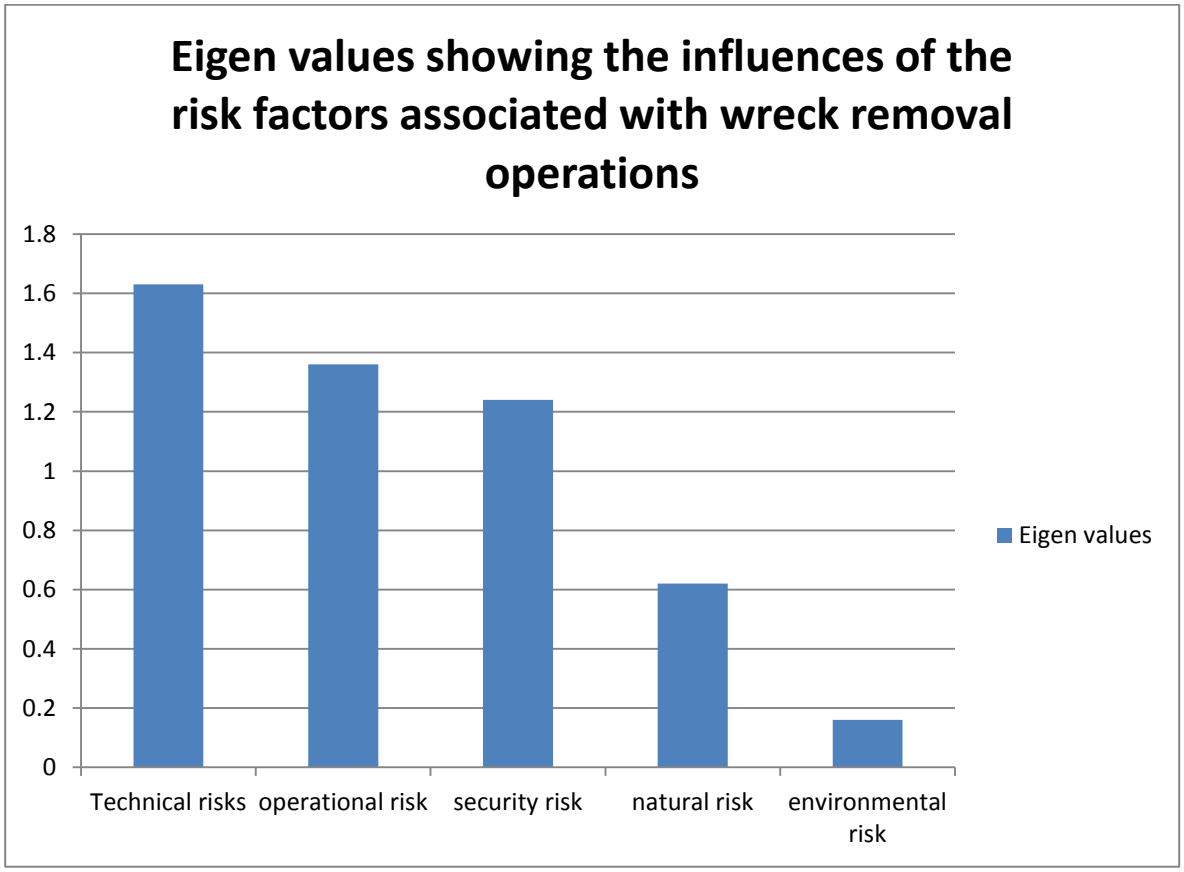

Figure 2.
Source: Prepared by author.

Table 4.: Effects of the Determinant Risk of Hazards associated with shipwreck removal on the overall rating of hazards impeding the success of wreck removal operation in Nigeria

Descriptive Statistics

	Mean	Std. Deviation	N
OVR	4.4643	.69293	28
TR	4.1071	.95604	28
OPR	3.9286	.89974	28
SR	3.0357	1.42678	28

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.810[a]	.656	-.031	.70356	1.949

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.084	3	.361	7.301	.544[b]
	Residual	11.880	24	.495		
	Total	12.964	27			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.583	1.827		1.962	.062
	TR	.036	.213	.050	.170	.867
	OPR	.066	.208	.085	.316	.755
	SR	.156	.126	.321	1.240	.227

Source: authors calculation

As seen in table-4., the result of the factor analysis carried out indicate that technical risks/hazards (TR), operational risks/hazards (ORP) and security risks/hazards (SR) constitute the determinant categories of hazards in shipwreck removal in Nigeria waters. Table-4.6 above shows the result of the multiple regression analysis implemented to assess the significance of the influence of each of the categories of the determinant risks of hazards on the success of shipwreck removal operations in Nigeria. The result of the regression analysis indicates that technical hazards/risks (TR), operational risks/hazards (ORP) and security risks (SR) have mean values of 4.4.11, 3.92 and 3.04 respectively with respective standard deviations of 0.956, 0.8997 and 1.426. The result also indicates that the coefficient of correlation R between the dependent variable and independent variables is 0.810. This indicates that there exist about 81% correlation between the technical, operational and security risks of hazards (explanatory variables) associated with shipwreck removal operation and the overall likelihood of success of the wreck removal exercise (explained variable). The R-square value of 0.656 indicates that technical, operational and security risks faced by salvors in shipwreck removal exercise explain about 66% of the total variations in the overall success rating of a shipwreck removal exercise, leaving about 34% unexplained variations. The regression model showing the relationship between the overall success rating of a shipwreck removal exercise and the determinant risk of hazards associated with shipwreck removal exercise is as shown below:

OVR = 0.036TR + 0.066OPR + 0.156SR + e -------- (2)

The implication is that for every unit increase in the exposure of wrecks and salvors to hazards/risks of technical nature, the overall risks faced by salvor in delivering the project increases by 0.036 while it increases also by 0.0660 for each unit increase in exposure of shipwrecks and salvors to operational risk types. Similarly, a unit increase in the rate of exposure of salvors to security hazards/risks will increase the overall risk of hazards faced by salvor in shipwreck removal operations by 0.15. The policy implications is that in order to decrease the overall risks of hazard to which salvors are exposed in shipwreck removal operations and ensure the success of the operations, the technical risks, operational risks, and security risks which formed the determinant risk types must be continually reduced and mitigated.

Table-5: Estimating the significance of the joint effects of the determinant risk factors in shipwreck removal operations

Variables	df	F-score	F-critical	Sig.
TR, OR, and SR	**3**	**7.301**	**2.93**	**.0544b**

Source: Authors calculation

The test of the significance of the independent variables shows f-score of 7.301, f-critical of 2.93, p-value of 0.054 at 3 degree of freedom (df). Since 7.301>2.93 (f-score>f-critical), we conclude that there is a significant effect of technical risks, operational risks and security risks on the overall rating of the influence of risks of hazards on the success or otherwise of shipwreck removal operations in Nigeria. See table-4.8 below for the test of significance of the individual risk/hazard types.

Table-6: Estimating the significance of the individual effects of the determinant risk factors in shipwreck removal operations

Variable	t-cal.	t-critical	p-value/sig.	Decision
TR	0.170	2.10	0.867	Non-significant
OR	0.316	2.10	0.755	Non-significant
SR	1.240	2.10	0.227	Non-significant

Source: Authors calculation. Non-significant *if P-value>0.05; significant if p-value<0.05*

The result on table-6 indicates that technical risks, operational risks and security risks have respective t-values (t-cal.) of 0.17, 0.316 and 1.240. Since for technical hazards/risks, 0.170<2.10; (t-cal.<t-critical); we conclude that there is no significant effect of technical hazards on the overall rating of risks of hazards associated with and affecting shipwreck removal operations in Nigeria. Similarly, for operational hazards, 0.316<2.10 (t-cal.<t-critical). Therefore, there is no significant impact of operational hazards on the overall rating of the risk of hazards influencing the success of shipwreck removal operations in Nigeria. Furthermore, the test of significance of security hazards shows that 1.24<2.10; indicating also that there is no significant effect of security hazards on the overall rating of of the influence of risk of hazards on the success of shipwreck removal operations in Nigeria. Though individually these determinant hazards shows no significant effects, the F-test shows that their joint impact significantly influence the overall rating of the influence of risk of hazards on the success of shipwreck removal operations in Nigeria.

5.0 CONCLUSION

Welding & cutting hazards, chemical fumes and dust inhalation hazards, and noise hazards with Eigen value for each exceeding 1 (Eigen value>1), constitute the determinant hazards of the shipbuilding and repair industry in Nigeria. However, exposure to welding & cutting hazards achieves the highest Eigen value of 2.813and as such, remains the most source of risks of injuries and illnesses to dockworkers in the shipbuilding sector. Also, electrical hazard, vibration hazard, fire & explosion hazard, fall hazards (slips & trips), and biological hazards, each of them achieving Eigen value lower than 1 (e.g: -9.067E-007<1); does not significantly influence the level of risks of injury and illness faced by dockworkers in the shipbuilding and repair sector in Nigeria.

6.0 RECOMMENDATIONS

From the foregoing, it is recommended that:

(i) The shipbuilding and repair industry in Nigeria in order limit the occurrence of physical injuries, work related illness and death of dockworkers as a result of exposure to occupational hazard in the shipyards should strategically focus of the determinant hazards associated with shipbuilding and repair operations which include: welding & cutting hazard, chemical fumes & dust inhalation hazards and noise hazards.

(ii) Hazard control methods should prioritize the control of dockworkers exposure to welding & cutting hazards since this is the source of most physical injury and illness in the shipyard as shown by the result of the study.

(iii) The proper use of personal protective equipment (PPE) is recommended to address frequent burns injury which is the most injury suffered by dockworkers as a result of exposure to welding & cutting hazards.

(iv) Similarly, cuts, bruises and arc eye injury associated with exposure to welding & cutting injury should be limited by the compulsory and appropriate use of PPE.

REFERENCES

.

Ahamad, A.F.; Schneider, P.; Khanum, R.; Mozumder, M.M.H.; Mitu, S.J.; Shamsuzzaman, M.M. (2021) Livelihood Assessment and Occupational Health Hazard of the Ship-Breaking Industry Workers at Chattogram, Bangladesh. Journal of Marine. Science & Engineering, 9 (718) 2-22. https://doi.org/ 10.3390/jmse9070718.

Chima J.(2017) Arbitration as a conflict resolution approach to oil spill compensation payment in oil producing Communities of rivers state, Nigeria. *International Journal of Advanced Legal Studies and Governance,* 2(1)17 – 32

Cherniack,M.,Brammer,A.J.,Lundstrom,R.,Meyer,J.,Morse,T.F.,Nealy,G.,&Fu,R.W.(2004).Segmental nerve conduction velocity in vibration-exposed shipyard workers. International archives of occupational and environmental health, 77(3),159-176

International Maritime Organization (IMO,2007) Nairobi Convention on Wreck Removal 2007. Available at: http//www.imo.rog. Retrieved on 13/10/2021

Iqbal, K.S., Zakaria, N.G.,& Hossain, K.A.(2011) Identifying and Analysing Underlying Problems of shipbuilding Industries in Bangladesh. Journal of Mechanical Engineering,41(2),147-158.

Kern J.M (2016) Wreck Removal and the Nairobi Convention—a Movement Toward a Unified Framework? Frontiers in Marine Science 3(11) Pp:1-10. Doi: 10.3389/fmars.2016.00011

Kutub, M., Pinto, C., Magpili, L.,& Jaradat, R (2015) Operational Risk Management: Momentum press, USA.

Lee J .P (2020) Design of a wreck removal method considering safety and economy. Journal of Transport safety and security 4(3)1037-1056. https://doi.org/10.1080/17445302.2019.

Muhammad M. (2013) Health hazards and risks vulnerability of ship breaking workers: A case study on Sitakunda ship breaking industrial area of Bangladesh. *Global Advanced Research Journal of Geography and Regional Planning (ISSN: 2315-5018) Vol. 2(8) pp. 172-184.* Available online http://garj.org/garjgrp/index.htm

Malherbe, L.,& Mandin, C.(2007) VOC emissions during outdoor ship painting and health-risk assessment. Atmospheric environment, 41(30),6322-6330.

Nwokedi T. C., Kalu D. I., Ibe C.C., Igboanusi C.C., Gbasibo L.A., Odumodu C.U. (2019) Constraint Theory Approach Analysis of the Nigerian Shipbuilding Industry. *LOGI – Scientific Journal on Transport and Logistics Vol. 10 No. (1) 50-61. DOI: 10.2478/logi-2019-0006,*

OSHA (2013) Occupational Safety and Health Standards in Shipyard Industry. US Department of Labor. No.: OSHA 2268-11R.

Puntoni, R., Merlo,F., Borsa,L., Reggiado, G., Garrone, E., & Ceppi, M.(2001) A historical cohort mortality study among shipyard workers in Genoa Italy. American journal of industrial medicine, 40(4),363-370.

Suleman Salau (2021) Government to spend N10 billion on shipwreck removal. https://guardian.ng/business-services/maritime/government-to-spend-n10-billion-on-shipwreck-removal/

Tsavliris A., (2020) Wreck removal issues–the contractors' perspective. International Salvage Union. A working document.

Ventikos N.P., Koimtzoglou A., & Louzis K. (2014) Shipwreck: A Crisis with Challenging Solutions. Journal of Risk Analysis and Crisis Response, Vol. 4, No. 3 (September 2014), 160-174.

Cite this Article: Ofurumazi, R; Emeghara, GC; Nwokedi, TC (2023). Determinant Risk of Hazards in Shipwreck Removal Operations in Nigeria's Waterways. *Greener Journal of Social Sciences*, 13(1): 87-100.